AN ECONOMIC ANALYSIS OF CLING PEACH PRODUCTION WITH EMPHASIS ON HARVEST MECHANIZATION

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ABSTRACT

In 1970, some 10 percent of California's cling peaches were mechanically harvested. Mechanization results in substituting machine investment for labor. For example, an estimated $25,000 invested in a mechanical harvester substitutes for 3,962 hours of labor a year on an 80-acre peach farm. The economical point for purchasing a mechanical harvester is an estimated 37 acres of mature peaches yielding 14 tons an acre. This equal-cost peach acreage is the point where hand and machine harvest costs break even. A relative 25-percent gain in labor costs from 1970 wage rates would lower the equal-cost point to 29 acres. Rate of adopting mechanical harvesters depends on the economic feasibility of such acquisition, processors' attitudes toward handling machine-harvested fruit, and their capabilities for such handling. Mechanization of cling harvest would call for a series of adjustments by growers and workers. Growers would have to increase investments in machinery and change some cultural practices. Some workers would have to acquire higher skills, while others would lose their jobs and need retraining for new ones.

Key Words: Cling peaches, Mechanization, Equal-cost acreage, Machine investment-labor substitution..

PREFACE

Part of a research program, this report is designed to investigate primary and secondary economic and social effects of mechanizing production of U.S. fruits and vegetables. Stressing economic efficiency and productivity of cling peach firms, the report also shows possible effects on farmworker employment. Although future reports also are expected to deal with these aspects of fruit and vegetable farming, some may place more emphasis on skill requirements, working conditions, effects on year-round employment opportunities of mechanizing production of various crops, and possibilities of retraining fieldworkers.

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CONTENTS

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TABLES

FIGURES

SUMMARY

Mechanical harvesting of all cling peaches in California--a total investment in machines of some $20.8 million if each machine harvests 100 acres--could replace 2.83 million hours of labor, dropping wages $7.1 million a year.

These are gross estimates of how successfully machine investment could substitute for labor if the cling peach industry were to swing all the way to mechanical harvesting.

How rapidly the shift to machines could go depends on (1) labor availability and cost, (2) what processors think about using mechanically picked fruit and how capably they can handle it, and (3) the sales outlook for cling peaches. In 1970, growers mechanically harvested about 10 percent of clings.

This report shows how a probable $25,000 investment in a mechanical harvester can substitute for 3,982 man-hours a year on an 80-acre peach farm. Every $6.31 invested in machines (the equivalent of 90 cents a year) substitutes for 1 hour of a man's time ($2.50 annual cost).

The economical point for purchasing a mechanical harvester is an estimated 37 acres of mature peaches yielding 14 tons an acre. This equal-cost peach acreage is the point where hand and machine costs break even. If labor costs advance 25 percent (from 1970 rates) but peach yields remain the same, the equal-cost point would be 29 acres. And, keeping the same yield, but lowering the assumed rate of machine output from 4 to 3 acres a day, results in an equal-cost acreage of 38.

Possible labor savings on cling peaches goes beyond mechanical harvesting. Shifting to chemical or mechanical thinning could reduce handwork almost as much as shifting to mechanical harvesting. Combined chemical (or mechanical) thinning and mechanical harvesting could cut cling peach production labor almost in half, while evening labor use throughout the year. Extending the pruning season could further improve the workflow.

Mechanizing cling peach harvest would mean that growers fixed costs become a larger share of total costs; cultural practices would require change to accommodate machines; and land values would rise to match gains in net returns from mechanization. This new technology would mean a loss of jobs for some farmworkers and a need for retraining them for other jobs.

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INTRODUCTION

Overproduction is a major problem for growers of cling peaches. A 50-percent gain in bearing acreage between 1955 and 1969, as shown in table 1, caused mounting surpluses of cling peaches. Canners' unsold inventories more than tripled--from 2.6 to 8.3 million cases--between June 1, 1960, and June 1, 1969. To counter severe price depressions, cling peaches are under marketing orders controlling prices and quantities sold, but not new plantings. Overabundance has retarded mechanization of cling production: Not all output from each acre can be sold. Some producers need larger acreages for the profitable adoption of harvesters; and price prospects seem less favorable than if supply and demand for clings were more balanced.

Cling peaches have pits that adhere tightly to the flesh of the ripe fruit. Primarily a California crop, clings go mostly for canning, in contrast to much softer freestone peaches, used primarily for fresh market. Major California cling production areas are the Modesto, Yuba City-Marysville, Stockton, Viasalia-Kingsburg, and Merced districts.

Extent of Mechanization

Mechanical harvesting of cling peaches has progressed from 1966, when the process was virtually nonexistent. By 1968, some 3 percent of the California harvest was by machine. Substantial but slow adoption of this new technology saw about 7 percent of the clings harvested by machine in 1969, and 10 percent in 1970.

Growers now facing decisions of harvesting by hand or machine must consider whether mechanization is more suitable to and economical for their particular peach acreages and varieties; acceptance by processors of mechanically harvested peaches; labor supply and cost; and cost of harvesting by machinery. The critical decision includes possible expansion or contraction of peach acreage and whether to enter alternative enterprises.

Table 1--California cling peaches: Acreages, tonnage sold, and prices, 1955-70

Year	Bearing peaches	Quantity sold, No. 1 grade	Price per ton
	Acres	Tons	Dollars
1955	42,872	498,927	80.50
1956	44,746	559,437	70.00
1957	46,873	485,684	65.00
1958	46,469	462,032	66.00
1959	48,929	539,021	59.67
1960	50,964	545,477	56.76
1961	53,898	582,439	67.00
1962	55,578	638,357	65.00
1963	59,558	675,969	57.00
1964	60,844	778,747	62.00
1965	60,789	624,027	69.00
1966	61,003	739,371	68.50
1967	61,955	600,568	83.00
1968	63,110	755,352	76.00
1969	63,810	775,184	74.00
1970	59,380	616,845	81.00

Sources: (1) and (2).

Growers face possibly dwindling labor supply, more complex management activities, and higher labor costs. The institutional framework built up around labor-intensive agriculture is changing. Potential unionization of farmworkers will mean less control by farm operators of direct hiring and wage rates, use of certain inputs, and day-to-day management. Congress may amend the Fair Labor Standards Act to provide higher minimum wages for farmworkers. And, stricter control of "illegal alien" labor--plus other restrictions on new labor--could cut labor supply.

Growers adopting mechanical harvesters for clings will substantially substitute machine investment for labor--seriously disrupting seasonal labor patterns on peach area farms. Cost of production will alter the entire production process, to some extent--with a higher ratio of fixed to variable costs and a change in traditional practices.

Some Previous Studies

Dean and Carter found costs of producing cling peaches declined as farm size expanded to about 60 acres, then remained constant for larger acreages (4). 1/ They found yields strongly affect production costs, and gains in labor costs significantly increase total costs. Anticipating mechanization of peach harvests for the early 1960's, in their study Dean and Carter estimated 55 acres would be the break-even point for mechanization. This equal-cost acreage (acreage size where hand and machine harvesting costs are equal) dropped to 25-30 acres when wages climbed 25 percent more than prevailing rates. Fry Consultants, sampling 86 cling peach growers who kept records for the 1967 crop year, found production costs then were $85.60 a ton, or $868 an acre, for yields of 10.7 tons per acre (3).

Objectives

This study has five goals, all concerned with mechanizing cling peach production: (1) To determine what are current production practices and costs on cling peach farms; (2) How mechanical harvesting of clings will change production costs and input use--revealing economical farm sizes, calculated at current and increased wages and varying rates of machine performance; (3) How changes in peach yields and prices will affect production costs, input use, and mechanization; (4) What forces will affect the pace of mechanization of cling harvests; and (5) How mechanization is affecting and will continue to affect the economies of California's peach growing areas.

SAMPLE SURVEY

The researchers selected and interviewed a sample of 33 progressive peach growers in Stanislaus County, Calif., in October-November 1970. These growers were considered representative of operators having greatest success with production inputs.

Classifying the sample farms in three acreage size groups for clings and freestones, the researchers found usable data from 31 of 33 farms surveyed. (Little information came from one grower, and another had a farm twice the size of any other in the sample.) But 11 farms had 10 to 50 acres of peaches, 12 had 51 to 90 acres, and eight farms had 91 to 265 acres of peaches. The 33-farm sample yielded data on farm acreage, land use, volume of production by variety of tree, production practices, input uses, and production costs.

Researchers also enumerated 15 other growers who used mechanical harvesters in 1970. This group of 15 growers yielded data on types of machine: costs and performance rates, amount of contract work performed, and other information pertinent to their experience with the machines.

1/ Underscored numbers in parentheses refer to items in the bibliography.

Because the sample was selected, not random, data from farms surveyed are not a basis for estimating precise features of all cling peach farms in California. They serve, however, as a base for ratios of input to output.

Characteristics of Survey Farms

Cling and freestone peach farms surveyed had little crop diversity--typically almonds, walnuts, and grapes. The 31 farms averaged 80.8 acres of peaches--some 77 percent of their average acreage of trees and vines (table 2). Of the peaches, 93 percent were clings, with 83 percent of the cling acreage devoted to trees at least 3 years old--considered of bearing age in this study. 2/ Of the farms surveyed, 12 had only peaches, but eight also had almonds, 11 walnuts, seven grapes and two also grew nectarines. A few had fairly large acreages of almonds and grapes, but almost all walnut acreages were below 15 acres.

Table 2--Crop acreages on 31 cling peach farms in Stanislaus County, Calif., by size of farm, 1970

Item	Farms			
	All	Small 1/	Medium 1/	Large 1/
	-- Average acres --			
Trees and vines	104.9	76.1	84.8	173.4
All peaches	80.8	42.2	64.9	156.7
Cling peaches				
Bearing 2/	62.4	32.7	51.7	119.0
Nonbearing	13.0	4.9	9.8	29.1
Freestone peaches				
Bearing 2/	4.6	4.2	2.9	7.6
Nonbearing	0.8	0.4	0.5	1.0
Almonds	9.3	16.1	6.8	3.6
Walnuts	4.4	4.2	3.7	5.6
Grapes	9.8	13.6	9.4	5.1
Nectarines	0.6	0.0	0.0	2.4

1/ Size in terms of peach acreages on survey farms.
2/ Defined as trees at least 3 years old.

2/ Normally not considered of bearing age, many of the 3-year old peach trees on the survey farms produced 10 tons or more peaches an acre.

Varieties, Yields, and Ages of Cling Peach Orchards

Cling peach varieties are divided into four maturity groups--extra early, early, late, and extra late. Most growers raise several varieties to keep orchard operations--especially thinning and harvesting--flowing over a longer period of time. Harvesting starts with the extra earlies beginning about July 15 and continues until final harvesting of extra lates, around mid-September. (See table 3 for varieties.)

