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THE DEMAND FOR SEASONAL FARM LABOR IN CALIFORNIA

by

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Abstract

California agriculture has changed since 1950. The production of many labor-intensive crops has been concentrated on the relatively few large and specialized farms that hire the most farmworkers. Mechanization has decreased the demand for farmworkers in crops such as cotton, sugar beets, and tomatoes, but acreage expansion in labor-intensive crops such as citrus, grapes, vegetables and tree fruits has increased the demand for equipment operators and irrigators. About 160,000 seasonal workers are employed at the peak in June, July, and September.

This report analyzes the demand for seasonal farmworkers in California agriculture. Section 1 shows (1) how the increased importance of large and specialized farms that rely on hired workers and (2) expanded production have maintained the demand for seasonal farmworkers despite mechanization. Section 2 reviews geographic and seasonal variations in labor needs and examines the patterns of labor-saving mechanization since 1950, including mechanical harvesters, labor-displacing machinery to lift and handle harvested crops, and chemicals and precision planting that reduce the need to thin and hoe. Section 3 outlines the enormous expansion of labor-intensive crop production in California that limited the decrease in peak seasonal farmworker employment and explains how man-years of farmwork are currently distributed among five kinds of jobs: heavy-hand tasks, light-hand tasks, tomato sorters, irrigators, and semi-skilled equipment operators. Section 4 reviews the status of mechanization in labor-intensive crops and explains why labor needs are likely to increase if labor-intensive agriculture is mechanized because workers will be needed to plant and prune trees for mechanical harvesting and to sort mechanically-harvested fruits and vegetables (however, women sorting will replace men picking).

The Demand for Seasonal Farm Labor in California

Introduction

California farmers sold crops and livestock with a farm value of $13.9 billion in 1981. Almost half of California's farm products were specialty crops: fruits and nuts, $3.1 billion; vegetables, $2.6 billion; and greenhouse/nursery products $0.9 billion. These specialty crops are considered labor-intensive because wages are 20 to 50 percent of total production costs. Pending immigration and labor laws may reduce the availability of harvest workers, so this paper was written to review the demand for labor in California agriculture.

California agriculture includes a variety of labor-intensive crops whose peak summer/fall need for hired labor is 10 to 20 times larger than trough winter employment. Hence, agriculture has demanded a flexible pool of workers that is able to swell and shrink rapidly without risk or cost to growers. This labor supply has traditionally included first generation immigrants to California, so immigration and other labor changes may require unprecedented adjustments in agriculture.

The demand for hired labor in California agriculture is affected by two offsetting trends. On the one hand, the mechanization of harvest and nonharvest tasks traditionally done by hand workers has reduced the peak demand for seasonal farmworkers. However, the production of labor intensive crops has doubled since 1950, offsetting the labor-savings from mechanization. The demand for short-term farmworkers declined sharply in the 1960s due to technological innovations but stabilized in the 1970s because labor-saving mechanical changes and production increases offset each other.

Farmworkers tend to be employed on one farm most of the year or move from farm to farm. The demand for hired workers employed by the same employer more than six months has expanded due to the increased need for irrigators, machine operators, and grape workers. Meanwhile, farmers and their families have been doing less and less of the peak season farm work because commercial farms and custom farmers have substituted machines and hired workers for the labor of farm families.

Structural and Production Changes Since 1950

The demand for farm labor in California is highly variable. Demand varies with the volume of output and with the condition of the crop. The proportion of the crop which is spoiled or rotten, the amount of brush removal that is necessary, and the amount of moisture in the fields are factors that affect the demand for seasonal labor. Warm weather can cause a crop to reach maturity more quickly than usual, shortening the harvest period and requiring more seasonal workers to satisfy the peak demand for workers.[1] These unpredictable swings in the demand for labor are the main reason employers have always asked for more workers than the predicted number of jobs. This surplus labor supply is a shock absorber for the inevitable fluctuations in farmers' actual demands for labor. Furthermore, the physical strains of farm work and the lack of continuous employment discourages farm work careers so that individual workers are constantly changing. The farm workforce is a rotating pool: experienced farmworkers move up to better farm or nonfarm jobs in the United States or return to Mexico, and new migrants replace them in entry-level farm positions.

Despite the relatively stable number of seasonal farm labor jobs in California since 1950, there have been important changes in the nature of

these jobs. Mechanization has eliminated many lifting and handling jobs. Belt-loaders, planters, thinners, spray rigs, and pruning towers eliminated many hours of work and reduced the drudgery of farm work. The most important nonharvest labor-saving innovation was the substitution of the bin and forklift for the field box, ending the need to lift each box of fruit, nuts, and vegetables onto a truck to be taken to packing sheds.

Harvest mechanization has eliminated even more hand labor. The adoption of mechanical diggers for potatoes and onions, shake and catch or pick-up machines for some nuts and processing tree fruits, and mechanical harvesters for cotton and tomatoes has reduced peak labor demands enormously. Tree shakers, used on half of the nut acreage and in many prune orchards by 1960, saved thousands of man-hours and permitted crop acreages to expand. The single most important labor-saving device was the cotton harvester which reduced the peak demand for cotton harvest labor from 89,000 in 1953 to 19,000 in 1962. The cannery tomato harvester was another important labor-saving innovation in the late 1960s.

Despite the mechanization of many farm tasks, the peak demand for seasonal farm labor persists at high levels. Employment Development Department estimates show that peak seasonal farm labor demands declined markedly in the 1960s but then stabilized at about 170,000 seasonal workers (see Graph 1).

Peak seasonal labor needs have remained high for several reasons. First, many seasonal labor tasks remain immune to mechanization. Strawberries and melons have benefited little from labor-saving mechanical innovation, and lettuce and cherries also rely primarily on hand harvesting. The thinning (chop) of the enormous cotton acreage and the harvesting and pruning of the

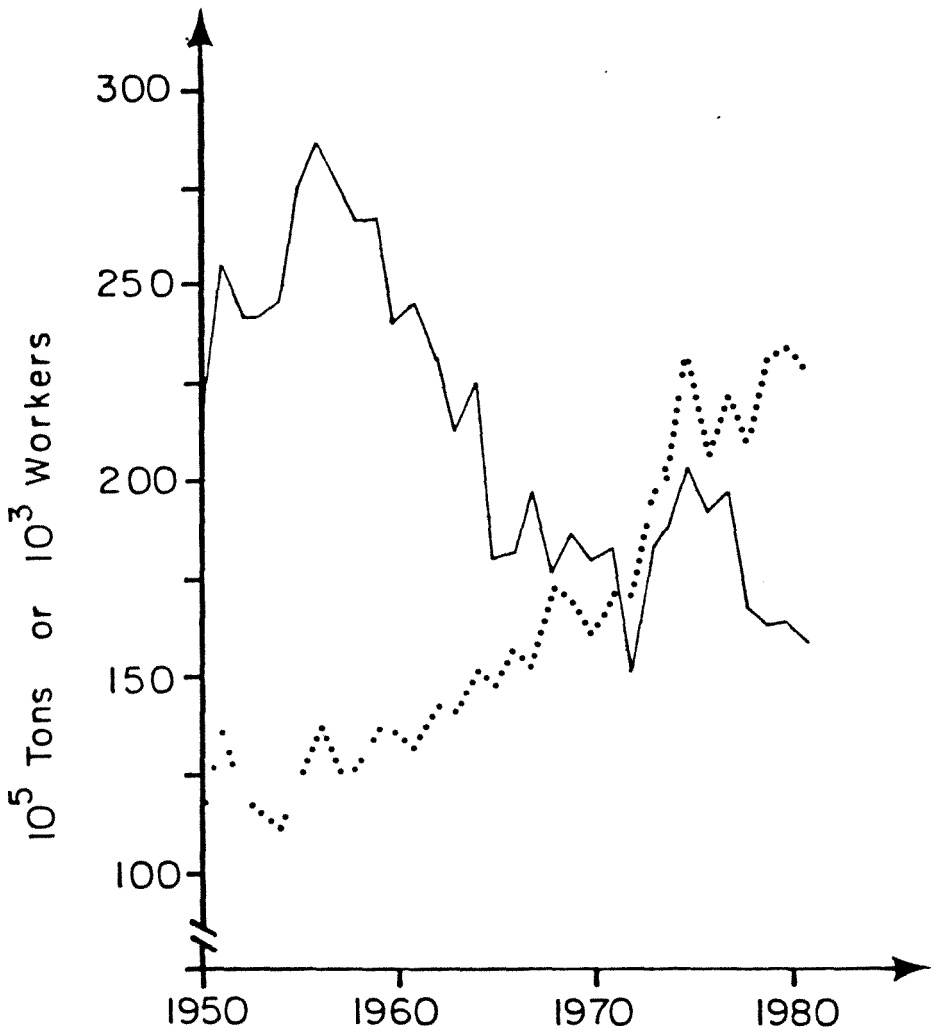
state's vineyards are only beginning to adopt labor-saving innovations like precision planting and herbicides.

