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Effect of Frequency of Picking Cucumbers on Income

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Introduction

ONE OF THE major problems confronting every rural area is the use of its available resources to the greatest advantage. Hundreds of families in New Hampshire reside on small part-time farms, own a few acres of unused land, and have family labor available for light work in the summer months. Often the father has employment off the farm, but the mother and older children have time to assist in increasing the family income if the opportunity for work existed. Due to location of the home, the older children may have difficulty in finding off-the-farm employment that is in line with their strength and experience. Sometimes semi-retired couples have a few acres associated with their rural residences, need additional income, and are happy to do a limited amount of work if it is not too taxing on their physical abilities. Thus, resources in the form of very small tillage areas and, more important, available family labor are often not now well employed.

Numerous families have found ways and means of adding to their off-the-farm incomes by intensive production on small acreage of their non-commercial type farms. Other rural families are operating dairy or poultry farms which are too small to use all the available family labor productively.

An Opportunity with Cucumbers

In the spring of 1948, a pickling and processing firm made contracts with a few New Hampshire growers to purchase cucumbers grown on a definite acreage. The crop seemed to fit into the economy of the small part-time farm with under-employed labor. Investment in specialized equipment was not needed. An acre of land was expected to furnish employment for two people for about six weeks in mid-summer. The contract guaranteed a market for total production at a definite price for each grade. Since many part-time farmers usually employ a neighbor to plow and fit their garden plots, the growing of the new crop would seem to require merely an expansion in the usual activities on these farms.

Such an opportunity as growing a limited acreage of cucumbers for processing may be the answer to under-employment for many families. Since the picking of the cucumbers demands by far the greatest amount of labor in the production of the crop, this bulletin has been prepared to show farm families the methods of deciding (1) how much labor to use in the picking of their crop, or (2) if a definite amount of labor is available, the amount of acreage to plant.

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* Mr. Woodworth, Professor of Agricultural Economics and Agricultural Economist in the Agricultural Experiment Station, died on September 18, 1953, a few months after preparing the manuscript for this bulletin. Most of the field work, including the picking on experimental plots, was carried on by Adam Goodrum, at that time a sophomore major in Agricultural Economics. This bulletin was completed by George Rogers, formerly Assistant Research Economist in the Agricultural Experiment Station.

Summary of Contract Growing in 1950

THE PROCESSING company expanded its operations and offered contracts in all counties of New Hampshire except Cheshire and Sullivan. The company agreed to purchase all cucumbers grown on contracted acreage at the rate of five cents per pound for Grade 1, three cents for Grade 2, one and one-quarter cents for Grade 3, and one-half cent for Grade 4.*

The processing company furnished transportation from pickup stations in each area to the plant. Each grower had to truck his crop from the farm to the puickup station daily.

A brief study was made of these contract operations with two objectives in mind:

1. To observe the methods used by producers, and to analyze the data obtained in order to aid the growers in reducing costs.

2. To cooperate with the growers and the processing industry by obtaining data and analyzing the possibilities of this intensive crop in meeting the needs of under-employed rural families.

The field man associated with this study visited approximately 100 growers in various parts of the state early in the season to observe the cultural practices, obtain quantity data as to material and labor used prior to harvest, and to arrange with a limited number of growers for detailed records concerning the labor used in harvesting.

A long, severe drought in July and early August checked the growth of vines and it was evident that many fields would be abandoned. Later observations made in the harvest period indicated that most growers were discouraged with the returns from picking and either had or would soon abandon their crops. The situation is indicated by the report from the processing company at the end of the season: 186, or about half of the contract signers, shipped less than $50 worth of cucumbers: 127, or about one-third, received from $50 to $200 for their shipments; only 53, or about 16 percent, of the growers received more than $200. A few had reasonably good crops, four receiving more than $600 for their shipments.

Due to the failure or partial failure of the crops on most farms, the data obtained from 61 growers as to practices were not complete.

While the drought was the major cause, other factors contributed to the low yields. Observations in the field indicated that over half of the contract signers had not followed good commercial practices and would have had low yields even if the weather had been ideal. It was apparent that many of the families on small part-time farms had not plowed and fitted their fields properly. They had not applied adequate amounts of fertilizer and they lacked experience and skill in growing the crop.

A few who had grown the crop efficiently up to harvest had underestimated the problem of picking, and even though yields were fairly good, the

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* Grade 1 — Straight, green, sound, and merchantable stock ranging in size up to 1″ in diameter.

Grade 2 — Straight, green, sound, and merchantable stock ranging in size from 1″ to 1¼″ in diameter.

Grade 3 — Straight, green, sound, and merchantable stock ranging in size from 1¼″ to 1½″ in diameter.

Grade 4 — Green, sound nubs, crooks, and bawls up to 2″ in diameter.

(The processing company furnished transportation from pickup stations in each area to the plant. Each grower had to truck his crop from the farm to the pickup station daily.)

operators did not have sufficient available help to harvest the crop. Several dairymen were confronted in early August with competing demands for their labor between harvesting hay and picking cucumbers. These particular dairymen should not have attempted to grow cucumbers. They did not have the available labor at picking time and could not afford to divert manpower from their regular roughage production program. Some who followed good cultural practices and planted on moist land had good yields. The success of these few men in 1950 gave a favorable indication of the possibility of the crop, if grown under good management and normal weather. The most productive fields were on farms operated by experienced truck farmers.

