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Handling of red tart cherries for processing—a review

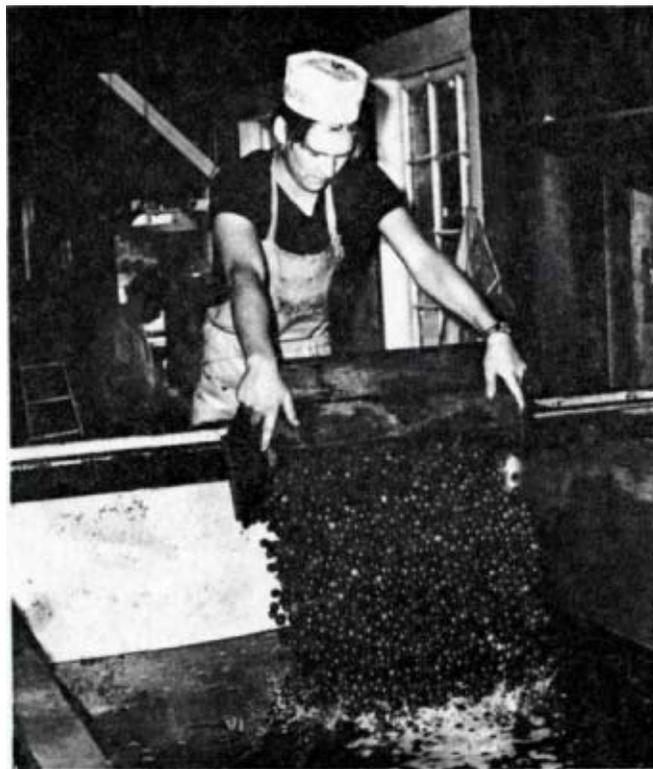
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There appears to be considerable interest now in handling cherries from tree to pitting line exclusively in half-ton pallet tanks in order to reduce rehandling damage to the fruit. The development of this operation has covered quite a time span, and it was felt desirable to bring the important facts together.

Historically, the harvesting and handling of fruit has been done by hand and has been considered one of the most expensive operations associated with the production of cherries. The expense is not only that of labor but also in the loss of fruit and fruit quality due to excessive handling. The initial bruising occurred when the fruit was picked into a pail or similar type container. When the picking containers became filled, the cherries were dumped into lug boxes that held 25 to 30 pounds. The grower then delivered the lugs of cherries directly to the processing plant or to a nearby receiving station where large trucks continued the haul to the processing plant.

Once at the plant, the contents of the lug boxes were dumped into large tanks for soaking and storing. The benefits from soaking cherries in cold water for several hours prior to pitting were recognized as early as 1918 (8). In 1954, it was realized that cherries could be transported from the orchard to the processing plant suspended in water in large metal tanks. Such cherries arrived at the plant in better condition than those transported in lug boxes, and in addition, the soaking process was

under way enroute (1). Unfortunately, some lug boxes and even baskets are still used (Fig. 1).



In the late 1950's when mechanical harvesting came into being, it was realized that any gains in harvesting efficiency achieved at the expense of fruit quality would be no real gain. The sooner the fruit got into chilled water, the better the fruit quality (7). With this information ever in mind,

chilled water tanks were soon attached to the mechanical harvester catching frame.

One major problem remained in eliminating unnecessary rehandling of cherries from the tree to the processing operation, and that was the dumping of fruit from the bulk chill tanks for weighing and conveying to the processor's soak tank.

In order to eliminate the dumping and rehandling of cherries for weighing, a method of measuring the quantity of cherries in a bulk tank had to be devised. Some novel approaches to the handling and processing of cherries were proposed in 1960 (3) based on work done at Cornell University's New York State Agricultural Experiment Station at Geneva. In 1965, a model of processing facilities designed around the exclusive use of pallet tanks for handling and soaking was exhibited (4), including the use of volume measurement as at least a temporary estimate of quantity delivered to the plant. Subsequently, these ideas were developed to a practical level in Michigan with the close cooperation of all parts of the industry, including growers, processors, researchers, and the Michigan Department of Agriculture.