Table 3--Varieties of cling peaches, California, 1970

Maturity group			
Extra early July 15-31	Early August 1-15	Late August 16-31	Extra late September 1-15
-- Variety --			
Carson	Andora	Carolyn	Corona
Dixon	Cortez	Gaume	Gomes
Fortuna	Johnson	Halford	Starn
Loadel	Peak	Stanford	Stuart
Vivian	Polora		Wiser

Cling peach maturity groups on the survey farms, although resembling distribution on all cling peach farms in Stanislaus County, differed on two counts: more abundant earlies and fewer lates (table 4). (The survey farms might be attempting to use labor more evenly during harvest.)

Table 4--Distribution of cling peach acreage in Stanislaus County and 31 survey farms in Stanislaus County, Calif., 1970

Maturity group	All peach farm acreages, Stanislaus County	31 selected farms growing peaches, Stanislaus County
	-- Percent --	
Extra early	25	25
Early	15	19
Late	37	33
Extra late	23	23

Earlies on 26 survey farms had the lowest yields, extra lates the highest--a pattern similar to 10-year statewide average yields. Five farms were omitted because of extremely low yields from frost, insect infestation, or other causes. On the 26 survey farms, extra earlies averaged 13.2 tons of net No. 1 peaches an acre; earlies, 12.7 tons; lates, 14.7 tons; and extra lates, 16.1 tons. But peach yields vary considerably from year to year among farms because of differences in soil, varieties, age distributions, weather, and cultural practices. Yields also vary on individual farms. For example, average yields on the 26 survey farms increased from slightly more than 10 tons an acre for 3- and 4-year-old trees to nearly 18 tons an acre for 13- and 14-year-old trees, and then began to decline.

Cling peach trees generally have a useful life of 20 years--only the best are kept in production longer--and 31 was the maximum age of trees in the survey. Because mechanical shaking promotes breakage, average peach tree age probably will decline as growers advance their use of machinery. Favorable tree-pull incentives also tend to lower removal ages of trees. Evidently some growers profit by removing trees at an earlier age than they did two decades ago.

Labor Use

Cling peach production requires at least 12 operations: pruning, brush removal, wiring, spraying, fertilizing, cultivating, irrigating, thinning, green-dropping, hoeing, propping, and harvesting. Pruning and brush removal usually occur from December to February, thinning and green-dropping are in May and early June, propping in July, and harvesting from July 15 to September 15. Wiring, fertilizing, cultivating, and irrigating occurs during the six months--April 15 to October 31--but spraying takes place essentially throughout the year.

Except for the extensive labor of pruning, thinning, and harvesting--generally by seasonal workers--family members or regular hired workers (employed at least 150 days a year) usually perform the rest of the work. On the survey farms, pruning took 20 to 60 hours an acre; thinning, 25 to 90 hours an acre; and harvesting, 30 to 100 hours an acre. Median crew sizes for these three operations varied by farm size and task. For example, a median of three workers pruned on small farms and 20 picked peaches on large farms. (See table 5.) The type of workers also varied: Pruning crews were 77 percent local seasonal hands (living near the farm), compared with 16 percent of the harvest crews. Migratory seasonal workers made up more than half the harvest or thinning crews. Scarcities of local seasonal workers during harvest likely stems from higher paying jobs then available in canneries, and from the relatively more labor for shorter periods required for thinning and harvesting.

The median hourly wage rate was $2.00. For pruners, the median rate was 80 cents a tree and for thinners, $1.25 a tree. For most pickers the wage rate was $5.00 a bin (about 1,000 pounds) for first pick peaches, $7.50 a bin for second pick. The rate for picking by bucket was 15 to 17 cents a 28-quart bucket.

Table 5--Workers on cling peach survey farms, Stanislaus County, Calif., 1970

Item	Operation		
	Prune	Thin	Harvest
	-- Median number --		
Size of operation 1/			
Small	3	10	10
Medium	5	13	14
Large	10	14	20
	-- Percent --		
Type of worker			
Local seasonal	77	41	16
Migratory	18	45	64
Both	2	14	20
Family workers	3	0	0

1/ Size in terms of peach acreages on survey farms.

Ages of Operators

Ages of farm operators surveyed averaged 49 years--varying by size of peach operations. On the 11 smallest farms, operators' ages averaged 52 years; on medium-sized farms, 49 years; and on the largest, 45 years. An operator's age probably affects his long-range planning--some older operators are reluctant to adopt new technology and expand the size of operation.

Attitudes Toward Mechanization

More than half the 31 farm operators noted they were planning to harvest cling peaches mechanically by 1975--more so for medium and large operations than for small ones. Some of those not planning on mechanical harvesting gave these reasons: (1) not enough peach acreage, (2) planning to retire or quit farming, (3) planning to switch to other enterprises, (4) dissatisfied with present performance of mechanical harvesters, (5) long-term arrangements with their workers for hand harvesting, and (6) feeling that processors are not satisfied with mechanically harvested peaches.

Moreover, some of the growers planning for mechanical harvesting by 1975 said they would wait until at least 1973 for possible improvements by manufacturers of current equipment. These growers believe later information will permit more accurate evaluations of machine performance. Some noted that labor availability will weigh heavily in their final decisions regarding machine harvesting.

ASSUMPTIONS

Specific characteristics of cling peach production are difficult to outline because of the mix of peach varieties, distribution of tree ages, and the variety of other crops on the farm. Therefore, realistic assumptions must be made about these elements to gain insights into costs and practices of cling production. This part of the report offers an initial base for analyzing cling production and outlines a set of production practices and associated costs. A later section evaluates various effects of further assumptions. Major aim is to find how harvest mechanization of clings affects production costs. However, the study analyzes the entire production system, evaluating total production costs, equipment, and labor use.

Initially, the study assumed 40-, 80-, and 160-acre farms producing cling peaches only. It defined these as small, medium, and large size farms with peach varietal mix construed as equal to the 31 sample farms, (as noted later in table 6). The study also assumed that an eighth of peach acreage is nonbearing, and that the balance--bearing acreage--one-eighth of total acreage each is 4, 6, 8, 10, 12, 14, and 16 years old. The input-output and cost data are based on the average age of all groups. The study further assumes growers will pull trees at the end of the 16th year, and that types and sizes of equipment are uniform for all farm sizes. Growers on large farms have multiple units of some machines. Yet, most blocks in cling peach groves are in rows 20 feet square, restricting equipment sizes.

Table 6--Peach acreages, California, 1970

Maturity group	Size of farm 1/		
	Small	Medium	Large
	-- Acres --		
Nonbearing	5.0	10.0	20.0
Extra early	8.7	17.4	34.8
Early	6.7	13.4	26.8
Late	11.6	23.2	46.4
Extra late	8.0	16.0	32.0
Total	40.0	80.0	160.0

1/ Hereafter, small, medium, and large farms refer to 40, 80, and 160 acres of peaches, unless otherwise stated.

Preharvest

The report shows 11 major preharvest production activities on cling peach farms, estimating their labor use and variable costs, which are all direct. 3/ These costs include expenditures for labor, materials, gas and oil, and repairs. Data also include an 8-percent (for 6 months) charge on production expenses. Bases for labor use and variable cost estimates are data from the survey and secondary sources--chiefly University of California Experiment Station and Extension Service publications (4), (7), (8).

Pruning

Pruning consists of tree shaping and removing dead wood plus small branches on the bearing surface. Usually the third most labor-intensive tree operation, pruning continues largely handwork--using pruning saws, hand or air shears, perhaps tree "squirrels" or tree-topping devices. Cost and labor estimates were based on using pruning shears and ladders. The study also assumed 40 hours of labor per acre--an output of 2.7 trees pruned an hour, about equaling pruning time on survey farms. Variable costs total $89.86 for labor at 80 cents a tree for 108 trees per acre.

Brush Disposal

Brush disposal can take place during or after the pruning season. Growers usually have a tractor and trailer for hauling large limbs, and a tractor and brush shredder for chopping small growth. Then a worker disks this material into the ground.

Wiring

Wiring the main limbs of peach trees to support fruit loads usually calls for a tractor and wire barrel, but continues largely handwork in some groves. The extent of wiring varies widely--some growers rewire every year, others wire once and patch intermittently, but many growers rope young trees.

This study assumed a two-man crew--one on a tractor, another in a wire cage--spend 0.7 hour an acre on wiring, and average 30 pounds of wire per acre each year (table 7).

3/ All costs are based on 1970 data. Assumed prices of study inputs were the same for all sizes of operation.

Table 7--Labor use and variable costs per acre, cling peach farms, California, 1970 1/

Activity and item	Equipment		Materials	Labor 2/		Interest at 8 percent for 6 months	Variable costs
	Hours	Cost	Cost	Hours	Cost		
	Number	-- Dollars --		Number		-- Dollars --	
Pruning							
Shears & ladder	--	--	--	3/40.0	86.40	3.46	89.86
Brush disposal							
Tractor & brush shredder	1.0	1.34	--	1.2	2.64	.16	4.14
Wiring							
Tractor & wire barrel	.7	.63	3.60	1.4	3.08	.29	7.60
Spraying							
Tractor & speed sprayer	2.5	9.38	64.72	2.5	5.50	3.18	82.78
Fertilization							
Tractor & fertilizer spreader	.6	.78	17.55	.7	1.54	.79	20.66
Cultivation 4/							
Tractor, disk & springtooth	1.9	1.77	--	1.9	4.18	.23	6.18
Irrigation 5/	--	--	--	3.9	8.58	.34	8.92
Green-dropping							
Ladders or poles	--	--	--	5.0	11.00	.44	11.44
Hoeing weeds							
Hoe	--	--	--	2.0	4.40	.18	4.58
Thinning							
Ladders or poles	--	--	--	50.0	6/135.00	5.40	140.40
Propping							
Tractor, trailer, & forklift	1.0	.89	--	3.3	7.26	.33	8.48
Hand harvest 7/							
Truck, tractor, & forklift	4.3	5.59	--	68.9	170.75	7.05	183.39
Machine harvest 7/							
Mechanical harvesters, truck, tractor, & forklift	6.3	21.34	--	12.3	31.63	2.12	55.09
Marketing fee	--	--	--	--	--	--	28.00
Tree care	--	--	--	--	--	.16	4.16
Miscellaneous	--	--	--	--	--	1.60	41.60
Total variable cost							
By hand							642.19
By machine							513.89

-- = Not applicable.