Peak seasonal labor needs have stabilized because the acreage and production of many labor intensive crops expanded. Between 1952 and 1980, vegetable production more than doubled and the production of fruits and nuts and field crops nearly doubled (see Graph 2). In addition, the expansion of irrigation has increased the demand for farm labor, and irrigation work now represents approximately one-sixth of all California crop work.[2]

Acreage and production began to expand in the 1950s, before the first wave of harvest mechanization. The result was a labor crisis, which was solved by increasing 11-fold the use of braceros. Bracero use during the peak season increased from 8,000 in 1950 to 90,000 in 1956 (see Graph 3), and then mechanical innovations, particularly the cotton harvester, permitted agriculture to expand without further increasing the peak demand for seasonal workers.

Employment Development Department estimates allow us to observe changes in postwar agriculture that led to shifts in the demand for three types of farmworkers: (1) long-term hired workers, (2) farmers and their families and (3) short-term hired workers (see Graph 4).[3] Several factors combined to increase the demand for long-term workers, who are generally semiskilled and reside in the United States. The near doubling of fruit, nut, and vegetable acreage has increased the demand for long-season irrigators. Acreage expansion and mechanization increased the demand for machine operators. The enormous increase in grape acreage was particularly important because many grape growers use a year-round labor force to perform a sequence of seasonal tasks. The end of the Bracero Program in 1964 forced many employers to stabilize their workforces by offering more months of employment to fewer

Graph I. Production of Fruits, Nuts and Vegetables, and Peak Demand for Seasonal Labor

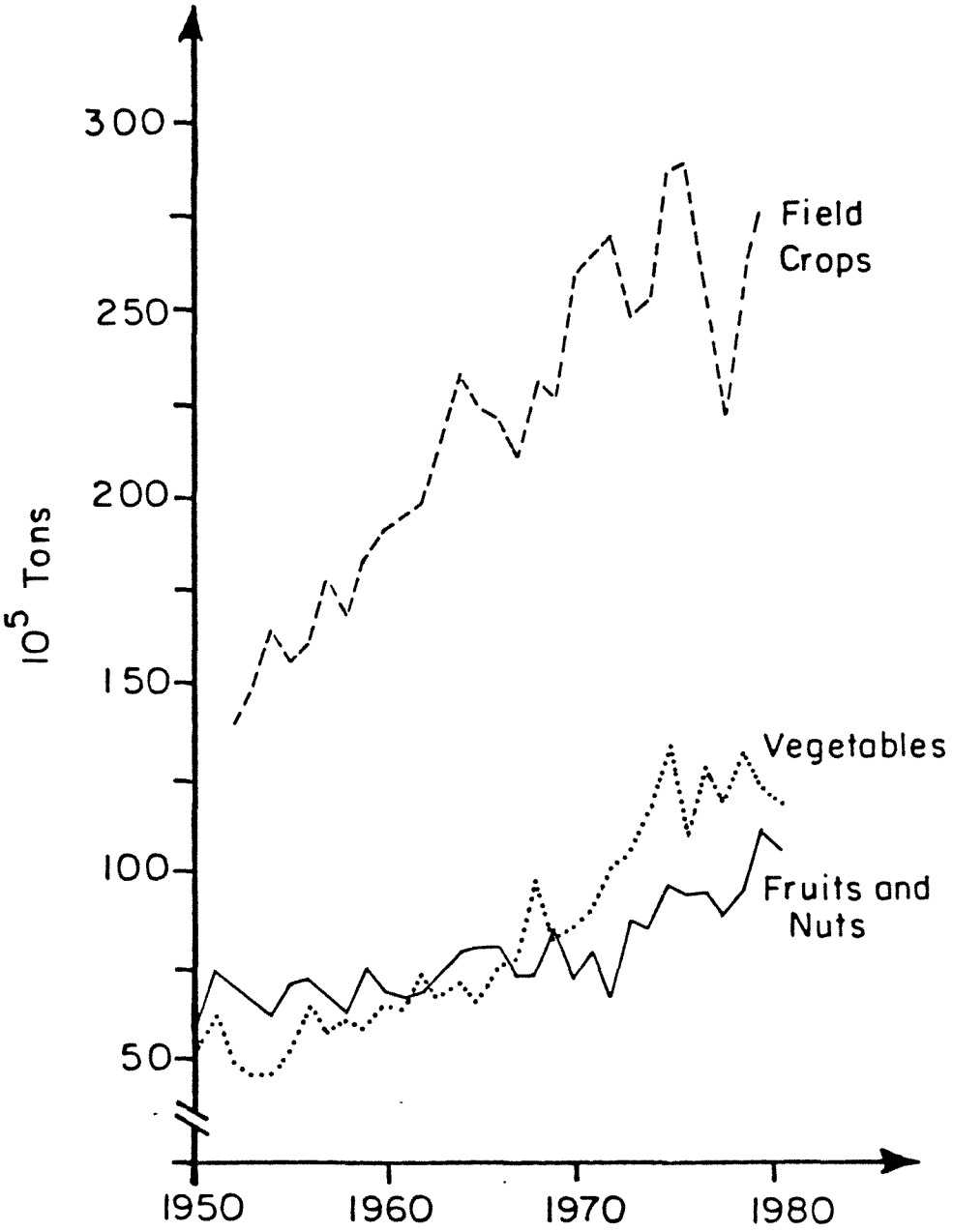


—— Peak demand for seasonal workers (1000's of workers)

····· Fruits, nuts and vegetables (100,000's of tons)