BACKGROUND FROM THE 1960 REPORT

Excerpts from the 1960 Report, still pertinent to the situation today, are provided here as background for this new approach to handling cherries for processing.

Bulk Handling

"The use of tanks to handle cherries in bulk has already been mentioned in connection with a completely mechanized harvest. Tank-hauling was investigated and popularized by J. H. Levin and H. P. Gaston in work begun in Michigan in 1953. They reported that hauling cherries from the orchard in cold water was not only a labor-saving method but also reduced the incidence of scald. The beneficial effects of tank-hauling on cherry quality were confirmed by subsequent tests in New York, both on a commercial scale and later in experiments on mechanical harvesting. In the latter tests, scald was found to be more than twice as severe in the lug-hauled fruit. At the same time, the tank-hauled fruit was observed to have a lower drained weight in both the canned and frozen product. This arises from the greater uptake of soak water compared to that experienced by lug-hauled fruit. The latter actually loses juice while in the lugs and is therefore less likely to bleed in the processed product.

	Lug-hauled	Tank-hauled
Scald index (0-200):		
after soak	61	16
frozen.....	25	14
canned	41	15
Drained weight, %:		
Frozen.....	94.5	93.3
Canned.....	88.8	87.0

"This uptake of water by the fruit is of more than passing interest to both grower and processor. How much water the cherry takes up depends primarily on the degree of bruise present and on the elapsed time in the water. Cherries may in some cases be so badly bruised that they actually lose weight in water. Normally, however, they will gain several per cent in weight during a 4 to 8-hour period. In the past with lug-hauled fruit, this gain has been the processor's. The weight for which he paid represented cherries which had lost some juice and which might more than regain this weight in his tanks. The grower's use of tanks to deliver the cherries in water reverses all this. It is the grower who benefits by the initial high rate of uptake, while the processor experiences very little additional gain within a reasonable soak time. It follows, therefore, that it is directly to the grower's advantage on the basis of yield to protect his fruit from excessive bruising and to deliver it to the processor in water.

Weighing Tank-hauled Cherries

"Closely related to this situation is the matter of weighing cherries which are delivered in water. The most widely used system in New York has involved draining water from the tanks and weighing the drained fruit which remains. This has the disadvantage of subjecting the fruit to movement about the yard unbuoyed by water, although this has not been definitely shown to be harmful. Also, some extra time is consumed in draining and refilling the tank. The accuracy of the weight obtained is affected by the water absorbed on the surface of the cherry and by the possibility of incomplete draining of water and ice. Water absorbed on the cherry depends on how wet the fruit was already with its own juice. The gain is about 2 per cent for cherries dry when tanked.

"Other methods suggested are subject to more basic handicaps. Weighing by the pail or lug before tanking does not lend itself to mechanical harvesting and will not be accepted by the processor anyway. In another method, the tank with water and ice only is preweighed; but when the filled tank is delivered, there is no ready proof that the water has not either been added to or spilled. Conveyor-belt scales have been used successfully,

but there is some understandable reluctance to replace or duplicate present plant scales. However, an added investment here may not be out of keeping with that currently facing the grower.

"Some study was given this weighing problem during the 1960 season in New York. Half-ton capacity tanks were used to haul cherries from receiving stations to processors. These tanks were not equipped with the usual drain but were intended to be dumped, water and fruit all at once, into the processor's tank. Since ultimately these small tanks should be filled right in the orchard, a method of weighing or estimating the weight of fruit in these tanks was needed. Such a method must, of course, be mutually satisfactory to grower and processor.

"Another approach involves estimating the weight of fruit from the volume occupied in the tank. The accuracy of this procedure depends on several factors. First, if we are to rely on a simple depth measurement either of the fruit or of the headspace to obtain the volume of fruit, the half-ton tanks must either be closely standardized or individually calibrated. Second, the weight of cherries in a standard volume—referred to as bulk density—must be fairly constant. It is the second that is more troublesome.