1/ All costs based on 1970 figures, 108 trees/acre, 14 tons/acre.
2/ Labor at $2.20/hour, including social security and workmen's compensation unless indicated otherwise.
3/ Labor at $0.80/tree.
4/ Disking 4 times, springtoothing once.
5/ In the Modesto irrigation district, water is free. Study assumes ridges are smoothed and broken at each irrigation.
6/ Labor at $1.25/tree.
7/ Based on an output of 24 tons/day and a yield of 14 tons/acre. Wages at $5.00/bin for pickers, $2.75 an hour for machine operators, and $2.20 an hour for other workers.

Spraying

Growers spray cling peach trees three to 10 times a year, depending on the degree of disease or insect infestation and how individual growers feel about spraying. A number of pests and diseases attack clings, including peach twig borers, mites, San Jose scale, peach blight, brown rot, and powdery mildew. Most peaches in the survey were sprayed with 500-gallon speed sprayers. Variable costs per acre amount to $82.78--$64.72 for spray materials, $5.50 for labor, and $9.38 for equipment (table 7).

Fertilizing

Cling peach growers usually apply fertilizer twice yearly--about 70 percent in November, the rest in March. Each acre gets actual nitrogen applications of 100 to 175 pounds each year. Some growers use a mixed fertilizer such as 14-7-14. This study assumed each acre received 300 pounds of ammonium nitrate and 200 pounds of 14-7-14, costing $17.55 for materials, $1.54 for 0.7 hour of labor, and $0.78 for 0.6 hour of equipment operation (table 7).

Cultivation

Tillage, depending on soil conditions, weed growth, and weather, usually comprises disking three to five times and springtoothing once or twice. In the study disking occurred four times and springtoothing once.

Irrigation

Water for most of the cling peach acreage studied came from the Modesto and Turlock irrigation districts. There was a very small irrigation fee only in the Turlock District. And, the study assumed irrigation water is free. Trees received water by pipeline--flood irrigation based on gravity. Beginning in April, mature trees usually received five to eight irrigations every 3 to 4 weeks. About 2 acres can be irrigated in an hour. Ridges were broken and smoothed at each irrigation.

Green-Dropping

Green-dropping is a method the cling peach industry uses to control production. It consists of knocking to the ground all peaches on a specified percentage of trees--either pulling the green fruit from the trees or beating it off with poles. In 1970, this requirement equaled 10 percent of total acreage. Changes in labor use and variable costs depend on the yearly differences in green-drop requirements. The amount and cost of labor also depend upon whether green-drop requirements have been announced before the thinning operation. The assumed 5 hours of labor costs $2.20 an hour for green-dropping (table 7).

Hoeing Weeds

Peach growers either hoe or spray weeds that grow too close to the trees for disking. The study assumed a rate for hoeing work of 2 hours an acre.

Thinning

Usually second only to harvest in the amount of labor required, thinning is a May and June task. For peaches to size properly, growers must remove some when the fruit is small, leaving about 1,200 to 1,500 peaches on each tree. Although primarily a hand operation for most growers--pulled by hand or knocked off with poles--some growers thin with chemical sprays. Chemical thinning shows promise for reducing labor inputs, but some growers have had problems of over thinning, especially in years of light set. Mechanical shaking is another current practice that might become more useful, for at least partial thinning. Later, the study expands on both chemical and mechanical thinning.

In 1970, when the set was light, the median number of hours for thinning on survey farms was 40. Thus, the study assumed 50 hours as normal thinning time. With labor costs $1.25 a tree, thinning labor totals $135 an acre, plus $5.40 for interest on this production expense (table 7).

Propping

Growers use propping when fruit nears maturity to prevent tree limbs from breaking. Mostly a July activity, propping may extend into August, especially for late varieties. Farms generally have a tractor and trailer in use for hauling props, and a forklift or a tractor forklift attachment to load props onto a trailer. Although variations exist in the extent of propping, several growers reported using two props per tree. Survey data yielded an assumed total 3.3 hours of labor an acre for placing and removing props--a tractor for 1 hour; a trailer, 42 minutes; and a forklift attachment, 18 minutes, besides 1.3 hours of handwork (table 7).

Harvest

Harvesting is the most labor-intensive activity in cling peach production. Ninety percent of clings were hand harvested in 1970. Because many growers are contemplating buying harvesters or using contract machine work to cope with the apparent dwindling labor supply, these two methods of harvest are compared below. (Fruit quality is assumed equal for both methods.) 4/

4/ Some growers and processors indicate that with proper handling of peaches and with present grading standards, machine-harvested peaches can equal or exceed the quality of hand-harvested fruit.

Hand Harvesting

Crews of various sizes pick cling peaches, and in the survey these were mostly migratory seasonal workers moving from harvest to harvest as various crops ripened. Hiring was largely through farm labor contractors.

Pay for peach pickers is by the bucket or bin. When picking by the bucket, workers position ladders and move them in and out of two rows of trees for access to the fruit. A tractor and bin trailer moves between rows. Pickers put peaches into buckets holding 16, 23, or 28 quarts and empty filled buckets into bin trailers. A checker keeps count of the numbers of buckets picked by each worker, who calls out a preassigned number as he empties his bucket. In 1970, wages for pickers ranged from 15 to 17 cents per 28-quart bucket.

For picking by bins, a tractor with forklift distributes bins throughout the grove. After filling their buckets with peaches, the pickers empty them into preassigned stationary bins, which have markings used as a guide in paying the workers. In 1970, payment was roughly $5.00 per 1,000-pound bin for first pick fruit, $7.50 for second pick.

Full bins of peaches move from orchard to receiving station in one of several ways. Stollsteimer shows basic handling methods for deciduous fruits and in his study presents a detailed description of each method, which assumes all growers use the bin, forklift, truck method of handling peaches (8).

The most efficient picking operation maximizes output and minimizes idle time. The equipment capacity should approximate the output of a picking crew which is large enough to use the equipment fully.

In the study, a 1-1/2-ton truck hauled 12 full bins of peaches to the cannery, and returned with empty bins. Assuming a 6-mile round trip takes 18 minutes, and cannery operations 24 minutes, the total time was 42 minutes. The total time for taking an empty bin from truck to orchard and returning was 5.74 minutes, or 68.88 minutes for 12 bins. The total time required for the entire orchard operation was 110.88 minutes per 12-bin load. Thus, one man operating both tractor and forklift, and driving a truck, can handle 24 tons of peaches in 7.4 hours, or 30 tons in 9.25 hours.

An output rate of one-fourth ton an hour for each worker requires 14 pickers to harvest 24 tons of peaches--in the usual 7-hour workday for pickers--and 18 workers to complete the harvest of about 30 tons of picking. With the smaller number of pickers, maximum harvest for each varietal group would be 288 tons (12 days times 24 tons). This crew could handle 21 acres yielding 14 tons an acre. The maximum acreage handled would vary with changes in yield. Maximum for a field yielding 18 tons an acre would be 16.3 acres picked, in the assumed acceptable time for peaches of a particular maturity group to avoid deterioration.

Labor use is 68.9 hours per acre for harvesting acreage with 14-ton yields--56 hours for pickers and 12.9 hours for an operator of tractor, truck, and forklift, and for two hourly workers such as graders. 5/ Variable costs per acre, as shown in table 7, follow:

Picking labor	$140.00
Other labor	30.75
Tractor	2.57
Forklift attachment .	1.76
Truck	1.26
Interest	7.05
	$183.39

Machine Harvest

Machine harvesting of cling peaches in 1970 used two basic types of machines--single unit and two unit. The two-unit catching frame, employing two drivers encloses the tree from both sides. These units have separate functions; one unit has the shaking mechanism, the other the conveying and grading equipment. Using one driver, the single unit machine envelops the tree, shakes, conveys, and grades the fruit. It harvests trees alternately in adjacent rows (6).

Size of crew may be three to eight workers; at least one or two drivers, a grader, a prop man, and a tractor forklift operator. And some operators use at least one pole knocker, when trees have long hangers.

Output per hour varies widely, depending on type of machine, condition of soil and trees, yield per acre, and experience of the machine crew. The 15 operators interviewed harvested 2 to 6 acres a day. An experienced team can harvest 4 acres a day maintaining fruit quality if orchard conditions are good.

Variable costs of machine-harvested fruit are substantially lower than that of hand-harvested fruit. With an output rate of 0.5 acre an hour--4 acres in an 8-hour day--labor at $2.75 an hour for two machine operators and two operators of tractors, forklifts, and trucks comes to $22.83. 6/ A grader and a bin handler each receive $2.20 an hour or $8.80 an acre. Total harvest labor costs are $31.63 an acre. Gasoline, grease, and oil cost about $3.75 an acre. Repair costs vary widely, but are an assumed $12.00 an acre, or $6.00 for each hour of use. Variable costs (excluding labor) of operating the machine come to $15.75 per acre.

The study assumes the same method of hauling for both machine- and hand-harvested fruit. But, with machine-harvest, two men, each driving a

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5/ Assuming peaches are picked only once.

6/ One man driving both a tractor with forklift and a truck can harvest about 21 acres yielding 14 tons an acre. But the equipment would be idle part of the time.

tractor with a forklift attachment, and each driving a truck, work 8.6 hours a day each instead of 7.4 hours. Thus, the two men can handle the harvest output of the machine. Cost of operating two trucks and two tractor forklifts totaled $5.59. Variable costs totaled $55.09 an acre, compared with $183.39 for hand-harvested peaches, as seen in table 7. Changes in any of the specified conditions would, of course, alter the costs.

COSTS AND RETURNS BY SIZE OF PEACH OPERATION

Fixed Costs

Fixed costs (incurred regardless of production activities) vary by size of farm because different complements of machinery reach capacity output at varying levels of production. These costs include interest and taxes on land investment; depreciation, interest, taxes, and insurance on machinery and buildings; cost of irrigation system; and annual salaries of foreman when operators do not perform managerial functions or need help in performing them.

Fixed costs of 40-, 80-, and 160-acre peach operations included equal-sized equipment, although larger farms have multiple units of some equipment (table 8-10). Total investment for fixed costs was $128,692 for 40-acre peach farms, $226,901 for 80 acres, and $443,903 for 160-acre farms.

To minimize fixed costs, the least amount of equipment should be spread over the largest possible acreage--keeping sufficient machinery for timely performance. Some growers keep on hand more than their minimum needs, to cope with emergencies such as a sudden insect infestation, or a rain which could brown-rot ripe peaches if not harvested immediately.

Table 11 summarizes fixed costs per acre with machinery complexes presented in tables 8-10. Fixed costs for hand harvesting an acre were $376.37 on 40-acre peach farms, $328.65 on 80 acres, and $364.21 on 160 acres. On same-size farms mechanically harvesting peaches, costs were $513.74, $397.24, and $398.41. Having a full-time foreman raised costs for 160-acre farms over those for the 80-acre farms. Yet, fixed costs per acre were lower than on 40-acre farms, because machinery units utilized larger acreages.

