RESOURCE USE AND RETURNS ON MICHIGAN FRUIT FARMS

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This is to certify that the

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ABSTRACT

RESOURCE USE AND RETURNS ON MICHIGAN FRUIT FARMS

By

Roger P. Hill

The objectives of this study were: (1) to describe the economic characteristics of Michigan fruit farms, (2) analyze resource productivities and rates of factor substitution, (3) determine the economics of size relationships, and (4) to suggest on-farm adjustment potentials.

Tabular analysis was used in the descriptive sections and a production function model (Cobb-Douglas type) was used to estimate resource productivities and size coefficients. From the estimated parameters in the production function analysis, marginal value products and rates of factor substitution were computed. In all of the analysis, a comparison was made between the area sample growers, presumably characteristic of the fruit industry, and the large farm sample growers, representing the largest growers as measured by volume of fruit sales.

The farms in the large farm sample were not only larger than the area sample farms, as measured by acres of fruit and total fruit sales, but they tended to be more specialized in fruit production. The large farms were less likely to have a non-fruit enterprise, but their fruit operation tended to be more diversified. Fruit yields

and percentage of fruit sold on the fresh market were generally higher in the large farm sample.

The large farm growers were much larger employers of hired labor than were the area sample growers. Each type of hired labor, regular, seasonal and harvest, was reported by a larger percentage of the large farm growers. While hourly wage rates dominated the wage rate structure for regular and seasonal workers in both samples, a much higher percentage of the large farm growers were paying monthly and weekly wage rates.

There were substantial differences in resource returns and adjustment potentials between the area and large farm samples, although approximately constant returns to size were indicated for both samples. The area sample growers were receiving a very low return (near zero) from machinery investment, while the large farm growers' return to machinery investment appeared to exceed the marginal cost of additional machinery investment. The returns from expenditures on hired labor were quite high in both samples, generally exceeding $1.70 for each dollar expenditure. The returns to operator and family labor were approximately zero in both samples. Fruit acreage had a much higher return in the area sample than in the large farm sample.

Suggested adjustments for the area sample growers included reducing their machinery investment and doing more equipment renting and custom hiring or increasing their fruit acreage and hired labor input. Additional machinery investment was suggested for the large farm growers. Even with added machinery investment, additional hired labor appeared profitable.

The hypothesis of constant returns to size was rejected for the area sample cherry farms and increasing returns to size were indicated. Increased use of all factors, particularly machinery investment, appeared profitable for area sample cherry farms. Profitable adjustments for large farm sample cherry growers included additional machinery investment and hired labor use.

The hypothesis of constant returns to size was rejected for all apple farms and decreasing returns to size were indicated. Decreasing the fruit acreage appeared to be the most reasonable of the alternatives available.

When all farms from both samples were subgrouped by alternative measures of size, only for the largest farms, as measured by level of hired labor expenditures, were decreasing returns to size indicated. Generally, the economies of size question did not appear to be critical.

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CHAPTER I

INTRODUCTION

Statement of the Problem

As the leading deciduous fruit producing state east of the Rockies, Michigan has been a major user of seasonal agricultural labor. In volume of production Michigan ranks among the top five states in the following fruit crops: apples, pears, grapes, sweet cherries, tart cherries, plums and strawberries. Fruit crops generally account for 8-10 percent of the cash receipts from marketings of farm products in Michigan, with apples and tart cherries consistently making the largest contributions.

The production of fruit is one of the more labor intensive operations in Michigan agriculture. The labor requirements are such that total labor cost can be as much as 50 percent of the total cost of producing apples and up to 70 percent of the total cost of producing cherries.[1]

Not only are large amounts of labor required, but the timeliness of the supply of labor is a critical factor. Unlike many other agricultural enterprises, fruit growing requires large labor inputs in relatively short periods of time. One or two weeks delay in the harvest operation, for example, could mean disaster to the grower.

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[1]Orlan H. Buller, "Profitable Adjustments on Selected Michigan Tree Fruit Farms," (unpublished Ph.D. dissertation, Department of Agricultural Economics, Michigan State University, 1965), p. 1.