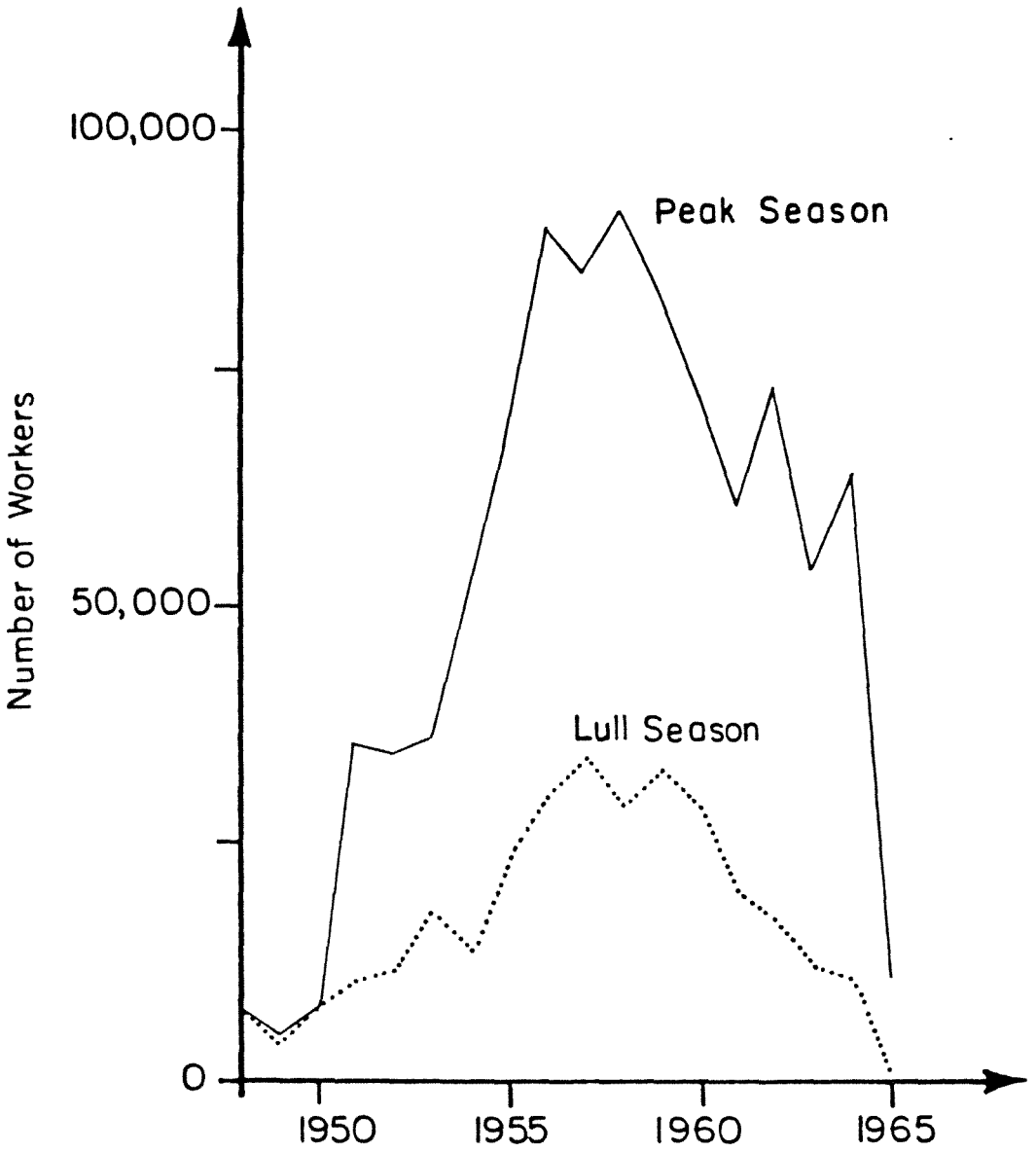
Sources: California Crop and Livestock Reporting Service, Annual Farm Labor Reports (1948-1972); Employment Development Dept. Report 881 M (1973-1981)

Graph 2. California Production of Fruits and Nuts, Vegetables and Field Crops



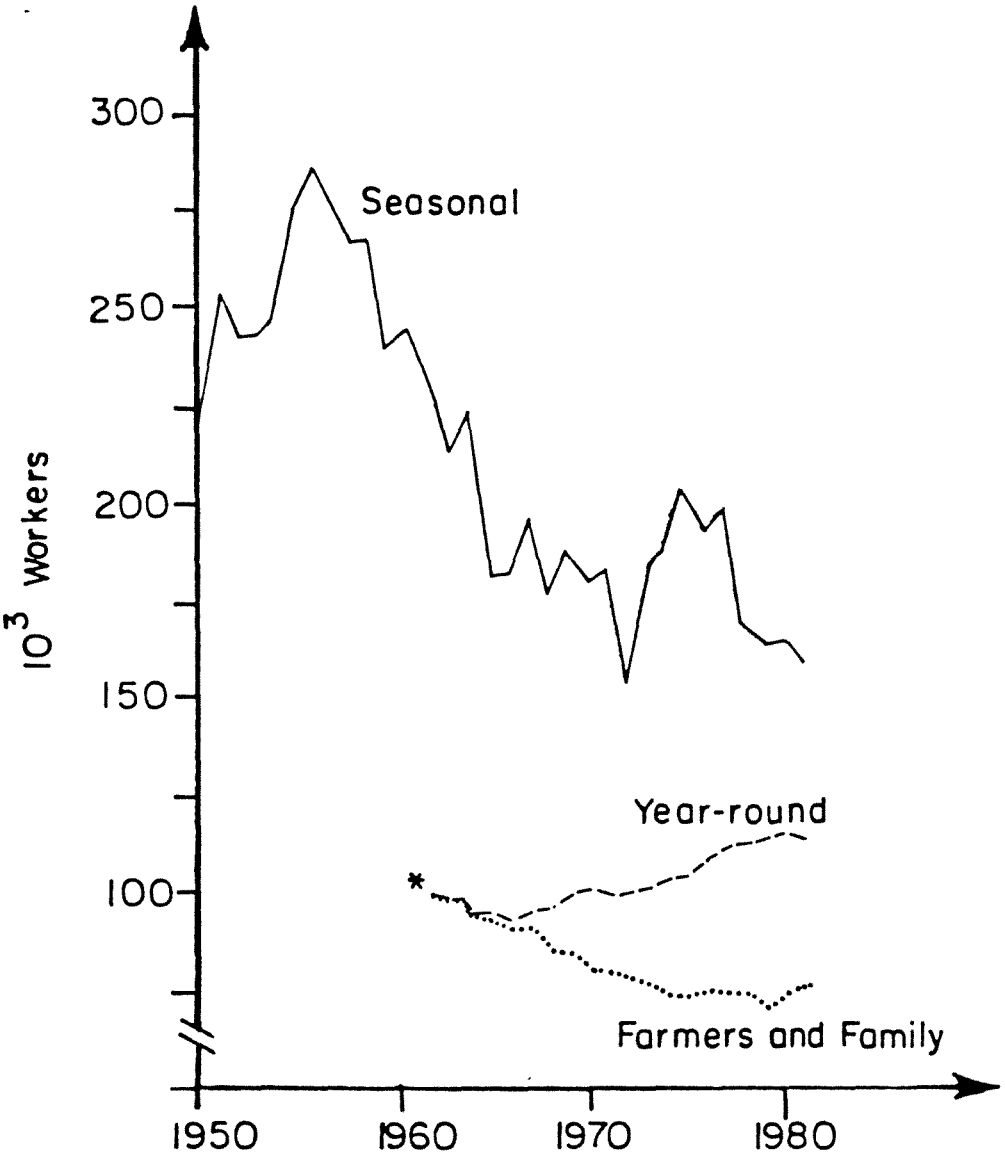
Source: California Crop and Livestock Reporting Service (1950-1981)

Graph 3. Number of Braceros in California Agriculture



Source: Annual Farm Labor Report (1948-1965)

Graph 4. Peak Season Demand for Employed Farmers, Year-round and Seasonal Workers



Sources: Annual Farm Labor Reports (1948-1972); Employment Development Dept. Report 881 M (1973-1981)

* Comparable data prior to 1962 not available

workers. Farm labor unions pushed for seniority recall systems[4] which spread quickly to both union and nonunion ranches and encouraged commitments to particular ranches, commodities, and/or areas. Some arduous harvest jobs were eliminated, an event that allowed local workers to substitute for seasonal migrants.[5]

The amount of farm work done by farmers and their families has declined since the early 1960s. Custom farming, labor contractors, and cooperative harvesting associations have reduced the time that individual farmers devote to recruiting and managing workers. Individual dairy, poultry, and livestock farms increased in size and decreased their employment 78 percent since 1950 (see Table 1).