From the viewpoint of an intensive crop to increase the income of underemployed rural families living on small tracts of land, the observations made in 1950 indicate little progress will be made unless the company or some agency gives detailed instructions and frequent supervisory visits to the farms to teach the proper practices and skills. The crop seems to have possibilities. A few families on small places did increase their incomes. But considerable intensive educational work will be required before the families needing this type of crop can benefit from its production. To promote most efficient production, careful selection of growers should precede the educational work. Field observations show that some families tend to grow cucumbers one year, do not acquire the essential skills, and because of poor yields and low returns for their efforts become discouraged and drop the program.

One solution of the problem might be the employment of a special field man by the company to aid the growers in production technique. This has been the usual procedure of processing companies elsewhere in developing the production of a new crop under a purchase contract. A company representative, by personal visits to new growers in May and June, could be helpful in many ways. For instance, he could encourage and aid in arrangements for custom work in plowing and fitting the land on farms where operators do not have adequate equipment. He could teach the essential skills for production of a profitable crop. He could encourage special arrangements whereby a producer would grow several acres up to harvest and lease picking rights to individuals who needed more income. However, these services to scattered, small-volume farmers might be fairly expensive and the company would need to analyze the situation in the light of its other alternatives.

Harvesting

Special emphasis was placed on observations of harvesting problems and a preliminary report was made.* The study of the harvesting phase of the production problem indicated that frequency of picking the crop was an important management decision. Comparison was made experimentally between three frequencies of picking: six times a week, three times a week, and two times a week. The lower total weight as frequency of picking increased was accounted for by the higher proportion of small cucumbers. The greater total value was due to these small cucumbers falling into high value grades. However, frequent picking required more hours of labor. An average of 314 man hours per acre were used picking six times a week,

* "Progress Report on Harvesting and Marketing Cucumbers for Pickles Under Contract", Harry C. Woodworth, Agricultural Economics Research Mimeograph No. 8, New Hampshire Agricultural Experiment Station, January, 1951.

186 man hours for three times a week, and 133 man hours for two times a week.

When estimated on the basis of output per man hour of picking, the more frequent picking resulted in fewer cucumbers, lower total weight and smaller value per hour. The value of the crop at contract prices was $.98 per man hour for picking six times a week, $1.52 for three times, and $2.02 per man hour for two times a week. This phase of the study of harvesting was repeated in 1951 in order to obtain additional data.

Results of Experimental Picking for the 1951 Crop

IN THE 1951 experiment, four frequencies of picking were compared: six times. three times. two times. and 1.4 times per week. Plots were laid out in duplicate series on two farms, making four duplicate series in all. On each farm the plots were selected at random within the area of the fields where the stand and the condition of the stand seemed homogenous.

Despite the care taken to select random plots within the area of the fields where the stand and condition of the stand seemed homogenous, it was obvious from the raw data collected that yields had been influenced to a considerable extent by variations in conditions between plots. In order to isolate the effects of frequency of picking upon yields and returns, the raw data were subjected to statistical adjustment. The results obtained in the 1951 experiment tended to confirm the conclusions reached on the basis of the 1950 data.

The field man did all the picking on the experimental plots and kept a record of the picking time. the number of cucumbers picked, and the total weight of cucumbers in each grade from each plot at each picking.

Frequency of picking has a pronounced effect on the per acre hours of picking labor required and the pounds of cucumbers produced as shown in Table 1 and Figure 1. Hours of labor required increased with greater frequency of picking as would be expected since the plot had to be gone over

Table 1. Picking Labor and Yield of Cucumbers with Varying Frequencies of Picking, 1951 Season

Frequency of Picking	Total Picking Labor per Acre	Yield of Cucumbers per Acre	
		Quantity	Value
(times per week)	(man hours)	(pounds)	(dollars)
1.4	105	20,653	275
2	128	18,173	332
3	167	17,540	346
6	294	15,837	375

more times. Pounds of cucumbers produced were less with greater frequency of picking because the cucumbers had no chance to grow large. Poundage yield is of importance to growers since they get paid on the basis of pounds rather than cucumber numbers.