In 1966 there were 53,000 local, 13,000 intrastate and 73,500 interstate (migratory) workers employed in Michigan agriculture. Due to the movement of workers between crops, as many as 85 percent of these workers were employed in the fruit industry at one time or another in 1966. Peak employment of seasonal workers occurred on July 31, 1966, when 67,635 domestic workers were employed. On specified dates, as many as 50 percent of the total number of seasonal workers in the state were engaged in fruit crop activities. The total number of seasonal workers and the number employed in eight fruit crops is shown for specified dates in Table 1.1.

Table 1.1. Total Number of Seasonal Workers Employed in Michigan Agriculture and in Eight Major Fruit Crops for Specified Dates in 1966.

Date	Total Seasonal Workers Employed in Michigan Agriculture	Seasonal Workers Employed in Eight Fruit Crops
June 15	25,064	2,600
June 30	51,098	29,035
July 15	49,280	25,840
July 31	67,635	37,832
August 15	59,144	23,505
August 31	51,230	16,800
September 15	34,872	11,675
September 30	28,567	14,095
October 15	22,288	12,575
October 31	11,118	5,995
November 15	4,095	1,155

Source: Post Season Farm Labor Report, 1966, Farm Labor Service Section, Michigan Security Employment Commission.

The importance of the timeliness of the supply of labor is indicated by the substantial variation in the number of workers employed between June 15 and November 15. For all of the time periods shown in Table 1.1 more than 50 percent of the workers employed in fruit crop activities were interstate or migratory workers.

The flow of the migratory stream of workers has been critical to Michigan fruit growers. These interstate workers originated in 21 states and Puerto Rico in 1966, with over 85 percent of the migrants coming from Texas and Florida. Traditionally, the migrant stream of labor works its way north from the southern states, completing harvesting operations in one area and moving further north to begin harvesting other crops. Michigan is generally the last place of seasonal employment, with the workers returning directly to their home states upon completion of the harvest activities. Since no one fruit enterprise affords continuous employment over an extended period of time, the sequence of crop activities is of critical importance in labor availability. Seasonal workers are generally unwilling to travel very far without assurances of some minimum continuous employment opportunities. Michigan fruit growers are dependent to some extent on the crop activities in states to the South and more particularly on the sequence of crop activities in Michigan. A selective freeze of one crop such as cherries or a delayed harvest of a major crop could disrupt the normal movement of migratory labor. The normal patterns could also be disrupted if the harvest of a major crop such as tart cherries was fully mechanized.

As labor becomes more expensive and less readily available, there is increased economic incentive to mechanize harvest and other operations. Increased mechanization will alter the demand for agricultural labor both in terms of quantity and quality of labor required and will have a substantial impact on the continuity of employment opportunities of seasonal workers. Growers have also been under pressure to adapt their enterprise combinations and size of operation to facilitate longer seasonal employment for a base crew of workers. In addition, there has been a strong incentive to add enterprises that have serial harvest dates. In some instances, a marginal enterprise may have been added because of the labor utilization pattern it facilitated.

Several interrelated forces have had a major impact on seasonal labor availability and the prices that growers have faced. In an industrial state such as Michigan, there are many alternative employment opportunities for workers with some skills. Alternative employment opportunities have been particularly good in the past few years when national unemployment rates have been at or near record lows. There has also been increasing public concern regarding the level of earning of agricultural workers and their exclusion from the benefits of types of social legislation covering most workers in other sectors of the economy. As a result of the increased public concern and activity by labor unions, the past few years have produced significant legislation affecting the agricultural labor situation.

Some of the major legislative changes affecting the agricultural labor situation include:

(1) Termination of the Mexican National Importation Program (P.L. 78) under which foreign workers from Mexico were admitted for seasonal employment in agriculture.

(2) Greater restrictions were placed upon the admission of all foreign workers under Public Law 414.