The demand for short-term seasonal workers decreased as mechanization spread in both harvest and nonharvest tasks. The Employment Development Department estimates imply that the employment of short-term workers experienced a marked decline in the 1960s, stabilized in the 1970s, and since 1978 has begun to decline again. The data since 1978, however, do not yet establish a trend. More detailed data indicate that the expansion of labor-intensive crops has offset the labor-saving innovations of recent years. The gap between peak and trough employment still oscillates (see Graph 5), meaning that mechanization has not eliminated peak labor needs.

Since 1950, the employment for family workers and peak season short-term workers decreased while the demand for the year-round workers increased. More farm work is being done by hired workers; hired labor is increasingly concentrated in labor-intensive fruit and vegetable crops; and a larger proportion of hired workers are long term rather than short term. However, short-term workers still experience spells of unemployment because the demand for their services fluctuates.

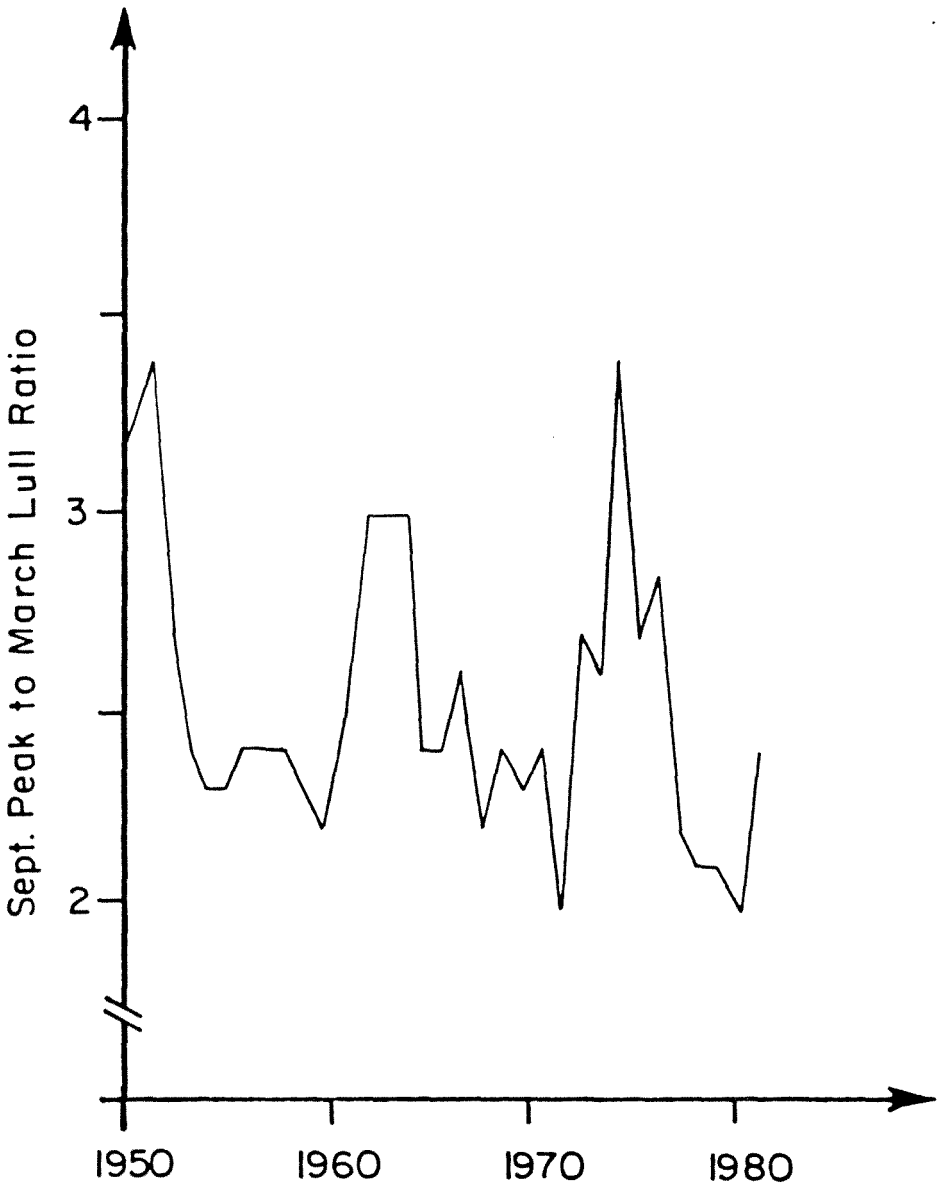
Table 1

Labor Used in Selected Crops, Pacific Region
Millions of Man-Hours

Year	Crops			
	Vegetables	Fruits, Nuts	Cotton	Milk, Meat, Poultry
1950	124	291	59	276
1955	124	253	44	258
1960	126	238	45	214
1965	124	211	26	170
1970	129	203	16	132
1975	158	223	12	92
1977	153	226	13	75
1979	156	243	11	61

Source: U. S. Economics and Statistics Service Statistical Bulletin No. 657, February 1981, table 43, p. 63.

Graph 5. September Peak to March Lull Ratio for Employment of Seasonal Workers



Sources: Annual Farm Labor Reports (1950-1972); Employment Development Dept. Report 881 M (1973-1982)

The Current Demand for Farm Labor

The Employment Development Department's statewide statistics give the impression that the seasonal farm work force faces one six-month peak season and one long slack time. During the rainy November to April period, the demand for seasonal workers averages 80,000 workers, while from May to October average seasonal employment climbs to over 140,000 workers (see Table 2). These figures imply that a worker should be able to obtain a job with one employer for at least half the year. However, aggregate statistics mask the fact that many seasonal workers must move around the state in order to be employed six months.

During the winter vegetable season, seasonal farmworkers are employed in the desert valleys of southern California where lettuce, broccoli, melons, and tomatoes are being harvested. Despite the rainy winter season, there is also considerable work picking navel oranges in the San Joaquin foothills and pruning the enormous acreage of vineyards and tree fruits throughout the central and coastal valleys.

In the spring, work in vegetables, citrus, and ornamentals becomes important. By April, lemon and Valencia orange picking has begun along the southern coast, and the Valencia pick has begun north of the Tehachapis in the foothill region. As spring progresses, vegetables, field fruits, and ornamental plants are tended along the California coast from San Diego in the south to Monterey County in the Bay Area. These coastal vegetables continue through the summer and fall.

In early summer, seasonal labor activity moves to the San Joaquin Valley.[6] The thinning and harvesting of the vast deciduous acreage (including plums, cherries, nectarines, peaches, and apricots) require large numbers of seasonal workers. Unemployment rates in June are just as low as in

Table 2

Monthly Peaks of Seasonal Farm Employment
and Weekly Volume of Unemployment for Farmworkers
(All California Counties, 1979)

Month	Seasonal Demand 100's of Workers	Unemployment 100's of Workers
1978		
November	820	194
December	810	239
1979		
January	820	261
February	770	290
March	740	290
April	890	265
May	1250	176
June	1640	118
July	1510	128
August	1530	132
September	1670	117
October	1420	124

Source: E.D.D. 881m Reports and Unemployment Insurance Payment Activities by Industry.

September, and since 1980 June and July have been the peak months for the employment of seasonal labor in the Central Valley (see Table 2). The vineyards require attention, the cotton chop uses thousands of hours of labor, and the San Joaquin Valley harvests fresh tomatoes and other vegetables in the early summer. The demand for labor remains high in mid-summer as the deciduous tree fruit and fresh tomato harvest moves further north into the Sacramento Valley. Meanwhile, the Valencia harvest continues in the San Joaquin Valley.

September is traditionally the peak month of farmworker employment because of the grape harvest. Approximately 700,000 acres of grapes need to be picked and hauled to packers or processers. Only a small (but increasing) portion, mostly wine grapes, is picked by machine. The fall grape harvest occurs throughout the Central Valley and in the coastal and northern valleys. In October, seasonal employment begins to decline despite the olive harvest throughout the Central Valley.

