WAGES, MECHANIZATION, AND EMPLOYMENT IN HARVESTING FLORIDA TOMATOES

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Two events are occurring which could have a profound effect on the Florida tomato industry. One is the development of a technology for harvesting fresh-market tomatoes mechanically. The second is the development of wage legislation affecting farm workers. This paper is an attempt to evaluate the effect of different minimum wage levels on the rate of adoption of mechanical harvesting, and the subsequent effect on employment and earnings in the tomato industry.

Florida's share of the U.S. market for fresh winter tomatoes has declined in recent years from about 57 percent during the 1963-64 season to 39 percent during the 1970-71 season, mainly because of increased imports of Mexican tomatoes.[1] In attempting to remain competitive, the Florida tomato industry and the Florida Agricultural Experiment Stations undertook research to reduce the cost of producing fresh-market tomatoes in Florida [3]. One direction this research took was development of mechanical harvesters suitable for fresh-market tomatoes. Two machines were developed and pilot tested in Florida. One, the "commercial harvester," was a modified commercial machine currently used in other areas for processing tomatoes. The second, the "semiharvester," was a field washer and grader which was modified to perform the harvesting operation.

The commercial harvester is a self-propelled machine having an estimated initial cost of $30,000. It requires a crew of 11 to 17 people for daily output of 25 to 50 tons. The semiharvester is pulled by a tractor and has an estimated initial cost of $12,000, exclusive of the tractor. It requires a crew of 11 to 16 people for daily outputs of 20 to 40 tons. The lower outputs represent performance under currently typical or average conditions. The higher outputs represent potentials that might be expected with high yields and under ideal conditions. Both systems are vine-destructive operations requiring once-over harvesting. Both machines perform similar operations, except that fruit removal is by manual shaking of vines on the semiharvester, while it is mechanical on the commercial harvester.

MINIMUM WAGES

Federal minimum wage legislation was extended to farm workers in 1967. The minimum wage that year was $1.00 an hour. It increased to $1.15 in 1968 and $1.30 in 1969. An amendment to the Fair Labor Standards Act that would increase the minimum hourly wage for farm workers to $1.60 in sixty days after enactment, $1.80 in one year, $2.00 in two years, and $2.20 in three years was passed by the Senate during the 93rd Congress. A House version of the amendment called for a similar increase. Regardless of the compromise reached the minimum wage level seems certain to increase in the near future.

The purpose of this paper is to estimate the effects which different minimum wage levels would have on agricultural workers employed in harvesting fresh-market tomatoes in Florida. The effects of wage levels on the profitableness of mechanical tomato

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[1] Based on data from USDA Consumer and Marketing Service, fruit and vegetable publications and special releases from Florida Tomato Committee [4].

harvesting in Florida is evaluated. Considerations other than current costs which can influence adoption of mechanical harvesting are examined, and projections are made of the amount of mechanical tomato harvesting likely to occur in Florida in the next 4 to 6 years. Then estimates are derived for the effects of mechanical harvesting on the number of jobs available, earnings of tomato harvest workers, skills needed by workers, and length of employment.

THE FLORIDA TOMATO INDUSTRY

Sales from tomatoes grown in Florida range from $50 to $100 million annually. The crop is marketed mainly as fresh fruit during the months of November through June.

Peak employment in growing and harvesting tomatoes in Florida ranged from 9,600 to 14,600 field workers between 1960 and 1970.[2] In addition, other workers were employed in packing-houses. Estimated total earnings from employment in tomatoes averaged $29.5 million during the four winter seasons 1966-67 to 1970-71. Employment in preharvest and harvest operations each provides about $11.3 million in wage earnings. An additional $6.9 million is earned from employment in hauling and packing fruit.

EFFECTS OF WAGES ON HARVEST COSTS

Cost estimates were developed to be representative of the industry average for the 1971-72 season [7].