(3) In 1964, the Michigan Minimum Wage Act was passed. All agricultural employers who employed four or more employees between 18 and 65 years of age for 13 weeks or more during the preceeding calendar year were covered. The minimum rates were $1.00 per hour in 1965, increasing to $1.15 per hour in 1966 and $1.25 per hour in 1967. The act was later amended to remove the 13 week provision and provided for the establishment of minimum piece-work rates for harvest workers.[2]

(4) Effective February 1, 1967, a Federal minimum wage was made applicable to certain agricultural workers. The Fair Labor Standards Act, as amended, provided for a minimum wage of $1.00 per hour in 1967, increasing to $1.15 per hour in 1968 and to $1.30 per hour in 1969. This minimum wage will directly affect the majority of Michigan's fruit growers and will have an indirect affect on all fruit growers.

(5) In addition there has been legislation requiring Workmen's Compensation coverage by certain farmers, a new licensing

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[2]The Minimum Wage Act was amended in 1965 to temporarily exempt employers of workers who traditionally harvested agricultural crops on a piece-rate basis. Adequate data was to be developed that would make possible the establishment of minimum piece rates that would reflect a minimum hourly wage. At the request of the Wage Deviation Board of the Michigan Department of Labor, the Rural Manpower Center at Michigan State University has conducted worker productivity studies on the harvesting of a number of Michigan farm commodities, including several fruit crops.

program for agricultural labor camps, and an Emigrant Agent Act providing for the licensing and regulation of emigrant agents.

The combination of alternative employment opportunities and social legislation have led to greater competition among producing areas for the available supply of labor, added costs of recruitment and transportation of workers from supply areas to producing areas, increased the level of wages paid to farm workers, and in general increased the cost of labor to fruit growers.

Objectives of the Study

An appraisal of the economic impact of developments in the fruit industry required reliable knowledge of the use of agricultural labor, the present organization of fruit farms and the relationships to current cultural and technological practices. Primary data were needed that would serve as a benchmark from which to measure the effect upon labor demand of changes in technology and the organization of fruit farming in Michigan.

To obtain the necessary data, a joint project was initiated between the Michigan Agricultural Experiment Station and the Farm Production Economics Division, ERS, USDA. The initial step of the joint project involved conducting a survey of fruit growers in Michigan to establish current patterns and levels of labor use, production practices, and technologies being applied. The survey was conducted during the winter of 1966-67. Data were enumerated for the 1966 crop year and included volume of production by commodity, production practices, quantity of labor used, labor costs, machinery and equipment inventory, certain characteristics of the operator and recent and anticipated changes in farm organization.

One of the objectives of this thesis is to describe the characteristics of the fruit industry as indicated by the survey data. Particular attention is given to those characteristics of the industry that could have a substantial influence on future labor use patterns. In addition to a detailed description of the sample data, it is the further objective of this thesis to provide at least partial answers to the following questions:

(1) What are the significant factor-factor, factor product and size relationships? Do any economies of size exist in fruit production?

(2) What are the marginal value products (MVP) of the factors of production at the aggregate level? Are the MVP's significantly different for different types of fruit farms or for various subgroups of farms?

(3) How does capital, in the form of machinery and equipment, substitute for labor in the production of fruit? How might a change in the price of labor affect the capital-labor substitution possibilities?

(4) Given the characteristics of the industry and the levels of technologies being used in 1966, what on farm adjustments may be made?

An additional objective of the study is to determine if there are any significant differences between the industry as characterized by the area sample data and a special group of the largest farms in the industry.

The Sample

Approximately 300 interviews of Michigan fruit growers were desired from the 20 principal fruit growing counties. Since it was expected that the largest fruit growers would account for a large part of the variance in farm labor use, one-third of the sample was allocated to the large farm group. Allocation of the other 200 interviews was made by means of the area frame.

The sample allocation to the area sample was based in part on data from the 1959 Census of Agriculture. As a result of rapid changes in the Michigan fruit industry, the expected number of fruit farm operators in the area sample was grossly overestimated. Instead of the expected 1.2 fruit farm operators per segment, the survey yielded only .57 operators per segment. To obtain the desired number of interviews it was necessary to double the number allocated to the large farm sample.

A total of 295 fruit growers were contacted and 258 schedules were collected, 88 from the area sample and 170 from the large farm sample. Based on the sampling procedure, it is estimated that the 88 area sample growers constitute 1.124 percent of the universe of 7,824 fruit growers in the 20 county area. Details of the sampling procedure as developed by the Statistical Research Service, USDA, are in Appendix A.1.