This regional summary of the demand for farm labor indicates that 8 to 10 months of farm work is obtainable if a worker is willing to move from one crop area to another. However, survey research has demonstrated that only a small proportion of the state's farmworkers, perhaps 20 percent, actually follows the crops.[7]

Some farmworkers avoid migrancy because they are better off staying in one area. Some workers remain in the long-season spring vegetable and citrus areas along the coast. The southern part of the San Joaquin Valley offers a combination of harvesting navel oranges and pruning in the winter and tree fruits, the grape harvest, and the cotton chop in the summer. The areas that offer the least long-term employment are those that specialize in a single

crop, such as grapes in Stanislaus County or pears in Lake County (see Table 3 for comparisons).

The Employment Development Department estimates are useful to examine long-term changes in employment, but more detailed data have been generated by the Department of Agricultural Engineering at the University of California, Davis. These data provide a more complete picture of the kinds of workers that perform specific tasks, and Table 4 separates workers by task. About 25 percent of the in-field man-hours required for California crops are contributed by semiskilled workers employed on a long-term basis by one employer. Almost two-thirds of these semiskilled workers are irrigators,[8] and irrigation requires one-sixth of all man-hours expended by hired workers in crop agriculture. The other one-third of the semiskilled Mexicans who have settled and other local workers consists of sprayers, tractor drivers, and other machine operators.

The remaining 75 percent of the in-field hours are seasonal farm labor tasks. Each job may be filled by several workers during the year, so the number of individuals engaged in this seasonal work is considerably more than three-fourths of the total number of workers employed in California crops sometime during the year.

Approximately 4 percent of the seasonal work--the equivalent of over 4,000 man-years of labor--is devoted to field sorting tomatoes on the tomato harvesters. Most of these sorters are Mexican women who have settled in California.[9] More than one-third of the seasonal work--over 33,000 man-years--is devoted to relatively light-hand tasks such as the thinning and hoeing of field crops and the pruning of grapes, citrus, and other tree fruits. These light-hand tasks are done primarily by older Mexican migrants who no longer devote full time to harvest work, but immigrant women and

Table 3

Ratio of Slow to Peak Labor Demand in Selected California Counties

Spring Vegetables/Citrus	
County	Ratio
Santa Barbara	.48
Ventura	.41
Riverside	.43

Early Summer Deciduous/Cotton Chop/Vineyard Care	
County	Ratio
Tulare	.44
Kern	.38

Monocultural		
County	Ratio	Crop
Stanislaus	.20	Grapes
Orange	.18	Valencias
Madera	.14	Grapes
Imperial	.13	Winter Vegetables
San Joaquin	.12	Grapes
Lake	.05	Pears

Source: E.D.D. 881a Reports, 1982

Table 4

Distribution by Man-Years (2,000 Man-Hours)
Among Different In-Field Job Tasks
in California Crops*

Job Description	Type Of Working Population	1976 Man-Years Worked	Percentage Of Total Work	Predicted Change 1976-1981 (Man-Years)
Irrigators (semi-skilled)	Settled and Local Men	21,785	17	0
Other Semi-Skilled	Settled and Local Men	12,275	10	0
Tomato Sorters	Settled and Local Women	4,145	3	860
Light Hand Tasks	Older Migrants and Family	33,400	26	2755
Heavy Hand Tasks	Young Male Mexicans	56,545	44	2960
Total		128,150		

*Some minor crops were not included in this table.

Source: Kumar, Chancellor, and Garret; Johnson and Zahara, see Appendix Table A-2 for method of calculation.

teenage boys are also employed. The heavy-hand tasks require over 60 percent of the seasonal labor hours and represent the equivalent of nearly 57,000 man-years. This arduous work includes the harvesting of fruits and vegetables and the thinning of deciduous fruits. The heavy-hand tasks are done predominantly by young male and often undocumented Mexicans.

About 70 percent of the seasonal farm labor tasks are dominated by immigrant workers.[10] These seasonal tasks are concentrated in tree fruits and grapes, which use three-fourths of the heavy-hand labor, and the balance is used in the vegetable and field fruit harvest. About one-half of the light-hand labor is used in tree fruits and grapes, vegetables use about one-fifth, and the remaining one-third works in field crops, especially hoeing and thinning cotton and sugar beets.

The Future Demand for Seasonal Labor

The mid-1950s through the early 1970s was a period of considerable labor-saving mechanization. Processed fruits and both fresh and processed vegetable harvests were mechanized, reducing the demand for seasonal workers considerably. But the acreage of such crops expanded in recent years, so the reduction in demand for labor brought about by labor-saving mechanization is offset by the extra labor needed to handle additional production.

In the mid 1970s, publicly-supported mechanization research became controversial. To isolate the influence of mechanization on demand for farm labor, yield and acreages increases were held constant at their 1976 levels and demand was projected to 1981.[11] During this five-year time period, it was predicted that the number of persons employed as tomato sorters would decrease rapidly (21 percent) because of electronic sorters, saving 860 man-years of sorter labor. In the light-hand work, however, predicted labor savings were

only 8 percent of 33,400, or 2,755 man-years. These light-hand labor savings were expected to follow from precision planting in cotton, sugar beets, and lettuce, resulting in less hoeing and thinning. In the heavy-hand tasks, expected labor savings were minimal, only 5 percent, or 2,960 man-years. These savings were concentrated in wine and raisin grapes, cling peaches, and fresh tomatoes.

If the assumption regarding constant acreage and yield levels is relaxed, overall labor requirements, especially for heavy-hand labor, were expected to increase between 1976 and 1981. Over two-thirds of the crops with increased labor demands rely heavily on immigrant labor (see Table 5).

Will mechanization begin to offset acreage expansion and reduce seasonal labor needs? It may, but the easiest horticultural and engineering advances have already been accomplished. There are serious obstacles to further progress, particularly in fresh fruit and vegetable production. Fresh fruit tends to mature unevenly and is easily damaged. Vegetables also mature in a nonuniform fashion, and selective harvesters often have low fruit recovery rates and tend to damage the plant and unripe fruit. The mechanization of both fruits and vegetables requires engineering advances and extra care in the cultivation and handling of the crop. The faster harvesting associated with mechanical devices also make it necessary to design and implement new bulk handling methods. Finally, the quality or appearance of the product may be altered by injury from the mechanical harvest or by biological design to make the product more easily harvested.

Despite these difficulties, mechanization is gradually becoming feasible for most of the significant crops (see Appendix Table A-2). The enormous wine grape acreage will probably be mechanized first. Continuously-moving over-the-row pruners and harvesters using rods and rails to shake loose the

Table 5

Predicted Increase in the Use of Labor (1976 to 1981) in Crops of Predicted Increase of Yield and Acreage* (Millions of Man-Hours)

Crop	Primary Type of Labor	Predicted Increase in Labor Use	Percentage of Total
Tree Fruit and Grapes	Heavy Hand Labor	6.81	42
Fresh Vegetables	Heavy Hand Labor	1.89	12
Cotton and Sugar Beets	Light Hand Labor	2.13	13
Processing Tomatoes	Light Hand Labor	2.03	12
Nuts	Semiskilled	3.40	21
Total		16.26	100

*Only the vegetable and fruit crops that showed an increase were tabulated for the table. In vegetables and fruits not included in this table, labor use was reduced by 0.51 million hours. The predicted net increase for fruits and vegetables was 7.2 million hours. Also, field crops other than cotton and sugar beets were excluded from the table.