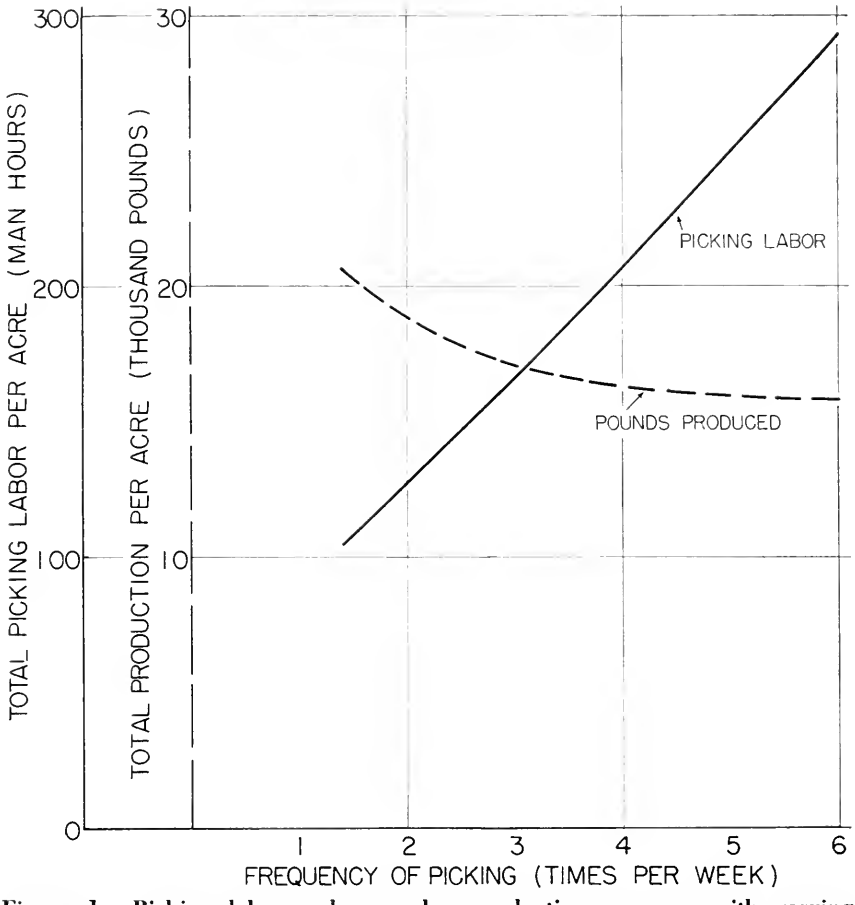

Figure 1. Picking labor and cucumber production per acre with varying frequencies of picking, 1951 season.

As shown graphically in Figure 1 the changes in labor inputs and pound outputs with increasing frequency of picking move in opposite directions. However, since more frequent picking increases the proportion of

Table 2. Production of Cucumbers in Pounds per Acre by Grades with Varying Frequencies of Picking, 1951 Season

Grade	Frequency of Picking (Times per Week)							
	1.4	2	3	4	1.4	2	3	4
	(pounds)				(percent of pounds)			
1	1,738	2,679	2,824	3,529	8.4	14.7	16.1	22.3
2	2,118	3,186	3,566	3,964	10.3	17.5	20.3	25.0
3	5,412	5,394	5,557	5,032	26.2	29.7	31.7	31.8
4	11,385	6,914	5,593	3,312	55.1	38.1	31.9	20.9
Total	20,653	18,173	17,540	15,837	100.0	100.0	100.0	100.0

Table 3. Production of Cucumbers in Value per Acre by Grades with Varying Frequencies of Picking, 1951 Season

Grade	Frequency of Picking (Times per Week)							
	1.4	2	3	6	1.4	2	3	6
	(dollars of value)				(percent of value)			
1	87	134	141	176	31.6	40.5	40.8	47.1
2	64	96	107	119	23.1	28.8	31.0	31.7
3	68	67	69	63	24.6	20.3	20.1	16.8
4	57	35	28	17	20.7	10.4	8.1	4.4
Total	276	332	345	375	100.0	100.0	100.0	100.0

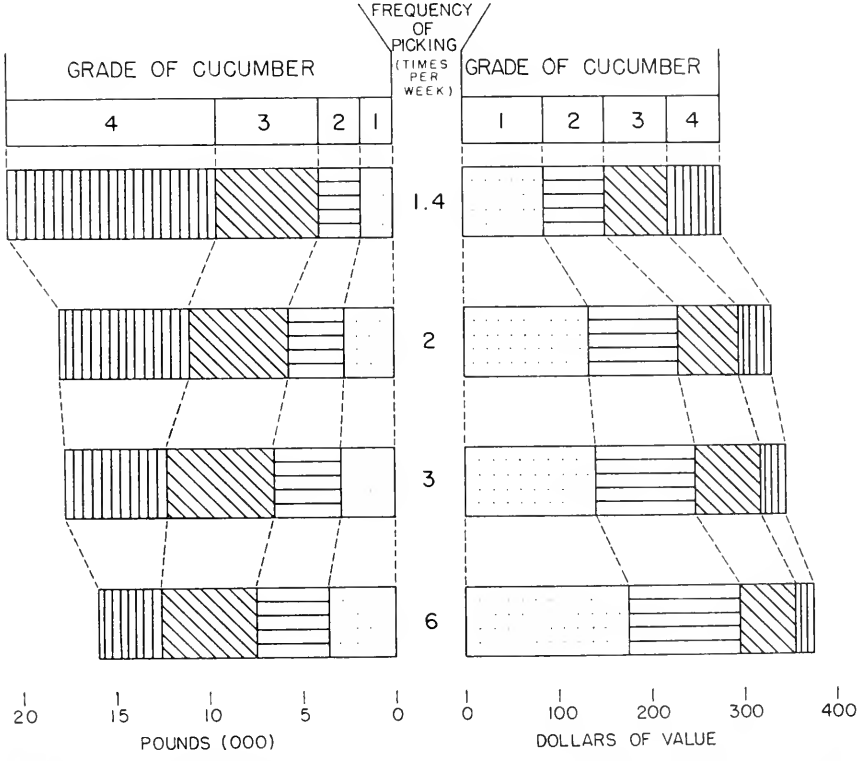

Figure 2. Comparison of cucumber production per acre in weight and value by grades with varying frequencies of picking, 1951 season.

the poundage in the higher priced grades* (Table 2), the value output increases with greater frequency of picking (Table 3 and Figure 2). This means that additional inputs of labor produce additional outputs of value. The question which this bulletin explores is the relationship of these two and the level of output at which it pays to stop adding labor.