CHAPTER II

CHARACTERISTICS OF MICHIGAN FRUIT FARMS

One of the principal objectives of this study was to describe the Michigan fruit industry in 1966, with particular emphasis on characteristics that could affect future labor-use patterns. Included in this chapter are characteristics of the fruit enterprises such as fruit crops grown, acreages, yields, and fruit sales. In addition, certain general characteristics of the sample farms are reported such as source of total farm sales, storage and packing facilities and recent and planned changes in farm practices and organization. The specific characteristics are reported under the broad categories of fruit enterprise characteristics and general farm characteristics; and, where appropriate, the data are reported separately for the area and the large farm sample.[3] A total of 257 farms reported usable data, 88 in the area sample and 169 in the large farm sample.

Fruit Enterprise Characteristics

Data were collected for each fruit enterprise on the farm. The data included acreage and variety of fruit, age of orchard, tree spacing, type rootstock, volume of fruit production and the percentage of each crop sold for processing and for fresh use. The data on variety, tree spacing, and type rootstock were considered

[3] In the descriptive analysis that follows, the term "large farms" will be synonymous with farms in the large farm sample.

insufficient and are not reported. The other data are reported in Table II.1.

Fruit Crops Reported

A total of ten different fruit crops were reported by growers in both samples. The crops included cherries (both tart and sweet), apples, pears, plums, peaches, grapes, raspberries, strawberries, blueberries, and apricots. More farms in both samples reported cherries more than any other single fruit enterprise. A higher proportion of the large farms were growing each tree fruit crop than were those in the area sample. Over one-half of the large farms reported either cherries, pears, apples, plums, or peaches, while in the area sample only two individual fruit crops, cherries and apples, were reported by more than 50 percent of the farms (see Table II.1).

All of the enterprise combinations in Table II.2 were reported by a higher proportion of the large farms with more than twice as many large farms reporting the enterprise combinations having four and five fruits. As expected, each successively more diversified combination was reported by a smaller percentage of the farms in both samples. The categories in Table II.2 are not mutually exclusive, however, since by definition each more diversified combination is a subset of each less diversified combination.

The majority of farms in both samples appeared to be multiple fruit enterprise farms, with area sample grape farms the major exception. The data indicate that the area sample farms were less diversified than the large farms. Less diversification by the smaller area sample farms was not unexpected, and could be entirely consistent

Table II.1. Selected Characteristics, 257 Sample Farms, Michigan Fruit Farm Survey, 1966.

Type Fruit	Farms Growing		Average Acreage	Percent Acres Bearing	Average Yield Per Bearing Acre (tons)	Percent Sold Fresh
	Number	Percent				
Area Sample						
Cherries, All	64	72.7	33.38	83.12	1.81	.76
Apples	49	55.7	24.04	90.91	7.52	41.96
Pears	40	45.4	8.83	74.03	4.41	9.65
Plums	38	43.2	7.11	95.10	2.71	43.60
Peaches	34	38.6	13.88	69.07	2.93	60.08
Grapes	32	36.4	12.66	90.62	3.14	0.00
Raspberries	15	17.0	6.80	95.10	.55	6.15
Strawberries	15	17.0	9.40	56.56	2.97	89.38
Blueberries	4	4.5	5.75	78.26	1.86	38.15
Apricots	1	.1	2.00	100.00	--	--
All Fruit	88		59.05		N.A.	N.A.
Large Farm Sample						
Cherries, All	148	87.0	47.32	82.11	1.84	2.49
Apples	143	84.1	72.84	86.15	7.83	55.93
Pears	101	59.4	14.52	76.89	3.77	21.44
Plums	97	57.1	10.58	67.90	3.84	33.47
Peaches	88	51.8	21.49	61.84	2.60	69.01
Grapes	20	11.8	31.75	92.76	3.94	.53
Raspberries	14	8.2	12.25	90.17	.64	6.99
Strawberries	26	15.3	31.08	76.87	4.07	42.44
Blueberries	4	2.4	28.50	100.00	1.98	24.58
Apricots	10	.59	4.40	54.55	1.11	73.68
All Fruit	169		138.64		N.A.	N.A.

with the profit maximizing enterprise combination, given the smaller bundle of resources. This diversification was one of degree, however, and referred only to fruit crop diversification. Factors that could have contributed to more diversification in the large farm sample include the potential for keeping a base crew of workers employed for a sustained period of time, differences in off-farm employment rates, and management ability.

