



Wine grape harvesting equipment includes the grape harvester, a 5-ton self-dumping gondola, and a 40 to 60 hp tractor.

## Progress in **MECHANIZATION** **OF WINE GRAPES** *... economic factors*

S. S. JOHNSON · R. T. ROGERS

**T**HE USDA'S ECONOMIC RESEARCH Service and the University of California, Davis, are cooperating in an economic analysis of the mechanical harvesting of wine grapes. Machine harvesting of grapes in California began in 1969 and expanded to over 100 machines

in the 1972 harvest. Just before the 1973 harvest, an initial survey was made which included 37 growers who owned grape harvesting machines and 40 growers who used hand labor for harvesting grapes. The study analyzed the effect of substituting machines for labor, provided current information on the status of mechanization, and gave farmers some background information to help them adjust to the changing technology. Some preliminary observations are given here, from a full report to be published later this year.

In mechanical harvesting of grapes, the harvester uses a beating action to shake the grapes loose. Straddling the row, the machine head beats the vine with a set of beater rods. The fruit falls to a catching tray, and from there is conveyed to the top of the machine, and is blown into a tractor-pulled gondola moving alongside. The closure device at the bottom of the harvester is flexible enough to permit moving around the trunk of

the vines and the stakes (for more technical information, see your local farm advisor for *Mechanical Harvesting of Grapes for the Winery*, University of California AXT-403, 1973).

The average crew consists of the harvester operator, two tractor drivers, and one other person who helps keep the operation running smoothly. Some growers have one or two people to help strip vines or to remove, from the conveyors, trash which could plug up the fans. Two 5-ton self-dumping gondolas are commonly used with each harvester, alternating in use so that while one is loading the other is dumping. Since these gondolas are much heavier than the 1- to 2-ton gondolas used for hand crews, tractors in the 40 to 60 hp range are required which are capable of very slow speeds. Where the smaller gondolas are used, a forklift or similar dumping device is needed.

The most important member of the crew is the machine operator. It is his

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responsibility to avoid damaging vines, wires, and stakes, and to allow for proper clearance of any obstacles—while obtaining the maximum quantity of trash-free fruit. The operator needs to be mechanically inclined and responsible. Many growers consider the operator the key to successful mechanical harvesting.

Harvester operators commanded higher wages than did tractor operators in 1972. Wages for harvester operators ranged from \$2.20 to \$3.50 per hour, with \$3.00 as the typical wage, while tractor operators and other harvest workers received from \$1.75 to \$3.00, with \$2.00–\$2.50 as the most typical. In addition, some growers provided housing.

### Capital investment

Mechanical harvesting requires a substantial capital investment for the machine and two gondolas. The harvester costs about \$33,200 to \$35,000, and the self-dumping gondolas cost \$3,000 each, for a total of around \$40,000. The useful life of a machine is still uncertain, so many of the operators were capitalizing the machine over a three- to five-year period, while still expecting a considerable trade-in value, should they sell at that time. Repair costs on the earlier machines, especially the 1969 and 1970 models, were high, averaging \$1,500. These machines also required considerable modification expense as new technology was developed on succeeding machines. Repair and modification expenses on the newer machines are likely to be considerably less because of the improvements incorporated into the later designs. Fuel and lubrication were not sizable expenses, averaging \$300 per season.

Some operators preferred operating at night, despite the drawbacks of early hours and poor visibility. Advantages in night operations include working more hours per day, cooler temperatures which improve crew efficiency, and apparently easier removal of grapes at temperatures under 90 degrees. A common operating pattern is to begin very early in the morning and to stop in mid-afternoon, although a few growers harvest around the clock.

### Short season

The 1972 operating season was short, averaging about 30 days. Harvest began early, in mid-August, and lasted till the end of October. Operators started on the early varieties like Salvadores, went on to French Colombards and into Thompson Seedless varieties, and finished up with White Malagas and Missions. The

harvest pattern depended to some extent on the winery hours, for many are closed on weekends, although it is common to be open to receive grapes for one-half day on Saturday. Therefore the average number of days worked during harvest was 5 or 5½ days per week.

Contract operations were common, and for many operators were a large part of their harvest program. Of 34 machine operators, about one-fourth were highly involved in contract harvesting, and another fourth did some contracting. Of those doing a small amount of custom work, many of the arrangements were between close neighbors or relatives. The basis for setting custom harvesting rates is the “going” hand harvest cost. Other factors in the cost bargaining process include personal relationships, such as with relatives or neighbors, the amount of competition among machines for acreage, variety and condition of the vineyard, time of year, and yields.

### Limited operation

In 1972, an estimated 103 machines harvested up to 600 acres per machine. Some machines did not operate at all, largely because of frost damage and low yield, or because of an ample supply of

hand workers. Of 54 machines on which data were collected in 1972, the average acreage picked per machine was 237.6 acres. Because of the short crop, tonnage was below normal for many of the growers. A rule of thumb for machine performance is one acre per hour.