Other Costs

Some costs not previously specified include a marketing fee of $2 a ton (or $28 an acre) on a farm with a 14-ton yield; miscellaneous costs totaling $41.60 an acre (office supplies, telephone, tax accounting, drinking water and toilet facilities for workers, small tools, etc.); and $4.16 an acre for tree care.

Table 8--Investment and annual fixed costs, 40 acres of cling peaches, California, 1970

Item	Life	Investment	Depreciation 1/	Interest on investment 2/	Taxes and insurance 3/	Total annual fixed costs
	Years			-- Dollars --		
Land	--	44,000.00	--	2,640.00	1,760.00	4,400.00
Trees 4/	16	34,000.00	2,428.57	1,360.00	340.00	4,128.57
Irrigation system	30	6,000.00	200.00	240.00	60.00	500.00
Buildings	30	5,000.00	166.67	200.00	50.00	416.67
Wheel tractor, 40 h.p.	12	5,800.00	458.33	220.40	55.10	733.83
Wheel tractor, 30 h.p.	12	4,500.00	356.25	171.00	42.75	570.00
Sprayer, 500 gal.	15	6,000.00	380.00	228.00	57.00	665.00
Disk, 9'9"	10	1,500.00	142.50	57.00	14.25	213.75
Springtooth, 10'	10	350.00	33.25	13.30	3.33	49.88
Ridger	10	500.00	47.50	15.20	3.80	66.50
Brush shredder	10	800.00	76.00	30.40	7.60	114.00
Trailer	15	1,400.00	88.67	53.20	13.30	155.17
Scraper	10	500.00	47.50	19.00	4.75	71.25
Fertilizer spreader	10	400.00	38.00	15.20	3.80	57.00
Wire barrel	15	100.00	6.33	3.80	.95	11.08
Forklift attachment	15	4,500.00	285.00	171.00	42.75	498.75
Ladders	10	304.00	30.40	12.16	3.04	45.60
Props	10	5,000.00	500.00	200.00	50.00	750.00
Pickup	8	2,700.00	320.63	102.60	25.65	448.88
Truck, 1-1/2 ton	8	4,500.00	531.88	171.00	42.75	745.63
Tractor trailer	15	700.00	46.67	28.00	7.00	81.67
Pruning shears	10	48.00	4.80	1.92	.48	7.20
Buckets 5/	10	90.00	9.00	3.60	.90	13.50
Mechanical harvester	7	25,000.00	3,571.43	1,000.00	250.00	4,821.43
Total hand harvesting	--	128,692.00	6,197.95	5,956.78	2,589.20	14,743.93
Total machine harvesting	--	153,602.00	9,760.38	6,953.18	2,838.30	19,551.86

1/ Assumes salvage value of 5 percent of the original investment for all equipment, except the mechanical harvester, ladders, props, pruning shears, and buckets which have none. 2/ Assumes interest is 8 percent of the average value of the investment. 3/ Assumes taxes and insurance are 2 percent of the average value of the investment, but land taxes are an assumed $40 an acre, and insurance on the farmstead is $4 an acre. 4/ Development cost for first 2 years; depreciation spread over 14 years. 5/ Buckets are not needed for mechanical harvesting.

Table 9--Investment and annual fixed costs, 80 acres of cling peaches, California, 1970

Item	Life	Investment	Depreciation 1/	Interest on investment 2/	Taxes and insurance 3/	Total annual fixed costs
	Years			-- Dollars --		
Land	--	88,000.00	--	5,280.00	3,520.00	8,800.00
Trees 4/	16	68,000.00	4,854.17	2,720.00	680.00	8,254.17
Irrigation system	30	12,000.00	400.00	480.00	120.00	1,000.00
Buildings	30	5,000.00	166.67	200.00	50.00	416.67
Wheel tractor, 40 h.p.	12	5,800.00	458.33	220.40	55.10	733.83
Wheel tractor, 30 h.p.	12	4,500.00	356.25	171.00	42.75	570.00
Sprayer, 500 gal.	15	6,000.00	380.00	228.00	57.00	665.00
Disk, 9'9"	10	1,500.00	142.50	57.00	14.25	213.75
Springtooth, 10'	10	350.00	33.25	13.30	3.33	49.88
Ridger	10	500.00	47.50	15.20	3.80	66.50
Brush shredder	10	800.00	76.00	30.40	7.60	114.00
Trailer	15	1,400.00	88.67	53.20	13.30	155.17
Scraper	10	500.00	47.50	19.00	4.75	71.25
Fertilizer spreader	10	400.00	38.00	15.20	3.80	57.00
Wire barrel	15	100.00	6.33	3.80	.95	11.08
Forklift attachment	15	9,000.00	570.00	342.00	85.50	997.50
Ladders	10	456.00	45.60	18.24	4.56	68.40
Props	10	10,000.00	1,000.00	400.00	100.00	1,500.00
Pickup	8	2,700.00	320.63	102.60	25.65	448.88
Truck, 1-1/2 ton	8	9,000.00	1,063.76	342.00	85.50	1,491.26
Tractor trailer	15	700.00	46.67	28.00	7.00	81.67
Pruning shears	10	60.00	6.00	2.40	.60	9.00
Buckets 5/	10	135.00	13.50	5.40	1.35	20.25
Mechanical harvester	7	25,000.00	3,571.43	1,000.00	250.00	4,821.43
Total hand harvesting	--	226,901.00	10,161.33	10,747.14	4,886.79	25,795.26
Total machine harvesting	--	251,766.00	13,719.26	11,741.74	5,135.44	30,596.44

1/ Assumes salvage value of 5 percent of the original investment for all equipment, except the mechanical harvester, ladders, props, pruning shears, and buckets which have none. 2/ Assumes interest is 8 percent of the average value of the investment. 3/ Assumes taxes and insurance are 2 percent of the average value of the investment, but land taxes are an assumed $40 an acre, and insurance on the farmstead is $4 an acre. 4/ Development cost for first 2 years; depreciation spread over 14 years. 5/ Buckets are not needed for mechanical harvesting.

Table 10--Investment and annual fixed costs, 160 acres of cling peaches, California, 1970

Item	Life	Investment	Depreciation 1/	Interest on investment 2/	Taxes and insurance 3/	Total annual fixed costs
	Years			-- Dollars --		
Land	--	176,000.00	--	10,560.00	7,040.00	17,600.00
Trees 4/	16	136,000.00	9,708.34	5,440.00	1,360.00	16,508.34
Irrigation system	30	24,000.00	800.00	960.00	240.00	2,000.00
Buildings	30	7,500.00	251.00	300.00	75.00	626.00
Wheel tractor, 40 h.p.	12	5,800.00	458.33	220.40	55.10	733.83
Wheel tractor, 30 h.p.	12	4,500.00	356.25	171.00	42.75	570.00
Sprayer, 500 gal.	8	6,000.00	750.00	228.00	57.00	1,035.00
Disk, 9'9"	10	1,500.00	142.50	57.00	14.25	213.75
Springtooth	10	350.00	33.25	13.30	3.33	49.88
Ridger	10	500.00	47.50	15.20	3.80	66.50
Brush shredder	10	800.00	76.00	30.40	7.60	114.00
Trailer (2)	15	2,800.00	177.34	106.40	26.60	310.34
Scraper	10	500.00	47.50	19.00	4.75	71.25
Fertilizer spreader	10	400.00	38.00	15.20	3.80	57.00
Wire barrel	15	100.00	6.33	3.80	0.95	11.08
Forklift attachment	15	13,500.00	855.00	513.00	128.25	1,496.25
Ladders	10	756.00	75.60	29.76	7.56	112.92
Props	10	20,000.00	2,000.00	800.00	200.00	3,000.00
Pickup	8	5,400.00	641.26	205.20	51.30	897.76
Truck, 1-1/2 ton	8	13,500.00	1,595.64	513.00	128.25	2,236.89
Tractor trailer	15	700.00	46.67	28.00	7.00	81.67
Pruning shears	10	72.00	7.20	2.88	.72	10.80
Buckets 5/	10	225.00	22.50	9.00	2.25	33.75
Foreman housing	30	15,000.00	500.00	600.00	150.00	1,250.00
Foreman salary	--	8,000.00	--	--	--	8,000.00
Mechanical harvester	7	25,000.00	3,571.43	1,000.00	250.00	4,821.43
Total hand harvesting	--	443,903.00	18,636.21	20,840.54	9,610.26	57,087.01
Total machine harvesting	--	468,678.00	22,185.14	21,831.54	9,858.01	61,874.69

1/ Assumes salvage value of 5 percent of the original investment for all equipment, except the mechanical harvester, ladders, props, pruning shears, and buckets which have none. 2/ Assumes interest is 8 percent of the average value of the investment. 3/ Assumes taxes and insurance are 2 percent of the average value of the investment, but land taxes are an assumed $40 an acre, and insurance on the farmstead is $4 an acre. 4/ Development cost for first 2 years; depreciation spread over 14 years. 5/ Buckets are not needed for mechanical harvesting.

Table 11--Fixed costs per acre, cling peach operations, California, 1970 1/

Equipment	Size of operation		
	40 acres	80 acres	160 acres
	-- Dollars --		
Land	110.00	110.00	110.00
Trees	103.21	103.21	103.21
Irrigation system	12.50	12.50	12.50
Buildings	10.52	5.21	3.91
Wheel tractor, 40 h.p.	19.23	9.62	4.59
Wheel tractor, 30 h.p.	15.32	7.66	7.13
Sprayer, 500 gal.	16.62	8.31	6.47
Disk, 9'9"	5.34	2.67	1.34
Springtooth	1.25	.62	.31
Ridger	1.66	.83	.42
Brush shredder	3.26	1.63	.82
Trailer	4.23	2.12	2.12
Scraper	1.78	.89	.45
Fertilizer spreader	1.43	.71	.36
Wire barrel	.32	.16	.08
Forklift attachment	14.25	14.25	10.69
Ladders	1.26	.88	.63
Props	18.75	18.75	18.75
Pickup	11.22	5.61	5.61
Truck, 1-1/2 ton	21.58	21.58	16.18
Tractor trailer	2.04	1.02	.51
Pruning shears	.21	.13	.08
Buckets 2/	.39	.29	.24
Foreman housing	--	--	7.81
Foreman salary	--	--	50.00
Mechanical harvester	137.76	68.88	34.44
Total nonmechanical	376.37	328.65	364.21
Total mechanical	513.74	397.24	398.41

-- = Not applicable.

1/ Based on acreage for equipment needed if 87.5 percent of the acreage is bearing and 12.5 percent is nonbearing.

2/ Buckets are not needed for mechanical harvesting.