* The prices of cucumbers in 1951 were the same as in 1950: five cents per pound for Grade 1, three cents for Grade 2, one and one-quarter cents for Grade 3, and one-half cent for Grade 4.

Table 4. Output of Cucumbers per Man Hour of Picking Time by Grades with Varying Frequencies of Picking, 1951 Season

Grade	Frequency of Picking (Times per Week)							
	1.4	2	3	6	1.4	2	3	6
	(pounds)				(dollars of value)			
1	16.6	20.9	17.0	12.0	.83	1.05	.85	.60
2	20.2	24.9	21.4	13.5	.61	.75	.64	.41
3	51.6	42.2	33.4	17.1	.64	.53	.42	.21
4	108.5	54.1	33.6	11.3	.54	.27	.17	.06
Total	196.9	142.1	105.4	53.9	2.62	2.60	2.08	1.28

Frequent picking of the field definitely required considerably more total labor for the season. Moreover, as frequency of picking increased, the poundage output per man hour decreased markedly from almost 200 pounds per man hour when picking 1.4 times per week to a little over 50 pounds per man hour when picking six times a week.

The output per man hour of Grades 1 and 2 did not vary as much for the various frequencies of picking as did output of Grades 3 and 4. Less frequent picking resulted in greatly increased output of the lower priced grades.

When the yields of the four grades were combined on the basis of the contract price of each grade, the output per man hour in picking cucumbers was $2.62, $2.60, $2.08, and $1.28 for 1.4, two, three, and six times per week respectively (Table 4). Thus in the 1951 experiment the output per man hour in terms of both weight and value decreased with greater frequency of picking, but because more frequent picking produced a greater proportion of the higher value grades, the decrease in value output was roughly half that of the poundage output.

The use of value as a measurement of output in this connection is influenced by the particular grade and price arrangement of a processing firm. With other grade and price arrangements, the results would be different. The grade-price relationships offered growers reflect the needs of the packer for the various grades of cucumbers. If the company wanted a higher proportion of small sizes, it could raise the price of Grade 1. It could also rearrange the size specifications of the grades. But when once the arrangement of grades and prices is fixed for the season, the growers have the privilege of harvesting the crop in a manner which will be to their advantage.

Using the Experimental Results

GROWERS ARE faced with one of two major types of decisions relative to the harvesting of cucumbers. One of these would be in the situation where the grower has a definite acreage of cucumbers planted and wants to decide how many times a week to pick his plot; or stating it another way, how many total hours of labor to use during the picking season. The other type of decision would be required in the situation where the grower has a definite amount of harvesting labor available, such as family labor, and wants to decide how many acres of cucumbers to plant. In both of these cases the decision is directed at the achievement of maximum net income

based on some value for labor. The cost of labor involved in any particular farm situation is going to depend first of all on whether or not it has to be hired. If it is hired, the price of labor is established by the wage rate. If it is not hired, then the farm family itself must decide what the use of its labor is worth. If this family labor has no other use, then the family may be content to achieve a rather low return per hour of picking time. If it has other uses or the family for some other reason wants a relatively high return per hour, this will establish a high labor rate per hour.

The first type of decision is arrived at in one of three ways, all of which are discussed in following sections of this bulletin. One method is to use the *marginal output* curve as shown in Figure 4 and find the input of labor per acre at which the marginal output is equal to the cost of labor per hour. A second method is to use the *total cost* curve as shown in Figure 5 and find the value output per acre at which the difference between total cost and total returns is a maximum. The third method is to use the *marginal cost* curve as shown in Figure 6 and find the value output per acre at which marginal cost per dollar of output is equal to one dollar.

The second type of decision is arrived at as shown in Figure 7. The total returns from applying 400 hours of labor to varying quantities of land are determined and the maximum returns acreage found. This is discussed in the final section of the bulletin.

Continuous Series of Labor Inputs

While the data were obtained on the basis of definite frequencies of picking, the nature of the harvest is such that these data can be considered as points in a continuous series of applications of labor to an acre of the crop. For instance, in actual practice an operator might pick a fraction of his field in a day and then begin where he left off on the following day. Thus any constant labor force available might, within limitations, be employed on the picking operations. We have assumed in the analysis which follows that each operator has the opportunity of varying the total hours of labor input in harvesting an acre of cucumbers and that this application of labor can be considered as a continuing series of inputs.

Physical Output Curves

In Figure 3 the total output data, measured in terms of total value of all grades, are plotted against the hours of picking labor per acre extending from 105 hours (1.4 times per week) to 294 hours (six times per week). According to this curve, the total output increases at a decreasing rate and beyond the application of 200 hours of labor it increases only moderately.