"Estimates of this sort were made on a number of tanks loaded with predetermined weights of cherries at the receiving stations. A simple gauge was used to measure the headspace above the leveled surface of the fruit. We immediately found that the cherries must be allowed to settle into a close-packed arrangement before a reliable depth measurement can be taken. Since this settling is accomplished during transport, the measure should be made on the delivered fruit. Probably a short trip would suffice. Buried ice must be avoided or recovered and weighed. The depth of water has no effect on the bulk density of the fruit if it at least covers the cherries.

"The second difficulty with estimating weight from volume is more fundamental. The assumption that the bulk density of cherries is constant is not correct. Individual cherries vary in specific gravity about 2 per cent. Ripe fruit with higher sugar content is more dense and would appear lighter than actual when estimated by volume. It should be possible, however, to apply a suitable correction by taking a simple reading of soluble solids content with a hand refractometer.

"Fruit firmness also affects the bulk density. Cherries are compressed in direct relation to their firmness, flattening under the weight of cherries above and reducing the spaces between. Therefore, bruised fruit or large ripe cherries which tend to be soft have a higher bulk density. Here again, the

volume-based estimate of weight would be less than the actual. Fortunately, only 7 per cent of the weight is transmitted downward when cherries are buoyed in water. This should greatly reduce the effect of firmness on bulk density. At any rate, the grower delivering excessively bruised fruit would penalize himself on weight, if estimated by volume.

"Again, a correction could readily be applied to the estimate by measuring the bulk density of a sample of cherries from the tank. Such a measurement would at the same time take into account the specific gravity of the fruit. It is convenient to use a container of about 10-pound capacity with a screen bottom to allow the water to drain off. The can must be tapped as it is filled to settle the fruit. It is important to judge the level-full condition the same each time.

"Trouble is experienced not so much from the measurement when carefully done as from sampling. As with many other commodities and containers, adequate sampling is very difficult. Yet, if correction is required, the success of the weight estimates depends directly on such sampling.

"The following data represent 16 half-ton tanks of cherries measured during the 1960 season.

	Average	High	Low
Lbs. per tank	1,140	1,306	674
Cherry depth, inches	25.5	28.7	15.2
Weight/volume, lbs./cu. ft.	47.8	51.2	45.8
Bulk density, lbs./cu. ft.	50.4	52.4	48.1
Specific gravity	1.068	1.078	1.054
Soluble solids, %	15.7	17.4	14.1

"The weight-volume ratio and the bulk density are the same thing determined in different ways. Weight divided by volume represents the whole tankful while the bulk density was determined on a 1 per cent sample. The latter is higher because cherries in the sample can are pressed more tightly together and are based on a wet weight. Unfortunately, in these tests, there was little relationship between these two figures from tank to tank, probably due to inadequate sampling. Therefore, correction of the estimates for bulk density would be meaningless here. There was, however, a trend for riper fruit to have higher bulk density. Also, specific gravity and soluble solids proved to be closely related.

"The probable error* for estimating the weight of fruit in any tank is about 1 pound per inch of depth, or 2 per cent. In practice, errors both larger and smaller would occur and in either direction. How much error is admissible is a matter for the contracting parties to decide.

*An error this great or greater would occur one chance out of two.

Processing Developments

"These anticipated major changes in harvesting and handling techniques will surely influence processing as well. Such aspects of processing as sorting and firming will be directly affected. The increase in sorting load and the desirability of performing this operation under suitable conditions have already been discussed. Tanking of cherries in the orchard obviously extends the soaking period usually employed to firm the fruit. To understand the significance of this new pattern of soaking, we must examine the results of recent research on firming of cherries.

"It has been shown that the factor chiefly responsible for the firming of cherries is the time elapsed after harvest. While soaking in water has the added effect of permitting the cherry to take up water and become more turgid, it has nothing to do with the desired toughening of the cherry flesh. Usually, both of these changes occur simultaneously. Actually holding in air is as effective as soaking, and heat is more effective than cold in toughening cherry flesh. But, of course, soaking in water has the additional benefits of buoying the mass of cherries to prevent crushing and of providing the rapid chilling required to prevent scald.