Total Costs

Total, variable, and fixed costs per acre are given in table 12. Variable costs are $642.19 when hand harvesting and $513.89 when machine harvesting, including interest on production expenses. Interest charges are at 8 percent for 6 months on production expenses, except marketing fees which are paid immediately. Fixed costs are $72.75 a ton when hand harvesting on 40-acre farms, $69.35 on 80 acres, and $71.89 on 160 acres. Comparable costs for machine harvesting peaches are $73.40, $65.08, and $65.16

Net Returns

Net returns are defined in this report as the returns to management and operator labor. 7/ They are gross sales minus production costs except the cost of the operators labor and management (table 12). Net returns vary with changes in yield, price of net No. 1 peaches, and production costs. During the last 15 years, prices have ranged from $57 to $81 per ton of net No. 1 peaches. Yields have fluctuated depending on both variety and year. Costs rise when yield increases (extra time needed for picking, and longer use of equipment during the harvest) but relatively less than added returns. Cost of performing preharvest operations would not likely differ with larger yields, although the cost of thinning and propping might increase.

7/ An alternative would have been to calculate returns to equity or investment, and assume a fixed charge for labor.

Table 12--Costs and returns per acre for cling peach operations, California, 1970 1/

Item	Hand harvest			Mechanical harvest		
	40 acres	80 acres	160 acres	40 acres	80 acres	160 acres
	-- Dollars --					
Variable costs	642.19	642.19	642.19	513.89	513.89	513.89
Fixed costs	376.37	328.65	364.21	513.74	397.24	398.41
Total costs	1,018.56	970.84	1,006.40	1,027.63	911.13	912.30
Gross returns 2/	1,134.00	1,134.00	1,134.00	1,134.00	1,134.00	1,134.00
Net returns	115.44	163.16	127.60	106.37	222.87	221.70

1/ Based on 87.5 percent of the acreage bearing fruit and 12.5 percent nonbearing. 2/ Based on a peach price of $81 a ton and a 14-ton yield per acre of net No. 1 peaches.

Assuming a 14-ton yield and 10-percent green-drop, net returns are positive for $81 a ton peaches and all but mechanically harvested peaches on 40-acre farms with prices to farmers of $73 a ton (table 13). But net returns are negative when prices to farmers are $57 and $65 a ton on all sizes of farms, although variable costs are covered. With a 14-ton yield at a cost of $81 a ton, break-even acreage--gross returns equal total costs--is about 20 acres for hand harvesting and 26 for machine harvesting. When the price is $73 a ton, break-even comes at about 37 acres for either harvest method. For lower peach prices with 14-ton yields, break-even acreage expands considerably. For example, on 80-acre peach farms hand harvesting would require $69 a ton to break even and machine harvesting, $65 a ton.

Tables 14 and 15 illustrate effects of changes in estimates of yield, cost, and returns of four levels of yields for clings on an 80-acre farm. Net returns to family labor and management are negative when yield is 11 tons an acre but positive when yields are 14, 17, and 20 tons.

As yields rise the differences increase between net returns of hand and mechanically harvested fruit. Also, variable costs increase relatively less for machine harvest, because of the extra labor used for hand harvesting.

EQUAL-COST ACREAGE FOR PURCHASING A MECHANICAL HARVESTER

Switching from hand to mechanical harvesting of peaches alters variable and fixed costs. As illustrated earlier, adopting mechanical harvesting reduces variable costs $128.30 an acre. However, fixed costs per acre advance or decrease in the opposite direction, depending on how much acreage the machine covers.

Harvesting by hand or machine requires three units of equipment--a tractor, forklift attachment, and a truck. To compare costs, the study assumed harvest requires 25 percent of total tractor use and 70 percent use of truck and forklift attachment. The study also assumed that unless otherwise specified, growers utilize two tractors, forklifts, and trucks to handle output.

Based on previously assumed output rates and costs, the equal-cost acreage for machine harvest is 37 acres (fig. 1). Total costs for both machine and hand harvest are about $1,017. But, equal-cost acreage would be even lower if labor costs increase, machine output rate mounts, useful life of the machine increases, or fewer workers are used on a machine. Opposite changes would ensue from higher equal-cost acreage. But if fruit quality drops, compared with hand-harvested fruit, the equal-cost point would he higher. The report reveals effects of some of these changes.

Table 13--Net returns per acre for cling peach operations, hand and mechanical harvest, California, 1970

Item	Size of operation					
	40 acres	80 acres	160 acres	40 acres	80 acres	160 acres
	Hand harvest			Machine harvest		
	-- Dollars --					
$81/ton						
Gross sales	1,134.00	1,134.00	1,134.00	1,134.00	1,134.00	1.134.00
Total costs	1,018.56	970.84	1,006.40	1,027.63	911.13	912.30
Net returns	115.44	163.16	127.60	106.37	222.87	221.70
Returns above variable costs	491.81	491.81	491.81	620.11	620.11	620.11
$73/ton						
Gross sales	1,022.00	1,022.00	1,022.00	1,022.00	1,022.00	1,022.00
Total costs	1,018.56	970.84	1,006.40	1,027.63	911.13	912.30
Net returns	3.44	51.16	15.60	-5.63	110.87	109.70
Returns above variable costs	379.81	379.81	379.81	508.11	508.11	508.11
$65/ton						
Gross sales	910.00	910.00	910.00	910.00	910.00	910.00
Total costs	1,018.56	970.84	1,006.40	1,027.63	911.13	912.30
Net returns	-108.56	-60.84	-96.40	-117.63	-1.13	-2.30
Returns above variable costs	267.81	267.81	267.81	396.11	396.11	396.11
$57/ton						
Gross sales	798.00	798.00	798.00	798.00	798.00	798.00
Total costs	1,018.56	970.84	1,006.40	1,027.63	911.13	912.30
Net returns	-220.56	-172.84	-208.40	-229.63	-113.13	-114.30
Returns above variable costs	155.81	155.81	155.81	284.11	284.11	284.11

Table 14--Costs and returns per acre, hand harvesting, 80-acre peach farms, California, 1970 1/

Item	Yield level			
	11 tons	14 tons	17 tons	20 tons
	-- Dollars --			
Gross sales	891.00	1,134.00	1,377.00	1,620.00
Variable costs				
All	603.02	642.19	682.11	720.34
Harvest	144.22	183.39	223.31	261.54
Fixed costs				
All	328.65	328.65	328.65	328.65
Harvest	25.80	25.80	25.80	25.80
Total costs				
All	931.67	970.84	1,010.76	1,049.09
Harvest	170.02	209.19	249.11	287.32
Net returns	-40.67	163.16	366.24	573.91

1/ Based on price of $81 per ton.

Table 15--Costs and returns per acre, mechanical harvesting, 80-acre peach farms, California, 1970 1/

Item	Yield level			
	11 tons	14 tons	17 tons	20 tons
	-- Dollars --			
Gross sales	891.00	1,134.00	1,377.00	1,620.00
Variable costs				
All	510.03	513.89	518.03	521.22
Harvest	51.23	55.09	59.23	62.62
Fixed costs				
All	397.24	397.24	397.24	397.24
Harvest	86.13	86.13	86.13	86.13
Total Costs				
All	907.27	911.13	915.27	918.46
Harvest	137.36	141.22	145.36	148.75
Net returns	-16.27	222.87	461.73	701.54

1/ Based on price of $81 per ton.

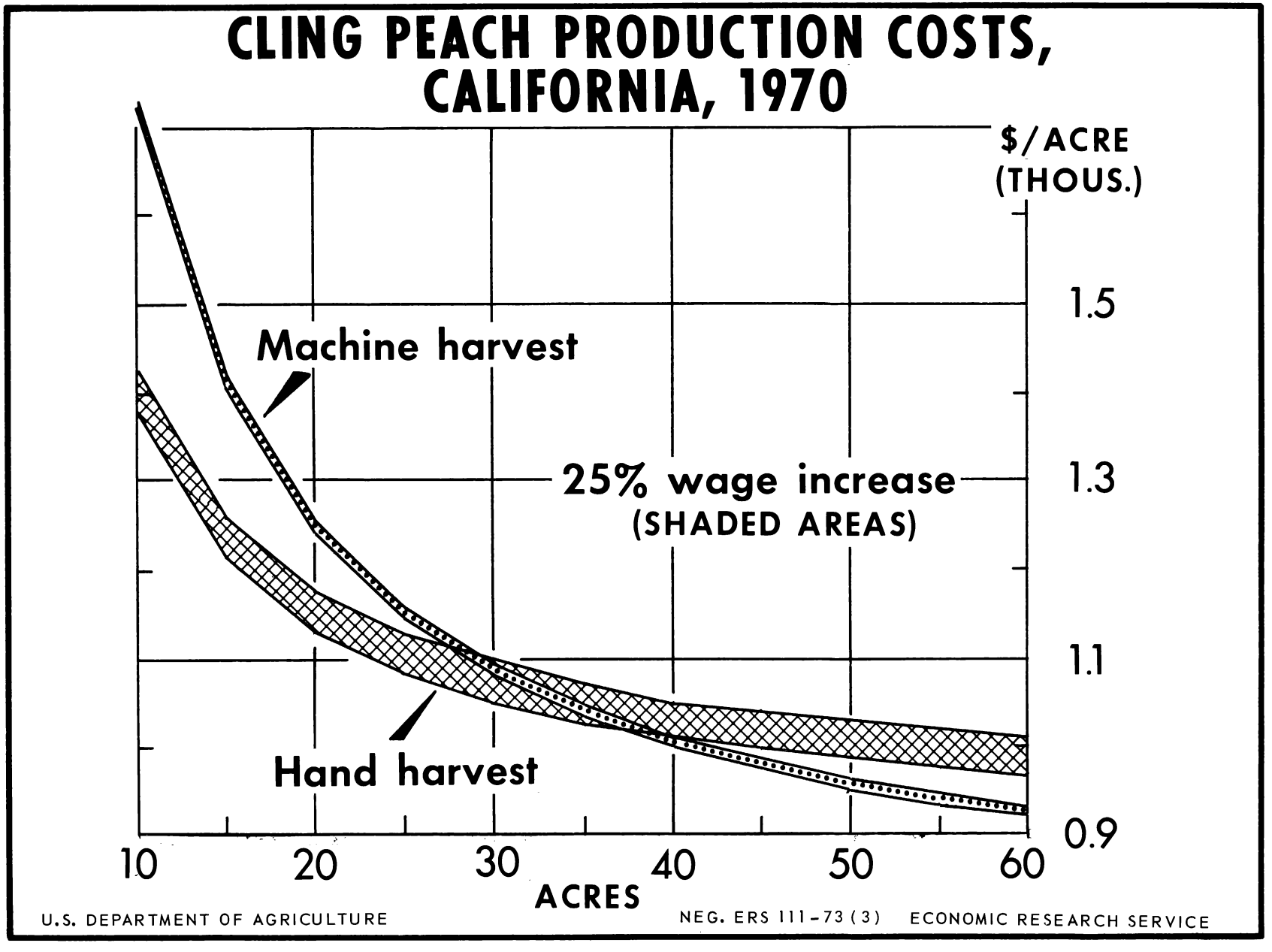
CLING PEACH PRODUCTION COSTS, CALIFORNIA, 1970
$/ACRE (THOUS.)
1.5
1.3
1.1
0.9
Machine harvest
25% wage increase (SHADED AREAS)
Hand harvest
10
20
30
40
50
60
ACRES
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Figure 1

Effect of Increased Labor Costs

During the last decade labor costs climbed faster than most production costs. For example, labor costs rose 30 percent faster than machinery costs from 1960 to 1970 and 22 percent faster from 1965 to 1970. The study assumes a 25-percent advance in labor costs from the 1970 wage rates while other costs remain the same (an unlikely effect but the same as if other costs had risen and labor costs had increased relatively by 25 percent). The equal-cost point then would be 29 acres (fig. 1) and total costs about $1,104 per acre. The 25-percent wage gain lowers the equal-cost point 8 acres, and total costs are $87 per acre higher at the equal-cost acreage than before the wage increase.

