Box Making Methods and Costs

comparison of labor and equipment costs with various methods of making pear, apple, and grape boxes

Bruce G. McCauley

One of a series of reports concerning studies on the effects of packing-house equipment, plant layout, and work methods on efficiency and costs. These studies were made cooperatively by the University of California Giannini Foundation of Agricultural Economics, and the Bureau of Agricultural Economics, United States Department of Agriculture, under the authority of the Research and Marketing Act.

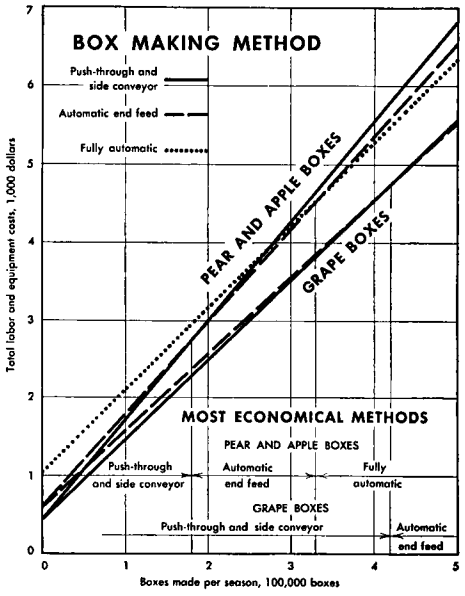
Studies of box making—an operation common to fruit and vegetable packing plants—were made in 13 California pear and apple packing houses and in 17 grape packing houses.

In all of the plants studied, the fruit was packed in wooden boxes. The volume of boxes handled per season ranged from less than 50,000 boxes in small packing houses to over 1,000,000 boxes in large houses. This volume factor is a very important determinant in the selection of the type of box making equipment that is the most economical to use in any given packing house.

In all 30 packing houses, nailing machines of various types were used in making the boxes. The most common type was a standard box making machine where the operator places two box ends and one side in the machine. These are nailed together with one stroke of the machine cross-head, to which nails are fed automatically. Then the partially completed box is turned in the machine and the bottom of the box is placed and nailed. This process is repeated to place the second side. Finished boxes are placed to the side on an inclined conveyor, which carries the boxes away by gravity.

A second type of box making method is similar to the above, except that the machine is so arranged that finished boxes can be pushed through the machine onto a roller conveyor on the opposite side.

A third, less widely used method, employs the same basic type of machine equipped with an automatic device which feeds the box heads into the machine, thus reducing the labor time per box.



A fourth type of equipment is the fully automatic machine, which feeds the shook and nails the box. A sufficient number of machines of this type in actual use was not available for investigation. However, data based on the manufacturer's specifications were used for an approximate comparison with the more common types of equipment.

Performance Standards

The studies indicated a standard performance of 395 pear or apple boxes and 465 grape boxes per hour for the side-conveyor machine. For the push-through type, the standard was 373 for the pear and apple boxes and again 465 per hour for the grape boxes. With the automatic end-feed machine the standard rose to 480 for the pear boxes and

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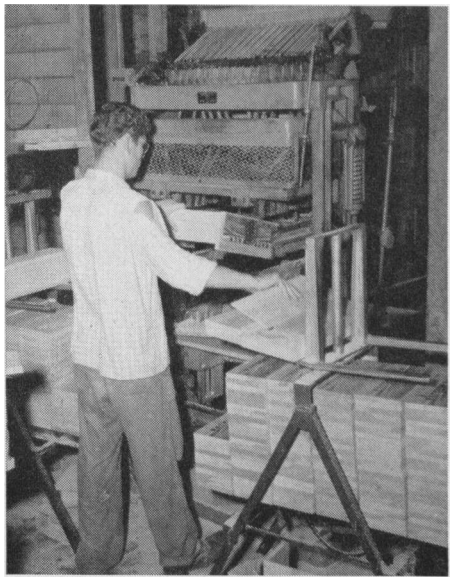
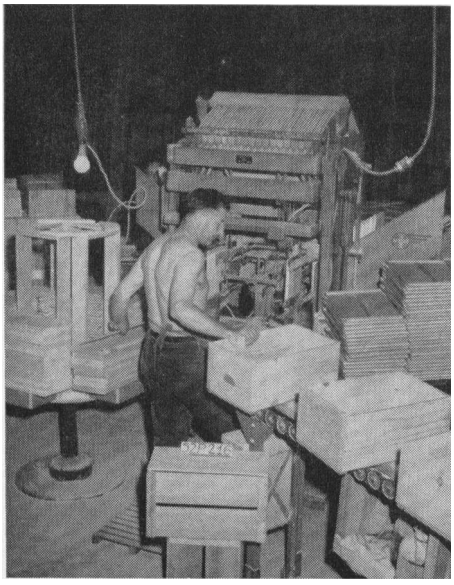


Making grape boxes on a standard box making machine with the operator pushing through finished boxes onto a roller conveyor.



Automatic end-feeding attachment being used to feed box ends automatically into position in the manufacture of pear boxes.

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to 531 for the grape boxes. Performance for the fully automatic machine was estimated at 600 pear or apple boxes per hour. No figures were available for making grape boxes with the fully automatic machine. These performance standards included a 10% allowance for fatigue, personal time and delays.

Higher or lower rates of output could be expected in a given plant, but these rates represent typical performance.