The average value output per hour of picking labor decreased with greater applications of labor as indicated in Figure 4. The situation is described with greater emphasis in the marginal output curve. This curve represents the value of the output of each succeeding input of man labor. At any point in the application of labor the production of the last hour applied is accounted for.

According to this curve, the 120th hour of labor resulted in an output of $1.50 in value of the four grades of cucumbers, while the 170th hour accounted for $.48 in value, and the 250th hour only $.10.

When once the field has been carried to the harvest period, decision

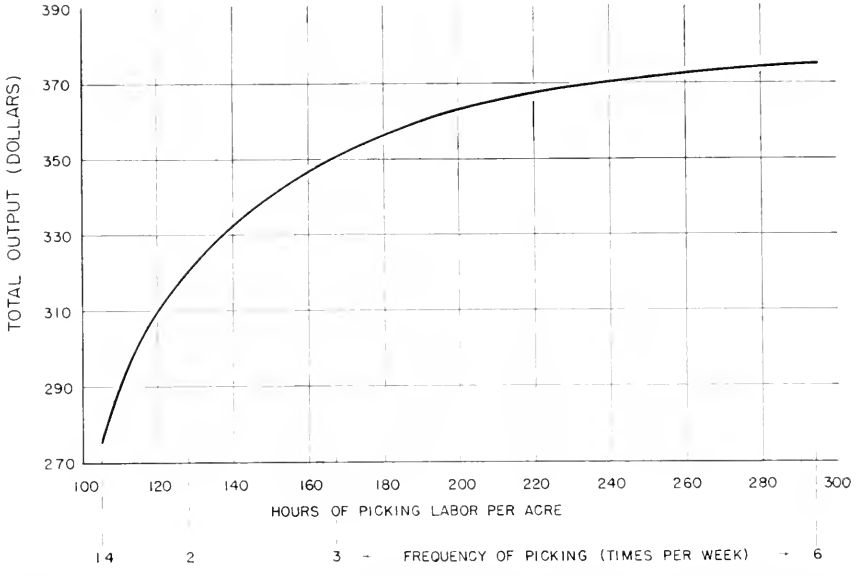

Figure 3. Total output per acre resulting from various quantities of labor input, 1951 season.

as to amount of labor to apply in the six weeks' harvest period depends on a short-run analysis. That is, it depends only on the cost of harvest labor and not at all on growing costs up to harvest time. In this case the expense

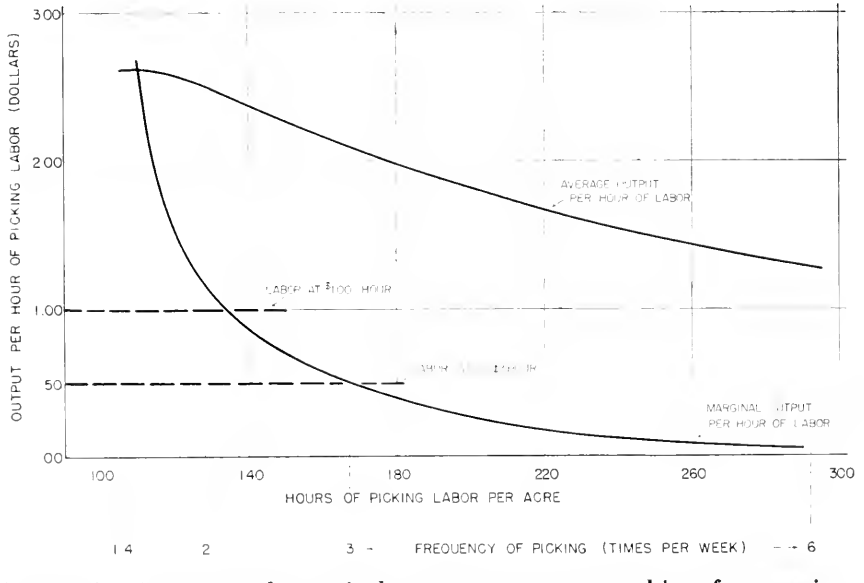

Figure 4. Average and marginal output per acre resulting from various quantities of labor input, 1951 season.

of production has already been incurred and the field of cucumbers ready to be harvested must be considered as a fixed cost factor and the application of labor for harvesting as a variable factor. Labor can be profitably applied to the harvest as long as the marginal or last unit of output, measured in value, is greater than the cost of the last unit of labor applied. With the figures shown in this analysis, if the labor charge is $.50 per hour, it would be profitable to use 167 hours. If the charge is $1.00 per hour, it would be profitable to use 133 hours. In both cases the marginal cost would be equal to the marginal returns, and when this is true profits are at a maximum.

If labor is available and cheap, which will depend on alternative opportunities, the field can be picked as often as once a day. If labor is scarce and wages high, three or fewer pickings a week might maximize net returns to the operator. This of course depends on the relative prices of cucumber grades. If Grade 4 became relatively higher priced, it would pay to reduce inputs of picking labor.

While this particular marginal curve, which is based on data from only a limited number of farms in one season, should not be used as an accurate foundation for decisions, it does indicate the general problem facing the grower in his decisions.

Total Cost Curves

The harvesting is only one part, in this case an important part, of the production process. The growing of the crop prior to harvest requires the use of land, equipment, supplies, and labor, and must be considered in decisions involving the entire season; that is, decisions made before commitment to grow the crop.