The minimum wage levels were assumed to represent rates paid sorter labor. Wages for other jobs such as tractor drivers, harvester operators, and mechanics were scaled upward from the minimum wage. Wage rates for hand picking were based on annual cost and returns data [2]. Hand picking costs during the seasons 1968-69 through 1970-71 were used as representative of costs with a $1.30 minimum wage level. As the minimum wage was assumed to increase, the hourly rates for all job skills were increased by an equal amount.[3] A 10 percent overhead for items such as Social Security and other benefits was added to wage rates to arrive at grower costs. Hand picking costs at the higher wage rates were derived by multiplying the new hourly picking labor costs times the hours of labor use.[4]

Hand picking fresh-market tomatoes costs less than mechanical harvesting with minimum wage levels of $1.60 per hour or less (Table 1). The cost for hand picking at the 1971-72 wage rates, the $1.30 per hour minimum hourly wage level, was $28.00 per ton or about $0.80 per 40-pound box.[5] Estimated mechanical harvest costs were $32.57 per ton for the commercial harvester and $34.27 per ton for the semiharvester. Mechanical harvesting becomes profitable at minimum wage levels above $1.60 per hour.

Hand picking costs increase rapidly with increases in the wage level. The cost for hand picking fruit consists almost entirely of labor cost. Increases in wage rates result in almost proportionate increases in the cost of hand picking. Costs for the two mechanical harvesting systems remain about the same or decline slightly with increases in the wage level.[6] The commercial harvester has a small cost advantage over the semiharvester at all wage levels.

OTHER FACTORS AFFECTING MECHANIZATION

Profit is only one of the factors affecting the rate at which the industry will adopt mechanical tomato harvesting. Some other considerations will be availability of workers, risks, the need for greater

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[2] Based on estimates derived by the Research and Planning Bureau, Florida State Department of Commerce, Tallahassee, Florida.

[3] Minimum wage increases have an immediate or "direct" effect on wages of those workers earning less than the new minimum. This direct effect tends to compress the wage scale raising wages on the lower end of the scale relative to those further up. There also is a delayed or "indirect" effect in which wages further up the wage scale adjust toward a similar relationship to the minimum as existed before the minimum wage change. The assumption that all wages increased by the same absolute amount was the method used to account for the indirect effects of minimum wage increases. One study indicates that the indirect effect may be greater than that assumed in this study [6, pp. 21-22].

[4] Hours of labor use were based on Brooke [1].

[5] This cost is for a ton of field-run tomatoes and is equivalent to 35 field boxes averaging 57 pounds each or 35 boxes of packed fruit weighing 40 pounds each.

[6] The decrease in mechanical harvesting cost occurs because the increase in labor costs is offset by a reduced cost of crop loss as wage rates increase. The cost for hand picking and packing tomatoes is subtracted from the value of fruit loss in deriving the cost of crop loss. Higher wage levels raise the cost of hand picking and packing and reduce the cost of crop loss. For the commercial harvester the lower cost for crop loss more than offsets the higher variable labor cost and the total harvesting cost decreases. With the semiharvester the two cost components offset each other giving very little harvest cost change at the higher wage levels.

Table 1. ESTIMATED COST PER TON FOR HAND PICKING AND MECHANICALLY HARVESTING FRESH-MARKET TOMATOES IN FLORIDA AT FIVE MINIMUM WAGE RATES, 1971-72 SEASON[a]

Minimum hourly wage rate	Hand Picking	Mechanical harvesting	
		Commercial harvester	Semi-harvester
		Dollars per ton	
$1.30	$28.00	$32.57	$34.27
1.60	31.70	32.17	34.20
1.90	35.39	31.78	34.15
2.20	39.09	31.39	34.10
2.50	42.78	30.99	34.04

[a]Costs are for a ton of field run tomatoes.
Source: [7, Table 6].

managerial precision, and availability of a complete system for growing and harvesting mechanically.

Growers are not as likely to seek an alternative to hand picking if sufficient workers are available to pick tomatoes. Adoption in such a situation may occur slowly over a period of years even when mechanical harvesting is profitable. A scarcity of workers, on the other hand, could cause the industry to change rapidly with a large part of the crop being mechanically harvested in just a few years.[7]

A high risk is associated with being the first to adopt a new technique. Later adopters have the advantage of benefiting from errors of early adopters. This may result in a learning or "wait and see" period between the time new machinery is first available and when a large part of the crop is mechanically harvested.

Another increased risk associated with mechanical harvesting is that a higher proportion of total costs are fixed than with hand harvesting. Most hand harvesting costs are variable labor costs. In case of a crop failure the grower loses only the growing costs he had invested up to the time of the failure. With mechanical harvesting, the fixed machinery ownership costs for the harvesting equipment also are lost. If crop failure does occur, a higher proportion of total costs will be lost with a mechanical harvesting system.