Table II.2. Number and Percent of Farms Growing Different Fruit Crop Combinations.

Fruit Crop Combination	Farms Growing			
	Area Sample		Large Farm Sample	
	Number	Percent	Number	Percent
Apples and cherries	40	45.4	126	74.1
Apples, cherries and pears	24	27.3	90	52.9
Apples, cherries, pears and peaches	16	18.2	67	39.4
Apples, cherries, pears, peaches and plums	11	12.5	48	28.2

Fruit Acreages

The average acreage of individual fruit crops was highest for cherries in the area sample and apples in the large farm sample. Average acreages of all individual fruit crops were larger in the large farm sample, with substantial differences in apples, strawberries, blueberries and apricots (see Table II.1).

Estimates of new plantings of individual fruit crops are shown in Table II.3 as the number of acres of fruit that were less than two years old in 1966. There were no new plantings of raspberries or apricots in either sample and only minimal new plantings of apples, cherries, pears and grapes. The largest between-sample difference was in blueberries, with no new plantings in the large farm sample compared to over 21 percent in the area sample.

Table II.3. Acres of Individual Fruit Crops Less Than Two Years Old.

Fruit Crop	Area Sample		Large Farm Sample	
	Acres		Acres	
	Number	Percent	Number	Percent
Cherries	63	2.93	23	.33
Apples	22	1.90	159	1.54
Pears	2	.60	2	.14
Plums	16	6.06	16	1.57
Peaches	41	8.69	69	3.65
Grapes	8	2.31	3	.48
Raspberries	0	0.00	0	0.00
Strawberries	16	28.07	30	13.22
Blueberries	5	21.74	0	0.00
Apricots	0	0.00	0	0.00

Only one area sample farm reported more than 200 total acres of fruit, compared to 34 or 20.2 percent of the large farms (see Table II.4). The highest concentration of area sample farms was in the 25-49 acre category, closely followed by the 1-24 acre category. In the large farm sample, the highest concentration was in the 100-199 acre category with only one large farm reporting less than 25 acres of fruit.

As expected, the large farms had larger average acreages of each individual fruit crop as well as substantially more total acres of fruit. Based on the percent of total acres bearing for each crop (shown in Table II.1) and the percent of each fruit crop less than two years old, it appears that raspberry and apricot acreage is probably declining in both samples. Blueberry acreage appears to be expanding in the area sample relative to the large farm sample.

Table II.4. The Number and Percent of Farms Reporting Different Total Acreages of Fruit.

Acres of Fruit	Area Sample		Large Farm Sample	
	Number	Percent	Number	Percent
1- 24	26	29.5	1	.6
25- 49	28	31.8	24	14.2
50- 74	13	14.8	24	14.2
75- 99	8	9.1	24	14.2
100-199	12	13.6	62	36.7
200-299	0	0.0	24	14.2
300-399	0	0.0	6	3.6
400-499	0	0.0	2	1.2
500-over	1	1.1	2	1.2

Fruit Yields

The average yields per bearing acre in Table II.1 appear to be reasonable and consistent, although generally higher than the state-wide averages reported in Michigan Agricultural Statistics. While it was difficult to say what yield differential was significant, it appeared that yields were generally higher in the large farm sample, with the exception of peaches and pears.

For cherries, apples, pears, and peaches the average yield and percent sold fresh were tabulated by acreage classification of the individual fruit crop (see Table II.5). For purposes of this tabulation, farms in the two samples were combined.

Cherries

The average yield of cherries increased and the percentage sold fresh decreased as the acreage of cherries increased. A partial

Table II.5. Average Yields and Percent Sold Fresh for Cherries, Apples, Pears and Peaches by Acreage Classification.