Effect of Reduced Harvester Output

Some growers using mechanical equipment harvest less than 4 acres of peaches a day, particularly during their first year, because of inexperienced crews, trees not pruned suitably for mechanical harvesters, faulty machine design, or other factors. The equal-cost acreage for purchasing a mechanical harvester for these growers would be higher than derived earlier.

To illustrate, the study assumed a 3-acre average output per 8-hour day. In a 48-day harvest season, the maximum output is 144 acres, down from 192 acres at the maximum output rate of 4 acres a day.

Crew size remains the same but labor costs increase because each acre absorbs 2.67 rather than 2.0 hours of labor and machine time. Time spent by the two tractor-forklift-truck operators does not change from 2.15 hours an acre. Although gasoline, oil, and grease costs probably would be lower because of reduced output, repair costs per acre likely would rise. These changes are assumed to be offsetting.

A lower output rate increases the equal-cost acreage from 37 to 38 acres. Total production costs for both hand and machine harvest are about $1,030 an acre.

Yield changes have a direct effect on the equal-cost acreage for mechanically harvested peaches. As indicated earlier, equal-cost acreage for 14-ton yields was 37, which mounts to 52 acres when yields are 11 tons but declines to 29 acres if yields go to 17 tons, and to 24 acres if yields are 20 tons.

Changes in green-drop regulations would similarly affect costs, returns, and the equal-cost acreage for mechanically harvested peaches. And higher green-drop requirements generally increase costs, lower returns, and raise the equal-cost acreage.

These examples show how changes alter equal-cost acreage, but each grower should consider his own situation before buying a machine. Although he might have insufficient acreage for economical mechanical harvesting, it might be feasible for him to buy a machine if he does contract work for others. On the other hand, growers on small farms might prefer hiring contract machine oper-

ators. Based on 14-ton yields and cost estimates derived earlier, growers on these smaller farms could pay nearly $14 a ton without a rise in variable costs of machine harvest over hand harvest, assuming equal efficiencies.

MACHINE INVESTMENT--LABOR SUBSTITUTION

A shift from harvesting peaches by hand to harvesting mechanically results in a significant substitution of investment for labor. For example, the $25,000 machine investment substitutes for 1,981 hours of labor a year on a 40-acre peach farm (35 acres bearing); 3,962 hours of labor a year on an 80-acre peach farm (70 acres bearing); and 7,924 hours on a 160-acre farm (140 acres bearing). On the 40-acre farm $12.62 of machine investment, or an equivalent annual investment of $1.80, substitutes for a current annual cost of $2.50 for an hour of labor. On the larger farms the ratio drops to $0.90 on the 80-acre farm, and $0.45 per hour of labor ($2.50) on the 160-acre farm. Customwork provides an opportunity for growers having smaller peach acreages to reduce their investment-labor ratios.

Substituting investment for labor displaces more labor than is apparent from the hours involved. And, skilled labor substitutes for unskilled labor, because many workers who handpick peaches have neither the skills nor inclination to operate mechanical harvesters.

LABOR USE ON CLING PEACH FARMS

In time, mechanical harvest of peaches likely will replace hand harvest. Mechanization substantially reduces labor input for harvesting peaches, but poses a problem for growers who use the same crews for pruning, thinning, and harvesting. Traditional migratory paths may change, creating a deficit labor supply for pruning and thinning operations. However, use of labor for pruning and thinning could gain flexibility, though less so for thinning, if traditional hand methods continue. But alternative economical thinning methods, currently in limited use, offer a new potential.

Labor for hand harvesting peaches amounts to about 188 hours an acre, totaling some 13,300 hours for 70 acres of mature and 10 acres of nonbearing peach trees. This would equal 6-1/2 man-years of work. But peaks and troughs in labor use cause uneven distribution of labor (fig. 2). Although in May about 17 workers could be fully employed on an 80-acre peach farm, one man would be underemployed in April and October.

Thinning by chemical or by mechanical shaking of peach trees might hold as much potential for reduced labor inputs as does mechanical harvesting, but data are limited. At the outset, labor savings likely would vary greatly, and some hand thinning might be necessary after using either thinning technique.

In assuming bases for comparisons, a chemical sprayer can thin an acre of cling peaches in half an hour; follow-up thinning by hand takes a fourth as much labor as complete thinning by hand. Thus, total costs of spraying would equal $73.13 an acre--$34.85 for labor, $30.00 for spray materials, and $8.28

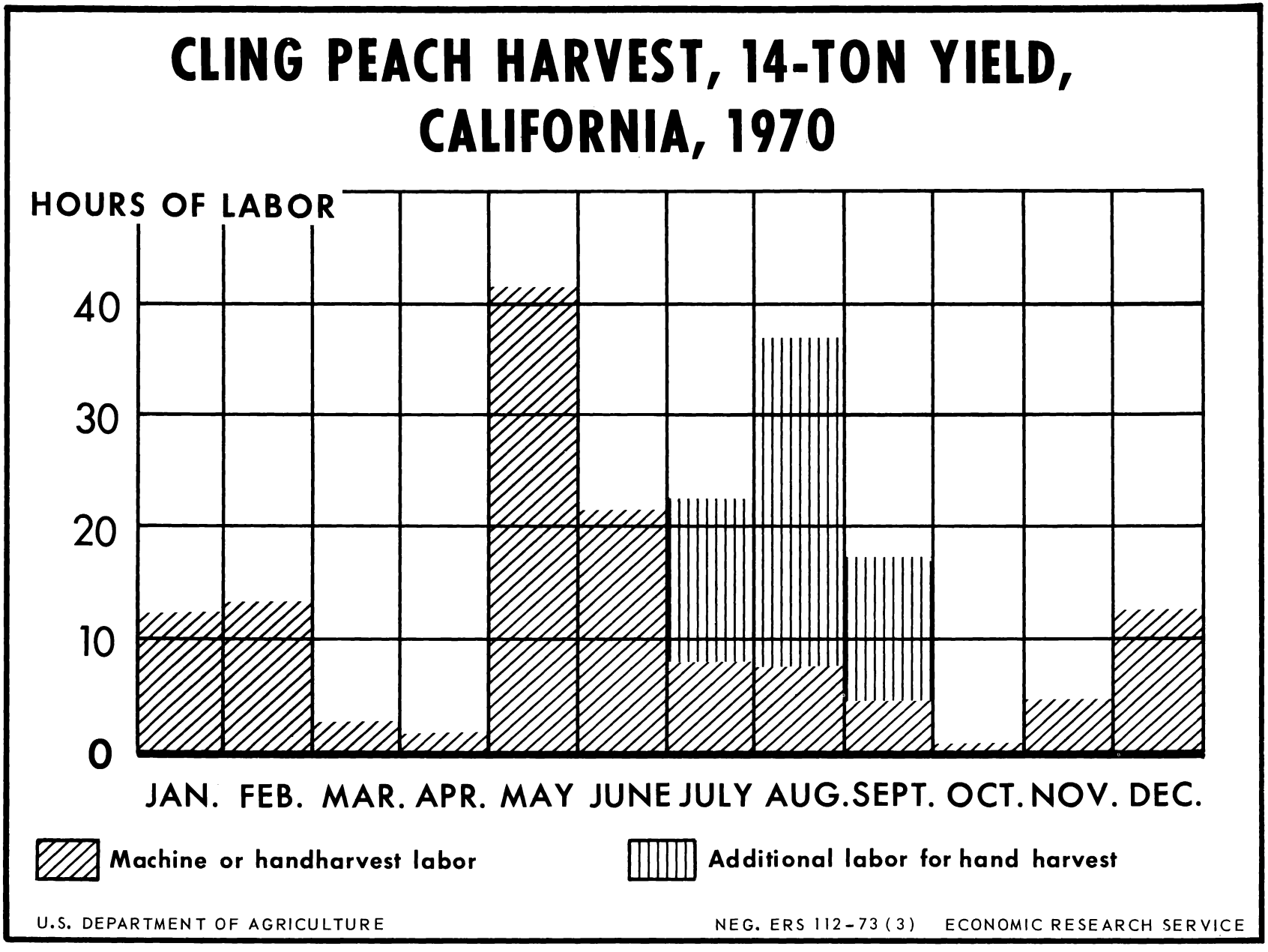
CLING PEACH HARVEST, 14-TON YIELD, CALIFORNIA, 1970
HOURS OF LABOR
40
30
20
10
0
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
Machine or handharvest labor
Additional labor for hand harvest
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 112-73 (3) ECONOMIC RESEARCH SERVICE

Figure 2

for other costs. Thinning costs drop by almost half, and labor use by almost three-fourths, on an 80 acre farm.

Assuming rates equal both for thinning and for mechanical harvesting, machine thinning costs on an 80-acre peach farm would be $93.54 an acre--if follow-up thinning by hand is light. Costs include $41.09 for labor, $15.75 for machine operation, and $2.27 for interest on production expenses. And the $34.43 allotted to fixed costs would be spread over twice as many acres of use. Mechanical thinning reduces costs about a third, labor almost three-fourths. Labor use is about the same as for chemical thinning.