For purposes of exploring the management problem, the cost of growing the crop prior to harvest was assumed to be $100 an acre. When a small part-time farmer hires custom plowing and fitting of land and purchases fertilizer, seed, and supplies, but uses family labor for growing, the total cash costs would be about $80 per acre. The contribution of family labor prior to harvest is difficult to determine. On some commercial specialized farms where labor is hired or has alternative uses, the operators might be interested in producing the crop up to harvest for $100 to $150 an acre, depending on their other alternatives.

In Figure 5, the $100 pre-harvest fixed cost curve and two total cost curves have been drawn. In curve I the rate of labor cost per hour is $.50 and in curve II is $1 per hour. It should be noted also that the level of production in these curves is based on a further assumption that variations in output are due entirely to frequency of picking during the harvest period of five to six weeks.

In each curve the total cost of the crop increases slowly until an output of about $350 is reached after which the cost rises rapidly. These curves of total cost are quite usable in deciding how much labor to use in the harvest of each acre of cucumbers. They show for each alternative output level the total costs expected with $100 worth of pre-harvest cost and either $.50 or $1.00 per hour charge for harvest labor. By comparing these curves with a curve showing the expected returns per acre, the location of the output at which the difference between costs and returns is a maximum can be determined. Using the figures in this study, the most profitable

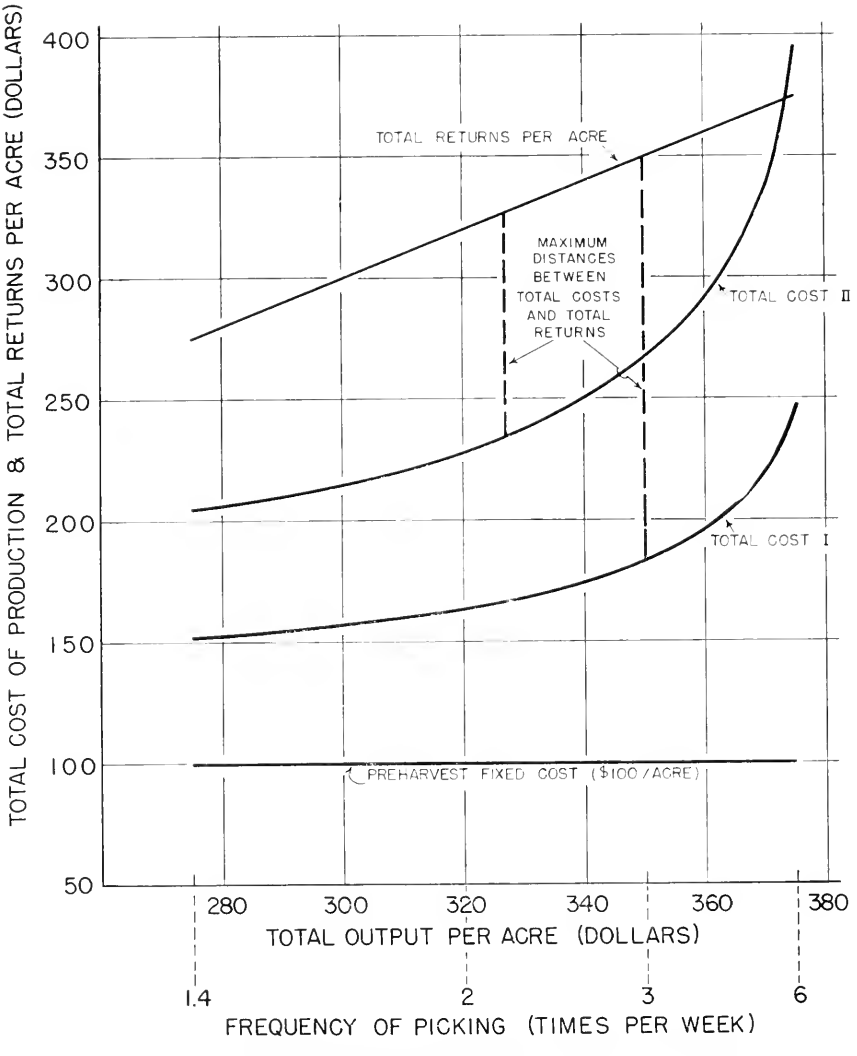

Figure 5. Fixed and total returns per acre in relation to output per acre, 1951 season.

output with $.50 per hour labor charge is $350. and with $1.00 per hour labor charge is $327. These correspond to 167 and 134 hours of labor input respectively (see Figure 3).