"The ideal elapsed time of holding between harvest and pitting is about 8 hours. This is long enough to permit most of the firming to occur but short enough to prevent excessive development of scald. The necessity of controlling scald makes soaking throughout the post-harvest holding period desirable. Tanking the fruit right at the catching frame accomplishes this very well.

"One factor not clearly understood is the effect of bruising the fruit during this period. Does the firming process need to start all over again after bruising? Such bruising midway in the period between harvesting and pitting often accompanies transfer from the grower's lugs or tanks to the processor's tanks. Perhaps the initial firming in the grower's tank ordinarily counts for nothing because of this. If this were so, post-harvest handling should be minimized or accomplished with great care. Flushing cherries from a tank in a high-velocity stream of water can be very damaging to the fruit if any abrupt changes in direction are encountered. This is all too common, as in flushing cherries into an elevator boot. Flushing should be done through large ducts to reduce stream velocity. Any necessary changes in direction should be accomplished by guiding the flow around smooth curves. This applies as well when the cherries flow out of the tank to the pitter.

"It clearly follows that the best technique would avoid any rehandling once the fruit is tanked in the

orchard. The half-ton tank could be delivered to the processing plant and held there until the cherries were ready for pitting. The required float-ing-off of trash and cooling in these small tanks should present no great problem other than manifolding the water supply. Tanks lacking a bottom outlet could be carefully dumped into a single reservoir continuously feeding the pitters. Such tanks might also be emptied by siphoning with pump or vacuum if it can be demonstrated that these procedures do not damage the fruit. Efforts to minimize handling should be rewarded by better quality and by lower costs.

"Lastly, we should consider the overall processing schedule. A largely outmoded procedure has been to receive most of the fruit in the evening and, after an overnight soak, to process it the next day. With this system, serious scald has occurred on hot days, and processing capacity has been overtaxed. More recently, many plants have instead instituted one or more afternoon and evening shifts in order to process the fruit the same day as harvested. Deliveries at noon have also become more common, enabling morning-picked fruit to be processed first. These trends should be encouraged."

RESULTS OF RECENT TESTS

Weight-volume relationships of tart cherries in water were investigated in 1966 in Michigan by USDA and Michigan State University scientists (5). The Michigan studies were continued in 1967 to include a variety of factors affecting the volume and density of the fruit (9). Considerable variation was found in the volumes of the tanks then in use, leading to the conclusion that each tank must be calibrated separately. The amount of water in a tank was significant and affected the amount of nesting of the cherries, that is the compacting together, which in turn affected the bulk density factor. The water level should be equal to or above the cherry level. The maximum compaction occurred in the first one-half mile of transport, and any additional distance did not seem to affect the nesting. The firmness of cherries had the most significant effect on the density; bruised cherries packed closer together with the result that weight was underestimated.

With the increased interest of growers, buyers, and processors in the buying and selling of cherries by volume, the Michigan Department of Agriculture conducted an independent study of cherry weight-volume relationships (10). The report, based on tests with more than one million pounds

of cherries, concluded that buying cherries by volume was as accurate and as fair as buying by weight.

In 1969, fifty million pounds of cherries were sold by volume in Michigan on a trial basis permitted by the Michigan Department of Agriculture with further studies being conducted by the USDA and Michigan State University scientists (5). In these latter studies, it was found that the measured volume did not depend on the individual doing the measuring.

Table 1, taken from the preceding study, shows the average pounds per cubic foot of cherries in water as determined during the 4 years of study in Michigan.

Table 1. Average pounds per cubic foot of tart cherries in water. Results are based on 4 years of testing in all areas of Michigan.

Year	Lbs. of cherries per cu. ft.	Research group
1966	47.48	USDA-MSU
1967	47.61	USDA-MSU
1968	47.44	Mich. Dept. Agr.
1968	47.52	USDA-MSU
1969	47.53	USDA-MSU
Average	47.516	

According to a survey of Michigan cherry-processing plants after the 1970 season, over 22,000 tons (39%) of the pack was retained in the original (calibrated) pallet tanks until ready for pitting (6). While it has been difficult to document the expected improvement in processing yield and quality attending the use of these new methods, everyone seems to agree that the results have definitely been encouraging.