Either of these methods of thinning cling peaches could reduce labor use on an 80-acre farm some 2,500 hours. Thus, the entire operation would drop total labor use from 13,300 to 6,800 hours, if the fruit is also machine harvested. Substituting this new technology significantly reduces peak labor needs on peach farms. Pruning could be spread over a longer period--from November through March, which cuts down on the number of workers used, but extends the time of each remaining worker. Further, the worker would have a more stable income, the employer a more dependable source of labor. Also, future union contracts or national labor legislation might require payments year-round. If so, employers will want to use the fewest numbers of workers as fully as possible.

Union contracts or national labor legislation calling for mandatory year-round payments to workers might make it profitable for cling peach growers to diversify, depending on relative production costs and prices received from other crops, and how yearly pay affects competitive positions of crops.

Effect of Diversification

Several of the surveyed peach farms produced other tree crops--most commonly almonds. The two tree crops are complementary because when harvest begins for almonds, harvest is virtually complete for peaches. Further, several units of equipment can be used for either crop.

General production practices for almonds and peaches are similar, although labor inputs are much fewer for an acre of almonds than for an acre of peaches--188 hours for peaches versus 31 hours for almonds. But, almond harvests are almost entirely by machine. Total labor time for producing an acre of machine harvested cling peaches is 100 hours more than for an acre of almonds.

Table 16 shows labor use for almonds by production operation and month. Labor for almonds peaks in September and November, dips in December and January. In contrast, labor use is highest for peaches in May and August, lowest in October and March. Having both tree crops on the farm would tend to even labor use.

Table 16--Labor use per acre for almonds, California, 1970

Operation	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	-- Hours per acre --											
Prune	--	--	--	--	--	--	--	--	--	--	7.0	--
Remove brush	--	--	--	--	--	--	--	--	--	--	1.0	--
Fertilize (2 times)	--	--	0.3	--	--	--	--	--	--	--	.3	--
Spray (3 times)	0.5	--	--	--	--	0.5	--	0.5	--	--	--	--
Cultivate	--	--	--	0.4	0.4	.4	0.4	--	--	0.3	--	--
Ridge up (6 times)	--	--	--	.1	.1	.1	.1	.1	0.1	--	--	--
Irrigate (6 times)	--	--	--	.5	.5	.5	.5	.5	.5	--	--	--
Knock ridges (6 times)	--	--	--	.08	.08	.08	.08	.08	.08	--	--	--
Hoe	--	--	1.0	--	--	--	--	--	--	--	--	--
Set and light heater	--	2.0	--	--	--	--	--	--	--	--	--	--
Float	--	--	--	--	--	--	--	.5	--	--	--	--
Knock	--	--	--	--	--	--	--	--	2.0	.5	--	--
Rake	--	--	--	--	--	--	--	--	1.2	.3	--	--
Pickup	--	--	--	--	--	--	--	--	.8	.2	--	--
Haul to huller	--	--	--	--	--	--	--	--	.8	.2	--	--
Miscellaneous 1/	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	0.5
Total	1.0	2.5	1.8	1.58	1.58	2.08	1.58	2.18	5.98	2.0	8.8	.5

-- = Not applicable.

1/ Includes tree care, recordkeeping, upkeep of equipment, and general supervision.

Figure 3 depicts labor use by month for two 80-acre farms--one with 80 acres of peaches, another with 40 acres each of peaches and almonds. Although peak labor use occurs in May and August on the farm growing both crops, the level of labor use is cut almost in half compared with peaches alone. The peach-almond operation results in more use of labor in April, October, and November than with peaches only. For the combined crops total labor use decreases from some 13,300 to 7,800 hours a year.

Growing both peaches and almonds on an 80-acre farm reduces total labor, distributing it more evenly throughout the year. However, 40 acres of each of these tree crops takes more total capital investment. Thus, with these acreages, buying a harvester is not economical for either crop.

Diversifying from an 80-acre peach orchard having an annual net income of $11,421.20 (70 bearing acres x $163.16) to one having 40 acres of peaches (35 bearing acres) and 40 acres of almonds (35 bearing acres) sharply alters production costs and returns.

Table 17 shows production operations and variable costs of producing almonds. Total variable costs for almonds are $302.91 an acre. Fixed costs for the entire operation are shown in table 18. Table 19 presents the costs per acre--allocating them to the peach and almond operation.

Table 17--Almond production costs, California, 1970

Operation	Variable costs per acre
	-- Dollars --
Prune	16.02
Remove brush	3.34
Fertilize (2 times)	20.66
Spray	50.19
Cultivate	6.18
Irrigate (6 times)	9.82
Hoe	2.29
Set and light heaters	4.58
Float	2.76
Knock, rake, pickup - custom	62.40
Haul to huller	6.00
Hulling charge	66.67
Miscellaneous 1/	52.00
Total	302.91

1/ Includes tree care, bees, farm insurance, and miscellaneous requirements.

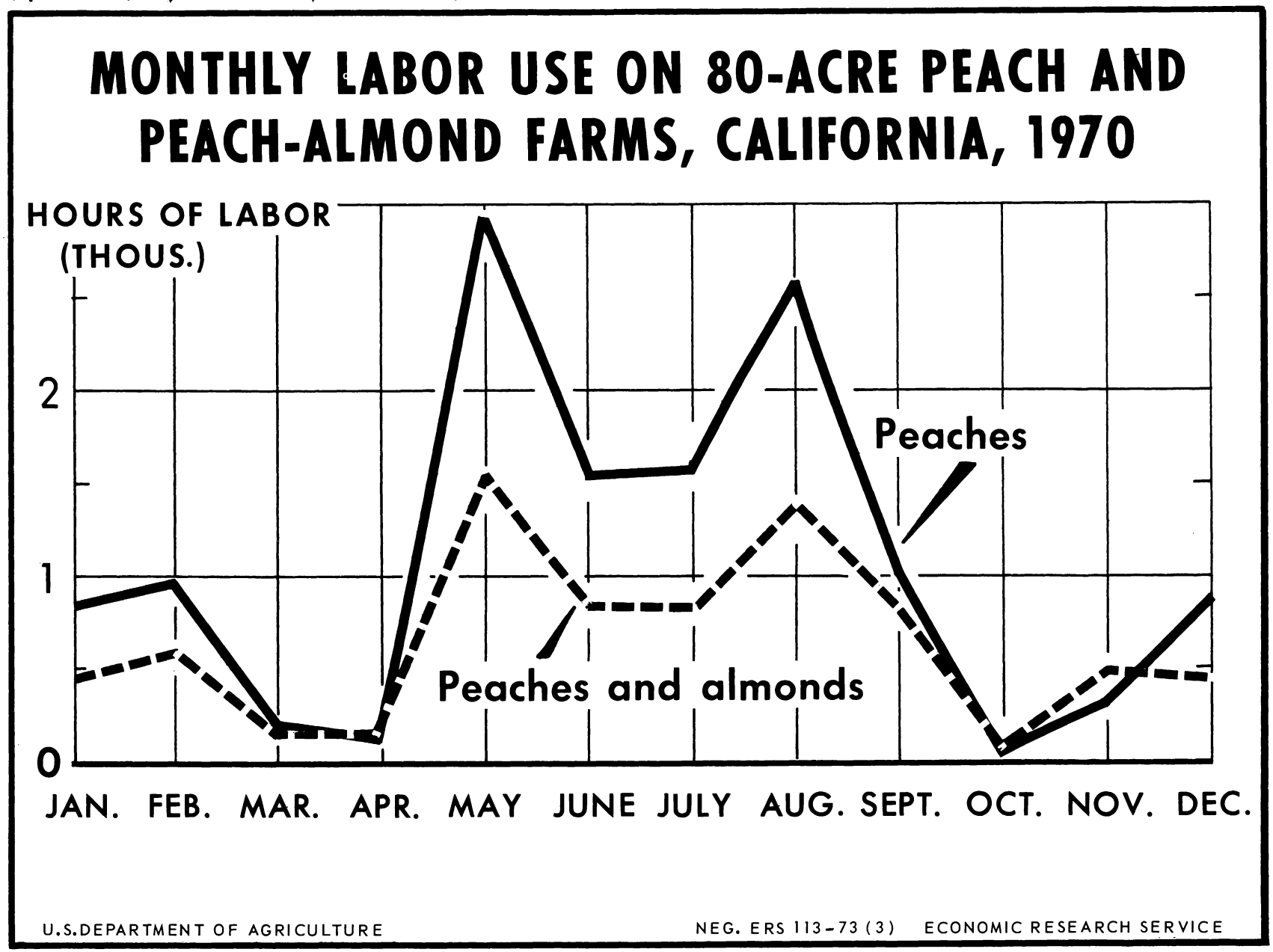
MONTHLY LABOR USE ON 80-ACRE PEACH AND PEACH-ALMOND FARMS, CALIFORNIA, 1970
HOURS OF LABOR (THOUS.)
2
1
0
Peaches
Peaches and almonds
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
U.S.DEPARTMENT OF AGRICULTURE
NEG. ERS 113-73 (3) ECONOMIC RESEARCH SERVICE

Figure 3

Table 18--Investment and annual fixed costs, 40 acres each of peaches and almonds, California, 1970

Item	Life	Investment	Depreciation 1/	Interest on investment 2/	Taxes and insurance 3/	Total annual fixed costs
	Years			-- Dollars --		
Land	--	88,000.00	--	5,280.00	3,520.00	8,800.00
Trees 4/	30	97,040.00	4,950.17	3,881.60	970.40	9,802.17
Irrigation system	30	12,000.00	400.00	480.00	120.00	1,000.00
Buildings	30	5,000.00	166.67	200.00	50.00	416.67
Wheel tractor, 40 h.p.	12	5,800.00	458.33	220.40	55.10	733.83
Wheel tractor, 30 h.p.	12	4,500.00	356.25	171.00	42.75	570.00
Sprayer, 500 gallon	15	7,000.00	466.67	266.00	66.50	799.17
Disk, 9'9"	10	1,500.00	142.50	57.00	14.25	213.75
Springtooth, 10'	10	350.00	33.25	13.30	3.33	49.88
Ridger	10	500.00	47.50	15.20	3.80	66.50
Brush shredder	10	800.00	76.00	30.40	7.60	114.00
Trailer	15	1,400.00	88.67	53.20	13.30	155.17
Scraper	10	500.00	47.50	19.00	4.75	71.25
Fertilizer spreader	10	400.00	38.00	15.20	3.80	57.00
Wire barrel	15	100.00	6.33	3.80	.95	11.08
Forklift attachment	15	4,500.00	385.00	171.00	42.75	598.75
Ladders	10	304.00	30.40	12.16	3.04	45.60
Props	10	5,000.00	500.00	200.00	50.00	750.00
Pickup	8	2,700.00	320.63	102.60	25.65	448.88
Truck, 1-1/2 ton	8	4,500.00	531.88	171.00	42.75	745.63
Tractor trailer	15	700.00	46.67	28.00	7.00	81.67
Pruning shears	10	48.00	4.80	1.92	.48	7.20
Buckets	10	90.00	9.00	3.60	.90	13.50
Orchard landplane	10	1,200.00	114.00	45.60	11.40	171.00
Heaters	15	4,400.00	293.33	176.00	44.00	513.33
Oil storage	15	1,000.00	66.67	40.00	10.00	116.67
Cart	15	325.00	21.67	13.00	3.25	37.92
Chain saw	10	150.00	15.00	6.00	1.50	22.50
Total	--	249,807.00	9,616.89	11,676.98	5,119.25	26,413.12

-- = Not applicable.