Marginal Cost Curves

The marginal cost curves which show the additional costs of producing one more dollar of output at each level of output are shown in Figure 6. Curve I uses $.50 per hour labor charge and Curve II, $1.00. The marginal cost curves rise rapidly after an output of $350 is passed. This is due to

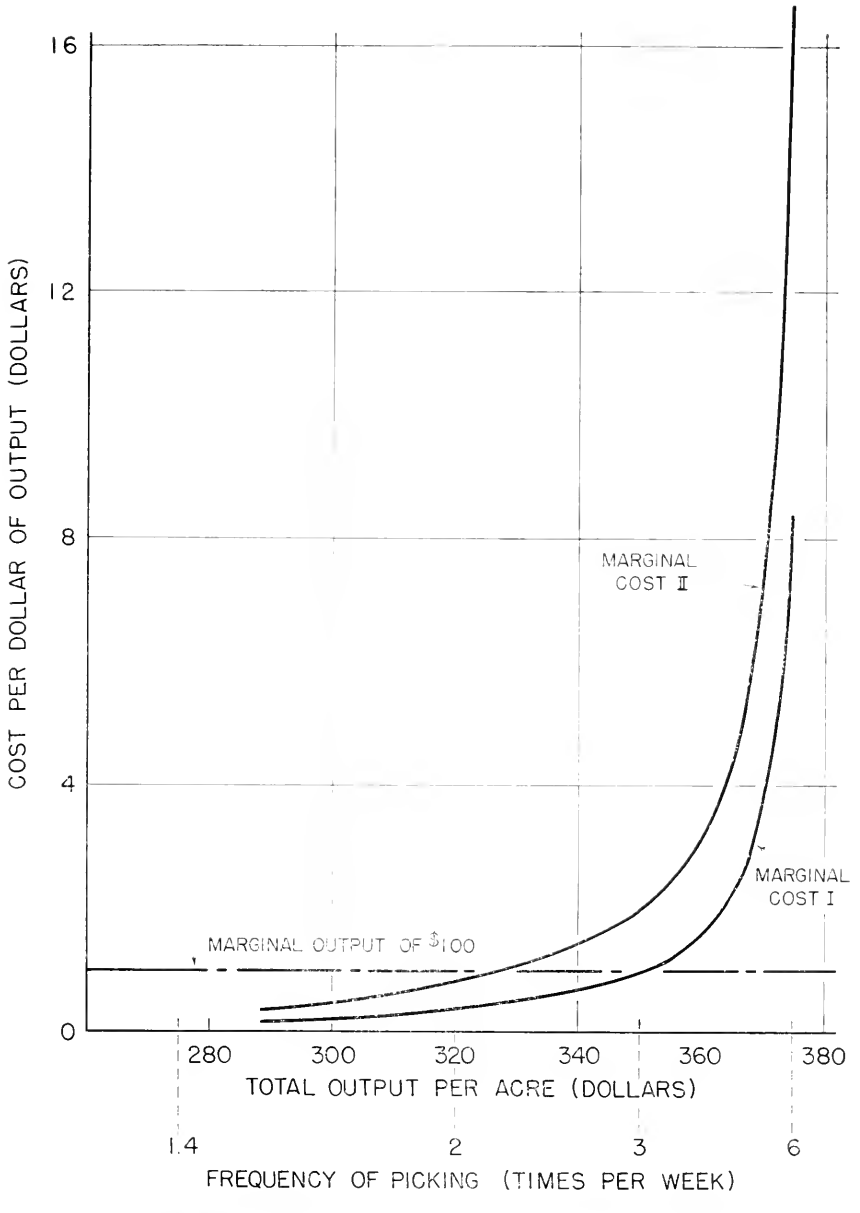

Figure 6. Marginal cost curves per dollar of output, 1951 season.

the low marginal output of labor after this point and hence the high cost of the additional value of output resulting from picking very frequently. In this case the operator would find it unprofitable to produce more than $350 of output with labor at $.50 per hour, or $327 of output with labor at $1.00 per hour. These outputs are equivalent to labor inputs of about

167 hours and 134 hours respectively (see Figure 3). This is the same set of conclusions as to labor use arrived at in the analysis of the marginal output curve on page 11 and the total cost curve on page 13.

Acreage for a Given Labor Force

One of the problems facing a few families is the best use of available family labor. For instance, a family estimates it could use 400 hours of labor on a crop in the harvest season. Assuming no alternative market