Some growers may see mechanical harvesting as reducing risks in the following way. Mechanical harvesting will reduce the number of workers a grower needs to harvest a given crop, and the workers he hires may be ones he can better depend upon to be available when needed. Growers who are fearful of not being able to recruit sizable picking crews in the future may view the smaller labor needs as reducing the risk of not getting their crops harvested on time.

Growing tomatoes for mechanical harvesting will require more exact management than for hand picking. Some growers may feel that mechanical harvesting is not worth the problems associated with the increased management precision. Tomatoes will need to be planted so that fruit is maturing at about the rate at which available equipment capacity can harvest it. Hand harvesting does not require as much scheduling precision because growers can plan the size of the picking crew around the amount of fruit maturing on a given day. Irregular winter growing conditions can cause an additional scheduling problem for mechanical harvesting. Tomatoes planted as much as one or two weeks apart may mature at about the same time under certain weather conditions. Such irregularity in maturity dates makes uniform crop scheduling difficult.

Technology resulting from a "systems approach" may be adopted more rapidly than that developed in isolation [5]. This is illustrated by contrasting the development and adoption of the mechanical tomato harvester in California with that of the cotton picker. The cotton picker was developed in isolation from research on other aspects of growing cotton for mechanical harvesting. The tomato harvester resulted from a systems approach. A team made up of engineers and horticulturalists, with assistance from

[7]In California, for example, rapid adoption of mechanical harvesting of processing tomatoes immediately followed discontinuation of the Mexican Bracero program. Less than 10 percent of the California crop was mechanically harvested when the Bracero program stopped. Three years later 80 percent of the crop was harvested mechanically.

agronomists and irrigation specialists, developed a machine harvestable variety, a production system, and a mechanical harvester simultaneously. The tomato harvester was adopted rapidly over a short period of time while nearly twenty years elapsed between the invention of the cotton harvester and its widespread use.

Interfirm difference is another consideration in evaluating how fast mechanical harvesting of tomatoes will be adopted in Florida. The above harvesting cost estimates were based on average yields and machinery performance rates. Some growers have higher yields and will expect higher daily machine outputs. Some also will expect to have more than the 60 harvest days per year assumed in the analysis. These growers may find mechanical harvesting profitable at wage rates lower than those indicated here. In addition some growers may want to gain experience in mechanical harvesting as a hedge against anticipated "labor problems." Such growers may be early adopters but probably will not account for much of the industry's total production.

EXTENT OF MECHANIZATION

Estimating the extent of future mechanization involves a great deal of judgment. Different people may arrive at substantially different estimates from essentially the same information. The most important considerations determining the rate of adoption of mechanical harvesting in Florida seem to be its economic feasibility and the continued availability of labor for hand picking tomatoes. Mechanical harvesting was shown to become profitable at minimum wage levels above $1.60 per hour. Proposed legislation would increase the Federal minimum wage to $2.00 or more over the next three years. Such changes will increase the profitableness of mechanical harvesting. Offsetting this potential is the generally sufficient supply of workers available to hand pick fruit. There is no apparent reason to suspect a big change in this availability of workers in the near future.

In this study three adoption rates were evaluated. They were 10, 25, and 50 percent of the total production. The 10 percent estimate is a rate of adoption likely to occur after a period of 4 to 6 years if wage rates increase to a minimum wage level of $1.75 to $2.00 per hour. The 25 and 50 percent estimates are included to illustrate the potential impact of more widespread adoption which might be expected with higher wage rates, severe labor shortages or over a longer period of time.

Only the impacts from adopting the commercial harvester were evaluated in this study. The semiharvester type machine may be used by some growers in the early stages of mechanical harvesting to gain experience. It provides a means for growers to gain experience in mechanical harvesting without making a large capital investment in highly specialized equipment. Because of the commercial harvesters greater capacity and lower harvesting cost, it seems to be the machine more likely to be used when mechanical harvesting becomes widespread.

EFFECTS OF HARVEST MECHANIZATION ON WORKERS

Changes in acreage need to be considered as well as changes in labor use per unit of production when evaluating the effects of harvest mechanization. In this analysis the amount of tomatoes produced in Florida was assumed to remain unchanged from the four season average 1966-67 through 1969-70.[8] That was 15.7 million 40-pound boxes from 49,700 planted acres and 47,000 harvested acres.