Source: Kumar, Chancellor, and Garret

fruit are already used on 25 percent of the wine grape acreage.[12] Damage to the fruit is still too great to use these harvesters for table grapes, but the harvester has been adapted for raisin grapes. In the future, it may be possible to grow pruning and fruiting canes on opposite sides of the vine to allow for the total mechanization of the picking and pruning operation, and it may be possible to shake only the cordon instead of the whole vine, leading to more fruit recovery and less damage to the plant. These changes would require improved pruning and tying of the canes on metal stakes and the redesign of many vineyards to allow the use of machines.

Continuously-moving over-the-row pruners and shake-and-catch harvesters may also be adopted in California's huge deciduous acreage, but radical adjustments would have to be made in traditional plum, pear, apple, nectarine, peach, and cherry orchards. Densely planted dwarf trees would have to be substituted for the present taller well-spaced trees, and these smaller trees would have to be trellised and trained.

Mechanical harvesting of California's citrus acreage appears even more difficult. Because of densely packed brush, it is costly to train trees for over-the-row harvesters and pruners. Moreover, most citrus varieties have ripe and immature fruit on the trees at the same time, making the shake-and-catch method difficult to adapt to citrus. The fresh market provides most of a grower's profits, but both fresh and processed fruit are harvested at the same time, so any shake-and-catch system would have to be designed to remove all the fruit without damage and harvested fruit would have to be sorted in packing sheds.

Mechanical harvesting in grapes and tree fruits will be greatly enhanced when chemicals that loosen the fruit to drop are perfected, as well as better

padding materials to catch the fruit and computer-assisted sorting devices to sort it efficiently. Harvesters for field fruits and vegetables have been developed and in some cases have been adopted by farmers. For example, a quarter of the nation's pickling cucumbers are harvested by a once-over pinch roller machine.[13] Large squash for processing are often harvested by a windrow and pick-up system which uses a vee plow to windrow the fruit and a pickup-loader to lift it into bulk containers, but fresh market squash must still be picked by hand. Conveyor-belt labor aids are available for the melon harvest but are not in general use. Windrowing melons to the edge of fields for a pickup-loader is also possible, but under present conditions this damages the melons.[14] Gravity chute loaders attached to trucks moving through the fields are being used to a limited extent.

The strawberry industry is experimenting with various prototype harvesters. A few once-over harvesters are used for processing strawberries in Oregon and Michigan. The mechanical harvest of strawberries at this time increases labor needs, since the fruit has to be cleaned, capped, and destemmed, but machinery to do these tasks is being developed. Multiple-pass selective harvesters are being tested in many places for field fruit and vegetables but so far there are serious problems with low fruit recovery rates and damage to the still-fruiting plants. Strawberry harvesters require level and weed-free fields to operate efficiently.

About 10 percent of California's fresh tomatoes are machine picked. Bush tomatoes can be picked in a mature green state by a modified processing tomato harvester, but mechanical harvesting creates additional work handling the fruit. The jointed tomato varieties have to be destemmed, cleaned, and require extra sorting, prompting research efforts to develop jointless varieties.

Most root vegetables are harvested mechanically, but green onions and radishes are still hand harvested. A digger-harvester capable of collecting the green onion crop without serious damage is expected to appear within ten years. Present mechanical harvesters require extra labor inputs for thinning and hoeing so that the machine can achieve a high removal rate.

Lift and cut harvesters for leafy vegetables are on the horizon. Spinach and collard greens and most cabbage for processing are already harvested by machine. A lift and cut technique is being tested for fresh celery, lettuce, and cabbage. Head lettuce in the southwest must be harvested selectively, but several mechanical harvesters are in experimental use, and flotation devices may be developed to make these machines practical on wet fields. Celery plants defy mechanization because they shift their location in heavily irrigated California fields, an obstacle that precision transplanting methods may alleviate. Broccoli and cauliflower harvest machines may have to await horticultural improvements that increase the uniformity of maturation.[15]

Impact on Labor

If fruit and vegetable agriculture substitutes machines for workers, there will be two effects on labor needs. In the short run, adoption of the over-the-row pruner and harvester for grapes, deciduous, and citrus fruit will require additional workers to plant, trellis, prune, and irrigate new and redesigned orchards. Many plants such as olive trees will need special shaping before machine harvesting is feasible. In the vegetable crops, more attention will have to be paid to cultural tasks that will increase the demand for semiskilled labor.

The first machines will require increased handling and sorting, since such machines tend to harvest more rotten or damaged fruit and debris than human hands. These sorting tasks are usually done by local women.

The demand for unskilled harvest labor should gradually decline as machines and precision techniques eliminate some peak harvest labor needs.[16] Fewer, longer, and better farm jobs should encourage workers who now return to Mexico in the off season to settle in the United States. The tendency for Mexican farmworkers to settle in the United States should reinforce a mechanized agriculture's preference for local workers.

The demand for semi skilled workers may eventually decline after vineyards and new dwarf orchards are replanted and after sorting machines eliminate the need to sort mechanically harvested products.

The mechanization of agriculture can be viewed from two perspectives. Machines that displace workers are productivity-enhancing because direct labor costs are reduced. This type of change includes the diggers that harvest potatoes, the shake-and-catch machines that harvest nuts and processed fruits, and the lift-and-shake machines that pick the processing tomato crop.

Another second type of mechanization consists of task facilitators that may not reduce labor costs but do reduce the drudgery of farm tasks. Examples of this technology include man-positioners which eliminate ladders and in-field conveyor belts that ease the burden of picking field fruits and vegetables. Available task facilitators are not always used because they are expensive and sometimes slow down piecerate workers who want to maximize wages (man-positioners are sometimes slower than moving ladders) and because in-field conveyor belts that eliminate carrying the harvested crop require that an entire crew work at the same pace. In recent years, the use of

conveyor belts in the melon fields in California, for example, has actually declined due to worker attitudes and a surplus of labor.[17]

The use of task-facilitating (back-saving) technology enlarges the pool of workers available to do harvest work to include women and older men. Making farm jobs easier would also encourage longer careers in farm work, minimizing the need to replenish the supply of immigrant workers. Task-facilitating technology may become popular if there is to be a transition to a machine-dominated agriculture since it makes possible a gradual "phase in" to a settled labor force.

Conclusion

California's labor-intensive agriculture is likely to adopt mechanical harvesting, precision planting, exacting horticultural controls, and careful postharvest handling. Continuously-moving over-the-row pruners and harvesters will eventually appear in orchards and vineyards. Selective harvesters and once-over harvesters for uniformly maturing plants will eventually become the rule for field fruits and vegetables. There is, however, no definite timetable for these changes. However, predictions made by engineers and economists usually underestimate the time required and the economic circumstances necessary for the diffusion of new techniques.[18]

Footnotes

[1]In 1949, for example, 125,000 workers picked cotton in California, well above the usual 70 to 80,000 for that period (Annual Farm Labor Reports, Employment Service, 1949).

[2]Kumar, Ramesh, W. Chancellor, and Roger Garret, "Estimates of the Impact of Agricultural Mechanization Developments on In-Field Labor Requirements for California Crops," in Technological Change, Farm Mechanization, and Agricultural Employment, Publication #4085, Division of Agricultural Sciences, University of California, 1978.

[3]Respectively defined as: (1) more than 149 days for same employer, (2) farmer and unpaid family working 15 hours a week or more, and (3) less than 150 days for the same employer.

[4]Unions are most entrenched in Salinas and Imperial Valleys and in Ventura County.

[5]The rising proportion of women in the 1960s is an indication of this trend. In 1959, 9.8 percent of the local seasonal workers were women while, in 1968, 22.4 percent were (Annual Farm Labor Reports, EDD various years).

[6]The grape harvest in the Coachella Valley is a notable exception to this.

[7]In the 1965 California Assembly survey, approximately 30 percent were counted as migrants; in the 1981 Tulare County study only about 20 percent traveled to work further than a commuting distance. Mines, Richard and M. Kearney, The Health of Tulare County's Farmworkers, California State Department of Health, April 1982 and The California Farm Labor Force: A Profile, California Assembly Committee on Agriculture, April 1969.