1/ Assuming salvage value of 5 percent of the original value for all equipment, but no salvage value for ladders, props, pruning shears, buckets, heaters, and oil storage.

2/ Assuming interest will be 8 percent of average value of investment.

3/ Assuming taxes and insurance are to be 2 percent of average value of the investment, but land taxes are assumed $40 an acre and insurance on the farmstead, $4 an acre.

4/ Development costs for first 2 years on peaches and first 5 years on almonds.

Table 19--Fixed costs per acre allocated to 40 acres each of peaches and almonds, California, 1970

Item	Peaches	Almonds
	-- Dollars --	
Land	110.00	110.00
Trees	103.21	123.44
Irrigation system	12.50	12.50
Buildings	5.21	5.21
Wheel tractor, 40 h.p.	11.70	7.54
Wheel tractor, 30 h.p.	8.97	6.35
Sprayer	12.48	7.49
Disk	2.67	2.67
Springtooth	.62	.62
Ridger	.83	.83
Brush shredder	1.63	1.63
Trailer	2.12	2.12
Scraper	.89	.89
Fertilizer spreader	.71	.71
Wire barrel	.32	--
Forklift attachment	14.25	--
Ladders	1.26	--
Props	18.75	--
Pickup	5.61	5.61
Truck, 1-1/2 ton	21.68	--
Tractor trailer	1.02	1.02
Pruning shears	.21	--
Buckets	.39	--
Bins	--	--
Orchard landplane	--	1.43
Heaters	--	14.66
Oil storage	--	3.33
Cart	--	1.08
Chain saw	--	.64
Total	337.03	309.77

-- = Not applicable.

Total costs were $612.68 an acre for almonds, and $979.22 for peaches. With an almond yield of 1.2 meat-tons an acre and a sale price of $525 a ton, net returns are $17.32 an acre for almonds, totaling $606.20 on 35 bearing acres. Net returns for peaches were $154.78 an acre, totaling $5,417.30 for 35 bearing acres. Diversifying brought a combined net return of $6,023.50--a drop of $5,397.70 in net farm income. On the other hand, if peach yields were 11 tons to the acre, net returns from peaches would be -$45.99--diversification would pay because positive returns from almonds would help to recoup losses from peaches. How profitable the diversification depends on relative prices and yields of the two crops, which vary from year to year.

As mentioned earlier, almost six times as much labor is used on peaches as on almonds. This drops down to about four times as much when machine harvesting peaches. Thus, especially when labor is scarce, some farmers prefer the less profitable almond crop over peaches.

With a goal of using hired labor year-round to satisfy a union contract of labor legislation, yet trying to maintain net farm income, adjusting acreage to 40 acres each of peaches and almonds is not feasible. The acreage is too small to permit purchase of a mechanical peach harvester, and without it labor peaks in May and August are still too high. A different mix of acreage--perhaps 60 acres of peaches and 20 acres of almonds--would permit machine use on peaches and customwork on almonds. This should allow growers to reduce labor from the May peak by using machine thinning, and from the August peak by machine harvesting. Retaining more peach acreage also would permit higher net farm income.

Future possible study on this labor project might delve deeper into the effects of diversification, focusing on an attempt to even out labor use.

IMPLICATIONS OF HARVEST MECHANIZATION

Rate of Adoption

The rate of adopting machines for mechanically harvesting peaches depends primarily on processors' acceptance of the machine harvested product. Two processors interviewed seemed ready to accept some mechanically harvested cling peaches if the quality standards are not sacrificed. If operators follow good managerial practices, quality of machine-harvested fruit can be at least as high as hand-harvested fruit. These practices include proper drop-padding, deceleration devices, conveyor, and bin filler on the machine, besides tree training and other recommended cultural practices to insure uniform ripening of fruit (5). Care by the machine operators is essential for successful mechanization of these operations.

Mechanization can proceed only as rapidly as processors can gear for handling machine-harvested fruit. Grading standards considered adequate for hand-harvested fruit need modifying to ensure more accurate evaluation of quality of machine-harvested fruit. For example, perhaps the need is to go to half-fruit rather than whole-fruit grading. That is, grade each half separately rather than the current method of grading the entire peach.

Growers need larger capacity, more sophisticated grading equipment, and sufficient facilities for rapid processing of mechanically harvested fruit. Efforts should be made to eliminate unnecessary handling of the fruit.

Another major determinant of when growers will purchase machines is how available labor is--in sufficient numbers and at the proper time. If labor seems in short supply at the current wage rate, growers are more likely to purchase a machine. Quality and dependability of labor also push growers to decide on mechanically harvesting peaches.

The demand outlook for peaches is another major factor in the decision to purchase a mechanical harvester. With the current surplus of clings, growers are hesitant about buying machines. If acreage is stabilized and a grower has greater certainty about future market potential, he is more likely to consider mechanization.

The pace of adopting machines has varied greatly among crops. Despite uncertain conditions, with advancing wage rates, improved harvesters, and the likelihood of processors increasing their handling know-how, there is little doubt that mechanical harvest of peaches will increase.

Machine Investment and Labor Displacement

Peach harvest mechanization has the potential of displacing considerable labor. The amount of labor displaced, of course, depends on the percentage of the harvest that is mechanized. Based on 14-ton yields and the labor coefficients presented earlier, machine work would displace 2.83 million hours of labor in California, if peach acreage stabilizes at 50,000 acres at some future date and growers machine harvest all peaches (table 20). 8/

The investment in machines would total $20.8 million, if each machine costs $25,000 and is used to harvest 60 acres. The wage loss to workers would come to $7.08 million a year. This is based on the average worker earning $5 for picking a bin of peaches per 2-hour period, and for displaced workers receiving equivalent wages. Under similar conditions, but with only 60 percent harvest mechanization, displacement of labor would total 1.7 million hours, wage loss would be $4.25 million, and the machine investment would be $12.5 million.

The critical decision for the number of machines to be purchased for harvesting cling peaches depends on how many acres each machine harvests and the share of total cling acreage to be machine harvested. Thus, if all peaches are harvested by machine, but harvest per machine is only 40 acres, the need would be for 1,250 machines at an investment of $31.3 million (table 21). But harvest could be effected with only 208 machines costing

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8/ Not considered here is a greater displacement of labor because of higher skilled machine operators substituting for lower skilled pickers. Neither does it consider the likelihood that chemical or mechanical shaking of trees for thinning might increase and displace even more labor.

Table 20--Displacement of labor, assumed levels of peach harvest mechanization, California, 1970 1/

Percent mechanically harvested	Investment in machines 2/	Hours of labor displaced 3/	Wage loss to workers 4/
	Million dollars	Million hours	Million dollars
10	2.08	0.28	0.71
20	4.18	.57	1.42
30	6.25	.85	2.12
40	8.33	1.13	2.83
50	10.43	1.41	3.54
60	12.50	1.70	4.25
70	14.58	1.98	4.96
80	16.68	2.26	5.66
90	18.75	2.55	6.37
100	20.83	2.83	7.08

1/ Based on an average yield of 14 tons (net No. 1's) and 50,000 bearing acres of peaches.

2/ Investment in machines is based on an average yearly output rate of 60 acres per machine.

3/ Excludes indirect labor such as servicing and repairing machines. Thus, slightly overestimating hours of displaced labor.

4/ Assumed average hourly wage (all workers) is $2.50.

Table 21--Number of machines and total investment for machine harvesting cling peaches, California, 1970 1/

Output rate per machine (acres)	Machines	Total investment in machines
	Number	Million dollars
40	1,250	31.25
60	833	20.33
80	625	15.63
100	500	12.50
120	417	10.43
140	357	8.93
160	313	7.83
180	278	6.95
200	250	6.25
220	227	5.68
240	208	5.20

1/ Based on the assumption that bearing acreage stabilizes at 50,000 acres and average yield is 14 tons of net No. 1 peaches per acre.

$5.2 million if harvest for each machine were boosted to 240 acres. Because growers will attempt to expand operations to push machine output, more reasonably, the range of machine capacity is more likely to be 100 to 160 acres. This would equal an investment of $7.83 million to $12.5 million for some 315 to 500 machines.

Ideally, a machine operator could harvest close to 200 acres a year. But he would have to move continually from one variety to another. Such an even distribution among peach varieties would be economical. It is likely that the distribution of acreage by variety will even out in the future not only because it renders more economical machinery use, but also because of tree pull incentives favoring the pulling of late varieties (the current distribution is more heavily concentrated in these varieties). Except for the Dixon Variety--not highly desirable because of its vulnerability to split pits--early and extra early varieties were favored to obtain tree credits in 1971. For example, 88 extra early and 80 early trees substituted for 100 late and extra late trees. A leveling of peach variety distribution is economical for growers and efficient for processors.

Community Welfare

For the cling peach growers, machines mean changes in the ratio to a larger share of fixed to variable costs. And, some cultural practices must change to accommodate machines. Further, land prices might be bid up as mechanization picks up. Of course, land values depend importantly on expected market prices of peaches.

For the farmworker, loss of work harvesting peaches could lead to the loss of his livelihood harvesting any fruit or vegetable crops. If the major crop in the area is peaches, it would not be worthwhile for the worker to seek other harvest work in the same locale. Besides possibly leading to changes in some cultural practices for cling peaches, without available workers harvest of other crops likely would swing more heavily to machines.

In turn, these actions could affect the entire community. Loss of workers' incomes to the community would cut into local sales of food, clothing, gasoline, shelter, and automobiles. However, the aggregate loss could be offset by increased sales of machinery and equipment if growers buy their mechanical harvesters locally. And, local sales of gasoline and oil for use in the new machinery might mitigate the lost sales of gasoline and oil to workers.

A further spinoff from cling harvest mechanization will be the need to retrain some workers for other tasks--operating machines and repairing harvesters. But such job openings would be limited. Thus, workers will need other helpful employment programs.

Mechanizing cling peach harvest also sparks a series of changes in buying patterns and adjustments requiring further research. And, the effect of cling harvest mechanization on California's competitive position in production of cling peaches needs more study than has yet been tried.

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