Harvest mechanization was assumed to affect only harvest labor. Labor use in growing, hauling, and packing tomatoes was assumed unchanged. An exception would be if some growers changed to ground-culture tomatoes from stake-culture systems in order to harvest mechanically. Such changes would substantially reduce the labor needed for growing, but this would occur mostly as the adoption rate rose above 25 percent.

Employment

Harvest labor is reduced by 0.23 hours per box mechanically harvested.[9] Labor needs for harvesting tomatoes would be reduced about 0.3 million hours annually if 10 percent of the Florida tomato crop were harvested mechanically (Table 2). This is equivalent to a 6 percent reduction in harvest labor or a 2 percent reduction in total labor used for tomatoes in Florida. Harvest labor would be reduced by about

[8] The basis for this assumption is recognition by both Florida and Mexican grower organizations that unrestrained competition on the part of either area will result in low returns to both groups. In addition, there has been an attempt on the part of domestic fruit and vegetable producers to obtain Federal legislation which would give domestic producers the same share of fresh fruit and vegetable sales on the U.S. winter market as they accounted for in the past. Either the passage of legislation or negotiation of voluntary quotas for importing areas would probably stabilize domestic production near recent levels.

[9] The estimates in the following sections are derived in Zepp [7].

Table 2. ESTIMATED HARVEST LABOR AND TOTAL LABOR FOR TOMATOES IN FLORIDA AT FOUR RATES OF ADOPTIONS OF MECHANICAL HARVESTING

Output mechanically harvested	Harvest labor	Total labor
Percent	Million hours	
0	4.9	15.9
10	4.6	15.6
25	4.1	15.1
50	3.3	14.3

Source: [7, Table 8].

Table 3. ESTIMATED TOTAL EARNINGS FROM EMPLOYMENT IN HARVESTING TOMATOES IN FLORIDA AT FOUR LEVELS OF HARVEST MECHANIZATION AND FIVE MINIMUM WAGE RATES, BASED ON 1966-70 AVERAGE ACREAGE

Minimum wage rate	Percent of production harvested mechanically			
	0	10	25	50
	Million dollars			
$1.30	11.3	10.4	9.1	6.8
1.60	12.8	11.8	10.3	7.8
1.90	14.3	13.2	11.6	8.8
2.20	15.7	14.5	12.7	9.7
2.50	17.2	15.9	14.0	10.7

Source: [7, Table 16].

0.8 million hours annually with 25 percent adoption, and 1.6 million hours annually with 50 percent of the state's tomato crop harvested mechanically. The 1.6 million hour reduction with 50 percent adoption is equivalent to a 33 percent reduction in harvest labor or a 10 percent reduction in total labor needed for tomatoes.

Workers' Earnings

Adoption of mechanical tomato harvesting lowers the average hourly earnings of harvest workers. Average hourly earnings with the $1.30 an hour minimum wage are $2.31 for hand picking and $1.59 for mechanical harvesting. A similar differential between earnings from hand picking and from employment with mechanical harvesting exists at higher wage levels. Most jobs with the mechanical harvester pay less on the average than what pickers earn. Only the mechanic with the mechanical harvesting crew was assumed to earn a wage equal to or greater than the $2.31 average for hand picking. Many pickers are paid on a piece-rate basis, and have an incentive to work diligently to earn a high hourly wage.

The impact of harvest mechanization on total workers' earnings can be determined by reading across Table 3 at a given wage level. For example, with the $1.30 minimum wage level, workers' earnings would be reduced by $0.9 million with 10 percent of the crop mechanically harvested. The impact of wage level is illustrated by reading down Table 3 under a given adoption rate. Estimated workers' earnings increase by $1.5 million as the minimum wage increases from $1.30 to $1.60 per hour with no mechanical harvesting.

Aggregate workers' earnings may not change very much with minimum wage increases up to near $2.00. Increases in hourly rates would be partially offset by decreases in employment and changes in the wage structure of employees due to adoption of mechanical harvesting. The extent to which mechanical harvesting is adopted will be related to the wage level. Higher wage levels will cause mechanical harvesting to become more profitable and more growers will change to it. The actual net effects of higher minimum wage levels on total workers' earnings are probably represented by numbers within

the lines on Table 3. These estimates range between $11 and $13 million for minimum wage levels through $2.20 an hour and adoption rates through 25 percent. Estimated total earnings are somewhat lower at the 50 percent adoption rate.