[8]Some proportion of these irrigators are actually "piperos" who move pipes in the fields for piece rates or very low wages--most of these are your Mexican nationals.

[9]See Scheuring for description of this labor force. Scheuring, A., From Lug Boxes to Electronics, Department of Applied Behavioral Sciences, UC Davis, December 1978.

[10]The number of immigrants engaged in this work through the year is probably at least twice this numbr.

[11]Estimates based on Kumar, Chancellor and Garret; and Zahara, M. and S. Johnson, "Status of Harvest Mechanization of Fruits, Nuts and Vegetables," Hortscience, Vol. 14, October 1979. See Appendix Table A-2 for details of calculations.

[12]G. K. Brown, 1980, p. 23, "Current Status of Harvest Mechanization of Horticultural Crops," Michigan State University, October 1, 1982.

[13]G. K. Brown, p. 27.

[14]Zahara Packing Co., Imperial Valley.

[15]G. K. Brown, p. 48.

[16]One counter-tendency will occur during this transition period. The pruning machines can actually serve to increase the need for hand labor because the less exact prune makes the harvest more difficult (e.g., table grapes).

[17]G. K. Brown

Table A-1. Technological Changes in the Harvest of Major California Crops (Estimates of Mechanization for 1981)

Crop	Percent Mechanized	Productivity Ehhancer	Task Facilitator	Obstacles for Productivity Enhancement
Avocado	0	Shake and catch	Man positioner	Two varieties on the same tree; steep slopes
Citrus	0	Shake and catch	Man positioner	Processed and fresh fruit picked together; two cultivars on tree together
Dates	80	hydraulic tower		
Fig	100	Shake and pick up		
Olive	0	Shake and	Man positioner	Careful pruning, shaping required
Apples	15	Trellis system with over-the-row harvester	Man positioner	Dwarf orchards needed; damage to fruit
Apricots	15	Shake and catch	Man positioner	Uneven maturity
Cherries	10	Shake and catch	Man positioner	
Peach (cling)	20	Shake and catch		Damage to fruit, careful training of trees necessary
Peach (freestone)	0	Shake and catch		Damage to fruit, careful training of trees necessary
Pears	0	Shake and catch		Bruises to fruit, high sorting costs
Plums	0	Shake and catch, being introduced for process		Quick processing needed, pit fragments cause damage
Prunes	99	Shake and catch		For continuously moving, careful prune necessary
Strawberries	0	Mechanical finger strippers	Conveyor belt	Need weed, clod-free soil; increased labor for capping
Wine grapes	25	Rod or rail shakers		Excess debris in gondolas, special training of vines
Raisin grapes	7	Same as wine		Frost inhibits harvest
Table grapes	0	Same as wine		
Pickling cucumbers	25	Once over harvester	Conveyor	Low recovery

Table A-1 (continued)

Crop	Percent Mechanized	Productivity Ehhancer	Task Facilitator	Obstacles for Productivity Enhancement
Cucumbers (fresh)	0	Selective harvester	Conveyor belts	Damage to vines, low recovery, careful cultural practices
Melons	0	Same as cucumbers		Same as cucumbers
Tomatoes (fresh)	10	Cut, lift and shake	Conveyor belts	Careful bed preparation fruit damage, debris removal
Peppers	0	Open helix		Debris removal, low recovery
Green onions	0	Diggers		Damage to plant
Radish	0	Diggers		Needs perfect spacing
Dry onions	50	Diggers		Easily bruised
Sweet potato	50	Diggers		Easily bruised
Asparagus	0	Reciprocating blades, selective harvester		Low recovery
Brussel sprouts	0	Rotary stripper		Cost
Cabbage	0	Life and cut	Conveyor belts	Damage to head
Celery	35	Transplanter	Conveyor belts, field pack	Shifting fields due to irrigation
Artichoke	0	Selective harvester	Field pack	Nonuniformity of crop
Broccoli	0	Selective harvester	Field pack	Nonuniform maturation
Cauliflower	0	Selective harvester	Conveyor belts	Damage to flower
Cotton	100	Precision planting		
Sugar beets	80	Precision planting		

Source: R. Kumar, W. Chancellor, and R. Garret, "Estimates of the Impact of Agricultural Mechanization Developments on In-field Requirements for California Crops," in Technological Change, Farm Mechanization and Agricultural Employment, Publication #4085, Division of Agricultural Sciences, University of California, 1978.

Table A-2. Labor Expended in California Crops By Type of Labor
(Millions of Hours in 1976)

Crops	Acres (1,000's)	Total Man Hours	Heavy Hand Tasks	Light Hand Tasks	Semiskilled Tasks	Predicted Savings 1961-1981 Heavy Hand	Predicted Savings 1961-1981 Light Hand
		Millions of Man Hours					
		FRUITS AND NUTS					
Almonds	260.9	10.51	.32	2.63	7.37	.06	-
Apples	21.6	4.09	2.70	.90	.53	.19	.13
Apricots	27.9	3.73	2.05	1.12	.56	.03	.14
Cherries	13.0	3.70	3.37	.11	.22	.15	-
(G) Raisin	236.7	20.99	12.59	5.25	3.36	.68	.05
(G) Wine	270.8	21.66	11.70	5.85	4.11	3.30	.09
(G) Table	63.2	8.69	3.13	3.82	1.74	-	.02
Lemons	47.5	6.95	4.73	.76	1.46	-	.04
Nectarines	13.1	3.30	2.21	.66	.43	-	.08
Oranges (navel)	114.9	15.51	11.48	.62	3.41	-	.09
Clings (peach)	49.8	9.62	5.96	1.92	1.83	.34	.02
Freestone	21.7	6.79	4.96	1.15	.75	.09	.05
Pears	37.5	8.59	3.35	3.78	1.46	-	.30
Plums	24.7	5.78	4.22	.98	.58	-	.07
Prunes	74.3	3.54	.28	1.45	1.81	.21	.07
Walnuts	169.7	7.69	.23	2.15	5.31	-	-
SUBTOTAL[1]	144.73	141.14	73.28	33.15	35.13	5.05	1.15
Dates[2]	4.1	.10	-	-	.10		
Figs[2]	14.4	.36	-	-	.36		
Grapefruit[3]	16.5	2.23	1.65	.09	.49		
Valencias[3]	82.8	11.17	8.27	.45	2.46		
Pomegranate[4]	2.1	.42	.26	.10	.06		
Olives[5]	30.7	3.22	2.30	.31	.61		
Avocados[6]	29.1	3.05	2.18	-	.87		
SUBTOTAL	179.7	20.55	14.66	.95	4.95		
TOTAL	1627.0	161.69*	87.94	34.10	40.08		

[1]Assumptions about last seven.
[2]Ten hours/acre machine harvest, 15 other.
[3]Assumed same labor usage as navel oranges.
[4]Fifty hours prune; 100 hours harvest; 30 hours other.
[5]Ten hours prune; 75 hours harvest; 20 hours other.
[6]Seventy-five hours harvest; 30 hours other.

*Total man hours does not equal sum of heavy, light and semiskilled due to rounding error.