Labor Costs

The major labor expense was the piece rate paid to the box makers, which depended on the box-making equipment used. The highest piece rate—$1.00 per 100 boxes—was paid for pear and apple boxes made by the push-through and side-conveyor methods, which require the greatest manual effort. Using this equipment to make grape boxes the piece rate was 80¢ per 100 boxes. The piece rate with automatic end-feed machines on pear and apple boxes was 90¢ per 100 boxes. The lowest piece rate—75¢ per 100 boxes—was paid operators of the fully automatic pear and apple box-making machines and operators of the automatic end-feed grape box-making machines.

A secondary part of the labor cost was the expense for handling shook. Because it was common practice to use the shook men for other packing house operations—trucking fruit, or loading box conveyors when they were not needed for shook work—the total costs considered were for time actually required for shook-up work.

The box maker piece rate and shooking cost—based on standard performance and shooking wages of $1.00 per hour—were the same for the side-conveyor and the push-through machines with a total labor cost of $1.24 per 100 pear or apple boxes and 99¢ per 100 grape boxes. The total labor cost for the automatic end-feed was $1.14 per 100 pear or apple boxes and 94¢ per 100 grape boxes. The fully automatic machine produced pear and apple boxes at a total labor cost of 99¢ per 100.

Equipment Costs

A large proportion of the equipment costs is in the category of fixed costs. These costs amount to a total annual charge of 13.2% of the current replacement cost of the equipment. This percentage includes: depreciation, 6.7%—based on a use-life of 15 years for equipment of this type; fixed repair expense, 1.5%; interest on the investment, 3%—approximately equivalent to 5% on the undepreciated balance; taxes, 1%; and insurance, 1%.

As the number of boxes made per season increases, the extra load on the machinery results in additional repair expense. This is a variable cost dependent on production volume and is estimated to be 1% of the original investment cost per 100,000 boxes made.

These percentage charges, applied to 1952 replacement costs for equipment, yield the following estimates of equipment cost. For the side-conveyor type or push-through machines—replacement cost, $3,400, annual fixed charge $449, and variable repair cost $34 per 100,000 boxes. For the automatic end-feed machine—replacement cost $4,600, annual fixed charge $607, and variable repair expense $46 per 100,000 boxes. For the fully automatic machine—replacement cost $7,600, annual fixed charge $1,003, and variable repair expense, $76 per 100,000 boxes.

Total Costs

In addition to the labor and equipment costs described, other costs are involved in box making, such as electric power, the cost of floor space required, and the cost of box materials. Such costs, however, do not vary significantly with the different box-making methods and therefore need not be considered in the cost comparisons.

A comparison of total labor and equipment costs in relation to the number of boxes made during the packing season shows that, because of the higher labor requirements, the levels of cost of making pear and apple boxes are greater than for grape boxes. With both types of boxes, unit costs per box decrease as the annual volume of boxes increases. The labor and equipment costs for making grape boxes varied from $1,473—$1.47 per 100 boxes—with a season total of 100,000 boxes to $5,569 to make 500,000 grape boxes—$1.11 per 100 boxes. With similar season volumes of pear or apple boxes, the total costs with this equipment were $1,723—$1.72 per 100 boxes and $6,819—$1.36 per 100 boxes.

Although the fixed annual charge for the automatic end-feed and fully automatic machines were higher than the side-conveyor and push-through types of equipment, total costs with the automatic equipment increase at a slower rate as the volume of boxes made per year increases.

In this study the side-conveyor and push-through methods of making pear or apple boxes were least in cost for annual volumes less than about 180,000 boxes per machine. With seasonal volumes between 180,000 and 330,000 pear or apple boxes per machine, the low-cost method was that using the automatic end-feed attachment. With season volumes greater than about 330,000 boxes per machine, the fully automatic machine appeared to be the most economical.

For grape box-making, the break-even point between the side-conveyor or push-through methods and the automatic end-feed method occurs at an annual volume per machine of about 420,000 boxes. With annual volumes per machine larger than this amount, costs are less with an automatic end-feed attachment.

The relative costs of different box-making methods used in this study were developed without consideration of the rate of box supply required by the packing operations. If the necessary rate of box supply is different from the capacity rate of the box-making equipment, a packing-house manager may have to consider the merits of extra-shift or pre-season manufacture and storage of boxes. With either procedure, additional costs are incurred for box handling and storage, the amounts of which depend primarily on the number of boxes and type of storage space involved.

For boxes made on an extra-shift basis, the additional handling and storage costs were found to be approximately $2.25 per 1,000 boxes. In choosing between additional box-making equipment and extra-shift operations, this cost must be balanced against the annual charges for the additional equipment. If the purchase of an additional standard box-making machine is considered—with annual fixed charges of $449 per machine—the break-even point is at 200,000 extra-shift boxes per season. This means that extra-shift box making would be more economical than buying an additional machine if the number of extra-shift boxes were less than this amount, and less economical if a larger number of extra-shift boxes were required.

Similarly, the break-even point with respect to the addition of an automatic end-feed to an existing machine—based on an additional annual fixed charge of $158—would occur with about 70,000 extra-shift boxes per season.

With pre-season manufacture and storage of boxes, the additional handling and storage costs are much higher, if it is assumed that special storage space is required.

If the storage space is roofed, the direct handling costs plus annual charges for storage space are approximately $32 per 1,000 boxes. At these rates the purchase of an additional standard box making machine would be warranted if the pre-season storage exceeded about 14,000 boxes per year. With an unroofed storage space the handling and storage costs average about $13 per 1,000 boxes, and the break-even point with respect

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