### Machine damage

Of concern to all growers is the possibility of machine damage including tearing out vines, removing too many canes or spurs, defoliation, or other damage that might lower future yields. Most growers reported no observable damage to vines. Several mentioned a little damage, and other said that there has not been enough time yet to tell. Most frequently mentioned was damage to stakes, especially when a machine is used for the first time in a vineyard where there are older stakes. Split hardwood or steel stakes were recommended because many reported that the new sawn stakes may break. However, growers thought that many of these problems could be avoided by judicious use of the machine.

The growers interviewed thought there would be no problems for wineries in use of mechanically harvested grapes. At least one winery paid a slight premium for their grapes. Many of the growers

The harvester operator is the key to an efficient operation. He must be able to harvest the grapes with a minimum of damage to the vines, stakes, and obstructions.



thought there should be a price premium for mechanically harvested grapes because the product delivered to the winery had fewer stems and leaves, as compared with hand-harvested grapes. They were thus delivering more grapes per ton of delivered product to the winery. However, growers mentioned that not all varieties were picked as easily as Thompson Seedless (the main variety picked in these tests). Certain varieties were harder to shake from the vine, causing juicing which brought on early fermentation. This problem is of greater concern among growers of varieties, which bring a much higher return. A device for field crushing may aid in solving this problem.

Although field modifications were few among the growers interviewed, many had to raise stake height to raise the fruit zone, and five-ft stakes were commonly replaced by 6-ft to 7-ft stakes. A consequence of mechanization was that growers were forced to observe better management in maintaining stakes and wires, in pruning vines so as to remove obstructing arms, and in preparing low, narrow and clean berms.

### **Independence**

Growers liked the machine because they felt it gave them independence from many of the problems encountered in hand harvest. They liked feeling more in control of the farm. A few also mentioned cost savings. Complaints about the machine were concerned with the long hours of work, repair costs, and the high initial cost of the machine and supporting equipment. However, the tone of growers was favorable towards the machine.

Since the harvester is specialized, it is idle between harvests. The manufacturers and some enterprising growers are developing additional uses for the machine. Some intended uses are as a spray rig, a cultivator and a pruning aid, all uses still concerned with grapes.

The estimated acreage needed to justify the purchase of a machine is being calculated and will be presented in a full report later this year. The report will also include comparisons of hand and machine harvest costs and problems, and implications for adjustments by growers.

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# **POTASSIUM NUTRITION AND DEFICIENCY IN CITRUS**

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**P**OTASSIUM DEFICIENCY OF CITRUS in California had not been recognized prior to about 1960. Since then, experimental work has led to a greater understanding of potassium nutrition and the effects of potassium levels (as determined by leaf analysis) on yield and fruit quality of oranges, lemons and grapefruit.

### **Leaf symptoms**

Symptoms of potassium deficiency on orange, lemon, and grapefruit are shown in the photos. Yellow to yellow-bronze chlorotic patterns develop on older leaves, along with a cork-screw type of curling toward the lower leaf surface, particularly on the lemon. Similar leaf curling often occurs on healthy lemon trees, but the leaves do not become chlorotic. The intensity of the curling and chlorosis on lemon leaves increases as the severity of the deficiency increases. Potassium deficient orange and grapefruit trees usually do not exhibit this particular kind of leaf curl. On orange and grapefruit the chlorosis develops primarily on leaves behind fruit, and may not be easily recognized even when the deficiency is severe. The symptoms on lemon are more conspicuous, allowing easy visual diagnosis. Visual diagnosis should be confirmed by leaf analysis.

### **Leaf analysis**

The potassium concentration in citrus leaves decreases with increasing leaf age. Leaf analysis guides are based on 5- to

7-month-old leaves. Obtaining a leaf of this age from orange and grapefruit is not difficult. In lemons, however, a 3-month-old leaf may look the same as a 7-month-old leaf. In some earlier research, potassium deficiency of lemon often went undetected because young leaves in the samples had high concentrations of potassium. For correct diagnosis, it is essential to avoid leaves younger than 5 months.

Experience with citrus shows that after leaf potassium drops into the deficiency range (below 0.7%), increasing it to the adequate range is difficult—even with several years of either soil or foliar potassium applications. Consequently, the potassium leaf concentration should not be permitted to drop below 0.7% in 5- to 7-month-old spring-cycle leaves from non-fruiting terminals. Leaves should be sampled and analyzed by competent personnel.

For most effective use of citrus leaf analysis, a record of annual leaf analyses and amounts of fertilizer applied should be kept for each leaf sampling unit. This information can help in making a decision on the proper use of potassium fertilizer.

### **Yield and fruit size**

The influence of the percentage of potassium in leaves on yield, fruit size, and quality for orange and lemon are shown in graphs 1 and 2. Preliminary information indicates that the potassium