Job Skills and Job Tenure

Change in employment from harvest mechanization would be a net change. Fewer workers would be employed in hand picking. New jobs such as sorters, additional tractor driver, harvester operators, mechanics, and sorter supervisors would be created. An estimated 97 percent of the workers employed in hand picking tomatoes are pickers and luggers, and 3 percent are picker supervisors. Sorters would account for about 56 percent of the jobs in a mechanical harvesting system. Twenty-five percent would be tractor drivers, 10 percent harvester operators, 10 percent sorter supervisors, and 5 percent mechanics. Some of the job skills required for the mechanical harvesting system probably will be performed by workers previously doing hand picking. Examples are sorter jobs and some tractor driver jobs. The sorter jobs, however, are less strenuous than picking and lugging and may be performed by more women and some less vigorous men workers than hand picking jobs. Workers performing the harvester operator and mechanic jobs probably will be persons not previously employed in tomato harvesting.

Mechanical harvesting would reduce employment peaks in harvest labor use, but it would not eliminate seasonal employment. Peak employment would be about 2000 workers fewer than the current employment peak (about a 20 percent reduction) if 50 percent of the Florida tomato crop were mechanically harvested. The new seasonal peak still would be about 30 times as large as the lowest level of employment during July. Lower peak employment would result from using fewer seasonal workers, but it does not represent longer periods of employment for those workers remaining in the industry. Job tenure in a given location probably would not be very different from that for the current hand harvest system.

SUMMARY AND CONCLUSIONS

Changes in the minimum wage level will affect the profitability of mechanized tomato harvesting in Florida. At minimum wage levels below $1.60 an hour, hand picking tomatoes is usually as economical as mechanical harvesting. Harvest mechanization becomes a breakeven proposition at minimum wages between $1.60 and $1.75 an hour. Mechanical harvesting has a decided cost advantage at minimum wage levels above $1.90 an hour.

Ten percent of Florida's crop harvested mechanically seems to be the maximum adoption likely to occur in the next 4 to 6 years. Even when mechanization becomes profitable, adoption of mechanical tomato harvesting is likely to occur slowly in Florida. There will be a period of experimentation and learning by growers. Harvest workers will generally be available to hand pick tomatoes during this "learning period."

Mechanization of fresh market tomato harvesting will not have very much effect on farm worker employment in Florida until a large proportion of the crop is harvested mechanically. Mechanization does not eliminate all jobs in harvesting tomatoes. Employment of some pickers and luggers will be eliminated, but other jobs such as machinery operators, mechanics, fruit sorters and additional supervisors will be created. A significant amount of mechanization such as 50 percent of the tomato crop harvested mechanically would reduce the total field labor used for tomatoes about 16 percent.

Mechanical tomato harvesting will lower the average hourly earnings of harvest workers. The new jobs created by mechanical harvesting will pay less on the average than what pickers earn. Many of the jobs created by mechanical harvesting would be fruit sorting. Sorting fruit is less strenuous than hand picking and would probably be performed by women and less vigorous men workers.

The effect of higher minimum wages on aggregate earnings of tomato harvest workers in Florida is likely to be small. Increases in hourly wages would be partially offset by decreases in employment and changes in the wage structure of employees due to adoption of mechanical harvesting. Estimated worker earnings in tomato harvesting range from $11 to $13 million with minimum hourly wages of $1.30 to $2.00.

Increases in the minimum wage rate would increase average hourly earnings of tomato harvest workers in Florida, but average earnings would increase a smaller amount than the minimum wage increased. Increases in hourly rates would be partially offset by decreases in employment and changes in the wage structure of employees due to adoption of mechanical harvesting. Estimated worker earnings in tomato harvesting range from $11 to $13 million with minimum hourly wages of $1.30 to $2.00.

Increases in the minimum wage rate would increase average hourly earnings of tomato harvest workers in Florida, but average earnings would increase a smaller amount than the minimum wage

increased. Increases in hourly rates would be partially offset by changes in the wage structure as more employees would be performing lower paying fruit sorter jobs.

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