Table A-2 (continued)

Crops	Acres (1,000's)	Total Man Hours	Heavy Hand Tasks	Light Hand Tasks	Semiskilled Tasks	Predicted Savings 1961-1981 Heavy Hand	Predicted Savings 1961-1981 Light Hand
		Millions of Man Hours					
FRESH VEGETABLES AND FIELD FRUIT							
Artichokes	10.5	1.15	.71	.20	.24	-	-
Asparague	32.1	1.77	1.43	-	.34	-	-
Broccoli	51.0	4.08	2.19	.80	1.09	-	.05
Cabbage	8.3	.77	.50	.19	.08	-	-
Brussel sprouts	6.0	.56	.36	.14	.06	-	-
Cauliflower	26.2	2.53	1.57	.47	.49	.09	-
Celery	19.4	4.62	2.72	.55	1.35	.14	.02
Garlic	10.0	.92	.42	.20	.30	.10	-
Lettuce	156.1	12.49	6.24	1.87	4.38	.12	.38
Onions	7.1	.72	.53	.07	.12	.15	-
Tomatoes	29.8	5.36	4.47	.30	.59	.27	.06
Watermelons	9.8	1.13	.44	.39	.30	-	-
Cantaloupes[1]	36.3	4.18	1.63	1.44	1.11		
Crenshaw[1]	1.2	.14	.05	.05	.04		
Honeydew[1]	8.4	.99	.38	.33	.28		
Spinach[2]	2.2	.23	.13	.04	.06		
Peppers[2]	8.7	.88	.50	.15	.23		
Cucumbers[2]	7.7	.77	.44	.13	.20		
Sweet potatoes[2]	7.6	.77	.44	.13	.20		
TOTAL	438.4	44.20*	25.15	7.45	11.46	.87	.51
PROCESSING VEGETABLES							
(Lima) Beans	23.1	.25			.25		
Carrots	33.1	.99			.25		
Onions	21.3	.72			.72		
Tomatoes	269.8	14.54		8.29	6.25		
Potatoes	60.2	.48			.48		
Sweet Corn[3]	15.9	.28			.28		
Spinach[3]	9.7	.17			.17		
Chili Peppers[3]	4.9	.09			.09		
TOTAL	438.0	17.52		8.29	9.23		

TOTAL VEGETABLES

	Total	Heavy Hand	Light Hand	Semiskilled
Fresh	44.06	25.15	7.45	11.46
Processed	17.52		8.29	9.23
TOTAL	61.58	25.15	15.74	20.69

Assumptions about hours taken from the average of the first 15.

[1]Same as watermelon
[2]57.32 heavy hand; 16.97 light hand; 26.07 semiskill per acre.
[3]Assumption 17.72 hours an acre figured as average of beans, carrots, onion, and potatoes.
*Total does not equal sum due to rounding error.

Table A-2 (continued)

Crops	Acres (1,000's)	Total Man Hours	Heavy Hand Tasks	Light Hand Tasks	Semiskilled Tasks	Predicted Savings 1961-1981 Heavy Hand	Predicted Savings 1961-1981 Light Hand
		----------Millions of Man Hours----------					
		FIELD CROPS					
(hay) Alfalfa	1120	3.36			3.36		
(seed) Alfalfa	49	.02			.02		
(dry) Beans	1007	.19			.19		
Barley	166	.50			.50		
Corn	264	.26			.26		
Rice	411	.68			.68		
Safflower	110	.11			.11		
Sorghum	183	.18			.18		
Wheat	873	.44			.44		
Cotton	1128	17.60		16.27	1.33		2.37
Sugar beets	285	9.26		8.98	.28		1.42
TOTAL		36.60		25.25	7.35		3.79

Source: R. Kumar, W. Chancellor, and R. Garret, "Estimates of the Impact of Agricultural Mechanization Developments on In-field Requirements for California Crops," in Technological Change, Farm Mechanization and Agricultural Employment, Publication #4085, Division of Agricultural Sciences, University of California, 1978.

California Crop and Livestock Reporting Service.

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Avocado	0	Shake and catch	Man positioner	Two varieties on the same tree; steep slopes
Citrus	0	Shake and catch	Man positioner	Processed and fresh fruit picked together; two cultivars on tree together
Dates	80	hydraulic tower		
Fig	100	Shake and pick up		
Olive	0	Shake and	Man positioner	Careful pruning, shaping required
Apples	15	Trellis system with over-the-row harvester	Man positioner	Dwarf orchards needed; damage to fruit
Apricots	15	Shake and catch	Man positioner	Uneven maturity
Cherries	10	Shake and catch	Man positioner	
Peach (cling)	20	Shake and catch		Damage to fruit, careful training of trees necessary
Peach (freestone)	0	Shake and catch		Damage to fruit, careful training of trees necessary
Pears	0	Shake and catch		Bruises to fruit, high sorting costs
Plums	0	Shake and catch, being introduced for process		Quick processing needed, pit fragments cause damage
Prunes	99	Shake and catch		For continuously moving, careful prune necessary
Strawberries	0	Mechanical finger strippers	Conveyor belt	Need weed, clod-free soil; increased labor for capping
Wine grapes	25	Rod or rail shakers		Excess debris in gondolas, special training of vines
Raisin grapes	7	Same as wine		Frost inhibits harvest
Table grapes	0	Same as wine		
Pickling cucumbers	25	Once over harvester	Conveyor	Low recovery

Table A-1 (continued)

Crop	Percent Mechanized	Productivity Ehhancer	Task Facilitator	Obstacles for Productivity Enhancement
Cucumbers (fresh)	0	Selective harvester	Conveyor belts	Damage to vines, low recovery, careful cultural practices
Melons	0	Same as cucumbers		Same as cucumbers
Tomatoes (fresh)	10	Cut, lift and shake	Conveyor belts	Careful bed preparation fruit damage, debris removal
Peppers	0	Open helix		Debris removal, low recovery
Green onions	0	Diggers		Damage to plant
Radish	0	Diggers		Needs perfect spacing
Dry onions	50	Diggers		Easily bruised
Sweet potato	50	Diggers		Easily bruised
Asparagus	0	Reciprocating blades, selective harvester		Low recovery
Brussel sprouts	0	Rotary stripper		Cost
Cabbage	0	Life and cut	Conveyor belts	Damage to head
Celery	35	Transplanter	Conveyor belts, field pack	Shifting fields due to irrigation
Artichoke	0	Selective harvester	Field pack	Nonuniformity of crop
Broccoli	0	Selective harvester	Field pack	Nonuniform maturation
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Cotton	100	Precision planting		
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Table A-2. Labor Expended in California Crops By Type of Labor
(Millions of Hours in 1976)

Crops	Acres (1,000's)	Total Man Hours	Heavy Hand Tasks	Light Hand Tasks	Semiskilled Tasks	Predicted Savings 1961-1981 Heavy Hand	Predicted Savings 1961-1981 Light Hand
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(G) Table	63.2	8.69	3.13	3.82	1.74	-	.02
Lemons	47.5	6.95	4.73	.76	1.46	-	.04
Nectarines	13.1	3.30	2.21	.66	.43	-	.08
Oranges (navel)	114.9	15.51	11.48	.62	3.41	-	.09
Clings (peach)	49.8	9.62	5.96	1.92	1.83	.34	.02
Freestone	21.7	6.79	4.96	1.15	.75	.09	.05
Pears	37.5	8.59	3.35	3.78	1.46	-	.30
Plums	24.7	5.78	4.22	.98	.58	-	.07
Prunes	74.3	3.54	.28	1.45	1.81	.21	.07
Walnuts	169.7	7.69	.23	2.15	5.31	-	-
SUBTOTAL[1]	144.73	141.14	73.28	33.15	35.13	5.05	1.15
Dates[2]	4.1	.10	-	-	.10		
Figs[2]	14.4	.36	-	-	.36		
Grapefruit[3]	16.5	2.23	1.65	.09	.49		
Valencias[3]	82.8	11.17	8.27	.45	2.46		
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Table A-2 (continued)

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Broccoli	51.0	4.08	2.19	.80	1.09	-	.05
Cabbage	8.3	.77	.50	.19	.08	-	-
Brussel sprouts	6.0	.56	.36	.14	.06	-	-
Cauliflower	26.2	2.53	1.57	.47	.49	.09	-
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Tomatoes	29.8	5.36	4.47	.30	.59	.27	.06
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