RECOMMENDED PROCEDURE

A practical step-by-step approach to the handling and volume measurement of cherries in pallet tanks is suggested in the following summary of "how it works" (2):

1. The grower is appraised of price/cu. ft. and quality standards; e.g., water temperature 50° or less, limits on trash and stems, decay, color, etc.
2. A delivery schedule is worked out with the grower. The time unit is usually $V\%$ hour with provision made for a deviation of $\pm ^x h$ hour. The grower will require sufficient tanks for a full day's picking. To maintain quality, grower is required to deliver more than once a day. Upon

delivery of second load, he picks up his tanks from the first load.

3. Tanks are delivered to a plant, or receiving station, and placed upon a level pad. There is a minimum distance the cherries must be hauled in order to settle them. The forklift operator must exercise caution in lifting tanks from the truck as jostling or fast turns will unsettle the cherries.
4. The measurement-gauge operator measures the volume in each tank, noting on the weight ticket the tank number plus cu. ft./in. factor for that tank as indicated by the calibration tag welded to the tank. He then notes the gauge reading expressed to the nearest .02 inch. These notations are made for each tank. In practice, the fork lift remains engaged with each tank for the few seconds required to obtain a reading. Note: New tanks are designed to read 1 cu. ft./in.
5. The inspection sample is taken.
6. The tank is placed on the holding pad and chilled water hoses attached to maintain temperature.
7. At the scale house, or office, the graded value/cu. ft. is extended by the volume, and the dollar value of the load is expressed.
8. One to 2 hours later, the tanks are emptied into the plant through the use of a turning head fork lift truck or stationary dumping device.

COSTS

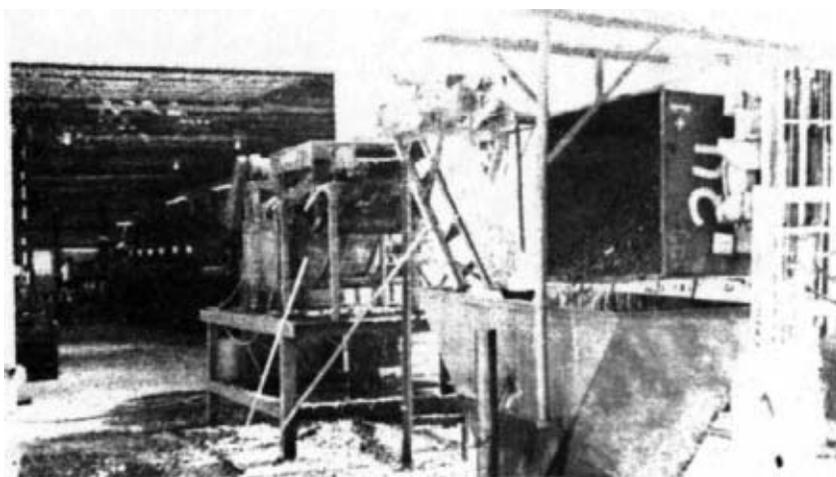
The estimated costs for equipment are as follows (2):

Costs

1. Tanks - \$40-\$75; \$60 is common
2. Tank calibration - \$4.00/tank (Michigan Weights and Measures Section of the Food Inspection Division, Michigan Department of Agriculture, Lansing, Michigan 48900 - Clyde O. Cotton, Supervisor). The common practice in Michigan is to split cost of calibration with the grower.
3. Tank measurement gauge - approximately \$225.
4. Cooling and holding pads - approximately \$800/month or dumping device, approximately \$2,500.

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New cherry-processing facilities operated by Rodney Bull on the Old Mission peninsula north of Traverse City, Michigan in 1970. Pallet tanks are kept chilled by a manifolded water supply along both sides of the building and subsequently dumped by rotary-head forklift truck directly into the pitting line.