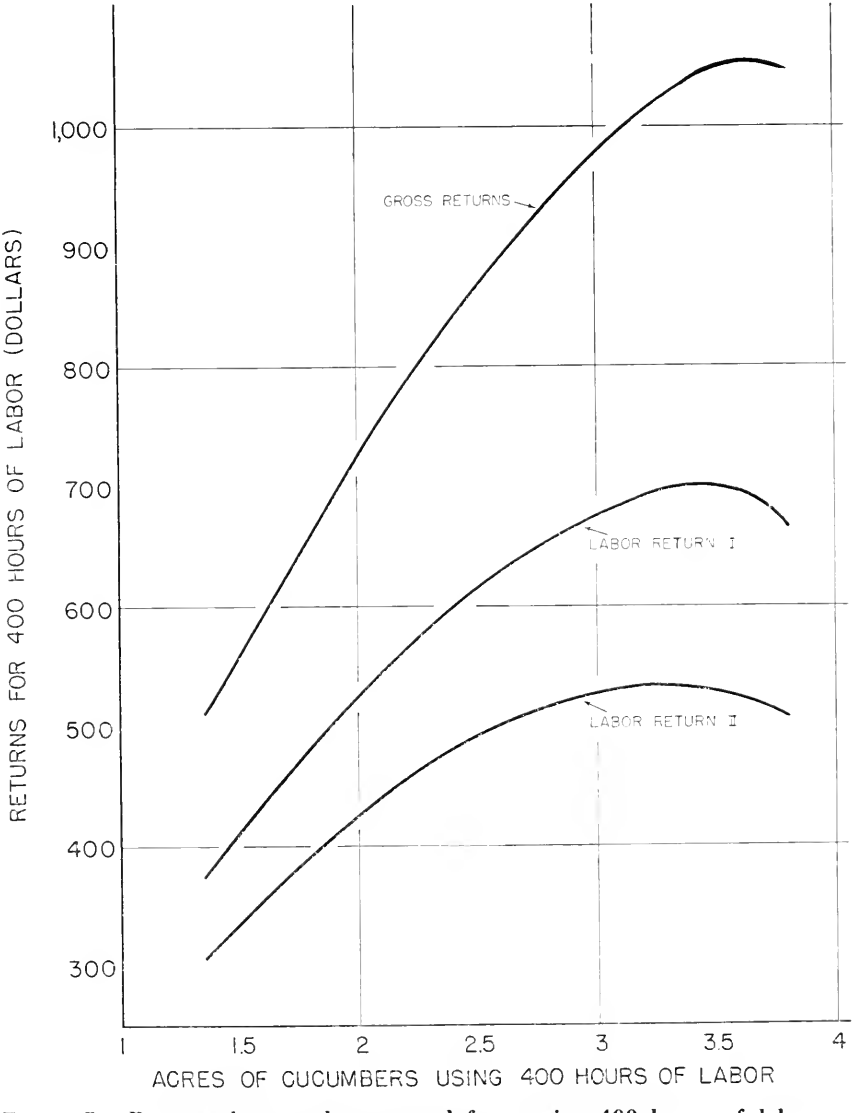

Figure 7. Returns that can be expected from using 400 hours of labor on various quantities of land.

for this labor, the problem is one of how many acres should be grown to maximize the returns. In this case the 400 hours of family labor can be considered as a fixed cost. The expenses associated with growing variable acres of cucumbers prior to harvest can be considered variable costs.

In Figure 7 the total returns and the estimated net returns from 400 hours of unpaid family labor in combination with variable acres of cucumbers are indicated. The top curve indicates the total returns, the next curve shows the net returns for 400 hours of labor assuming costs prior to harvest of $100 per acre. The bottom curve shows total net returns assuming costs prior to harvest of $150 per acre.

If the 400 hours are used in harvesting an acre and a half, the field will be picked about six times a week to achieve maximum returns. With this acreage the net returns will be about $410 and $335 with pre-harvest cost of $100 and $150 respectively. With costs prior to harvest at $100 the returns would be maximized at about 3.5 acres. When costs prior to harvest are assumed at $150, the returns would be maximized at a slightly lower acreage of about 3.25 acres.

This analysis is based on data inadequate for application in detail to other seasons or other farms. The analysis does indicate the need for growers to give considerable attention to the problem of the most desirable acreage to grow in relation to the available labor.

Conclusions

THE ANALYSIS of data on frequency of picking cucumbers was directed toward the particular production problems on the typical small farm where the family might be interested in growing this intensive crop. The main characteristic of the production process on such farms is that many of the resources employed are already available on the farm, often have no alternative productive use, and do not represent definite out-of-pocket costs. The problem facing the operator is largely one of combining these available resources with limited amounts of other resources to maximize his returns. On the other hand, since many of these farms more nearly represent a family household situation than a commercial business enterprise, personal aspects may condition the desire or necessity for maximizing of net income.

The analysis, to be useful, must indicate a procedure for arranging the data for decision making by the family. The "theory of the firm" as a procedure of analysis of combinations of fixed and variable resource inputs fits the situation described above very well.

In the short-run discussion of this problem the acreage of cucumbers grown and ready for harvest was considered as a fixed resource since the operator has already incurred the expenses of bringing it to the picking stage. Only inputs of labor in picking are considered as variable and as subject matter for decision making. No fixed costs, whether small or large, influence the decisions as to picking practices, when once the cucumbers have reached the harvest period.

The average physical productivity curve for labor in picking decreases moderately. This is because the data available are so far out on the horizontal axis that the average output is not sensitive to changes resulting from applications of more units of labor in harvest. The marginal productivity curve, on the other hand, indicates dramatically that each successive additional labor input applied results in substantial diminishing returns.

A somewhat longer period, that of the entire season of growing and harvesting, was also employed to explore the influence of variable inputs of picking on total costs. The cost curves constructed were based on the physical input-output data, but the cost rates for both the fixed and variable resources were assumed. The resulting curves, of course, should not be interpreted as exact costs, but rather as indications of the general effect of variable labor inputs on costs. Actual costs cannot be determined because the cost per unit of inputs, such as family labor, can only be imputed or estimated.

Since the family, in the usual case, has available labor, an important decision is the acreage of cucumbers that will utilize this available labor to the best advantage. In the analysis of this full-season problem, the family labor available for picking was considered as the fixed resource and the number of acres of cucumbers grown to the harvest stage was treated as a variable input. The cost of producing an acre of cucumbers to the harvest season was assumed. The curves in the chart indicate the general effect of combining a fixed labor force with varying inputs of cucumber acreages on total net income for the family.

The results shown in this analysis depend upon the grade prices in existence at the time of the study. Present grade prices may be quite different from the ones used.