Item	Number of Farms	Average Yield Per Acre (tons)	Percent Sold Fresh
Acres of Cherries			
0- 24	91	1.48	4.68
25- 49	52	1.61	2.39
50- 99	46	1.68	2.20
100-199	17	2.12	1.73
over 200	4	2.65	.61
Acres of Apples			
0- 24	67	7.23	50.85
25- 49	41	7.34	51.82
50- 99	49	7.97	52.19
100-199	23	8.89	55.43
over 200	10	7.80	58.95
Acres of Pears			
0- 24	118	3.15	26.81
25- 49	17	4.35	10.67
50- 99	6	4.91	19.30
100-199	0	0.00	0.00
over 200	0	0.00	0.00
Acres of Peaches			
0- 24	92	2.46	70.27
25- 49	15	2.36	81.49
50- 99	13	3.05	54.40
100-199	2	2.84	76.83
over 200	0	0.00	0.00

explanation of these two findings is that the sweet cherries were probably concentrated in the smaller acreage categories. Generally, sweet cherries have lower yields than do tart cherries, and practically none of the tart cherries are sold for fresh use. Even so, there appears to be a tendency for yields to increase as acreages increase.

Apples

Except for the largest acreage classification, apple yields increased as apple acreage increased. Timeliness of certain production practices, such as spraying, is probably more critical for apples than most other fruit crops and could account for the lower yields in the very large acreage category. Management capacity is more likely to be a limiting factor at the large acreage level. Without exception the percentage sold fresh increased as acreage increased. More of the growers in the larger acreage categories were likely to own their own packing house or have an interest in a fresh marketing agency.

Pears

The yield of pears increased as acreages increased, although the small number of larger acreages made comparisons difficult. There was no apparent pattern in the percent sold fresh.

Peaches

With the exception of the acreage category, 100-199 acres, peach yields increased as acreages increased. Again a small number of the larger acreages made comparisons difficult. In peaches as in apples, management capacity could be a limiting factor for the larger acreages.

Fruit Sales

Gross fruit sales were computed for 256 sample farms, 87 in the area sample and 169 in the large farm sample. Estimates of gross sales for each farm were obtained by multiplying the production of each fruit by the 1966 Michigan average price for the season. Since most of the fruit crops were marketed for both fresh and processed use, it was necessary to use a fresh price for known production sold fresh and a processed price for known production going into a processed use.[4]

In addition to computing average fruit sales for the two samples, each farm was classified by type of fruit farm, and average fruit sales were computed for each type.[5]

Area Sample

On almost 90 percent of the area sample farms, a single fruit crop accounted for over 50 percent of total fruit sales, with only 10.3 percent of the farms classified as mixed. There were over twice

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[4]Published prices were obtained from Michigan Agricultural Statistics, Michigan Department of Agriculture. Unpublished prices were provided in confidence by G. A. Swanson and W. J. Spencer of the Michigan Crop Reporting Service. (The published prices used are shown in Appendix Table B.1).

[5]If a farm derived 50 percent or more of its total fruit sales from one fruit, then the farm was considered that type of fruit farm. If no one fruit accounted for as much as 50 percent of total fruit sales, then the farm was considered mixed. It should be noted that most of the farms in the mixed category were growing apples and cherries in addition to other fruit enterprises.

as many cherry farms as grape farms, the second most frequent type (see Table II.6). Cherry, grape, and apple farms accounted for 77 percent of all area sample farms, with no other single type accounting for five percent of the total.

Average fruit sales for all area sample farms were $21,831. The majority of the nine mixed farms were growing both apples and cherries, in addition to other fruit enterprises. The mixed farms had average sales of $51,298, the highest of all categories of farms studied. Grape farms had the lowest average sales of $4,773, but grapes were the most likely fruit crop to be grown alone. Both cherry and apple farms had sales of between $23,000 and $24,000.

Almost 10 percent (eight farms) of the 88 area sample farms had fruit sales of less than $1,000 (see Table II.7). More farms had sales of between $1,001 and $10,000 than in any other category. Only two farms in the area sample had sales in excess of $100,000, but 10 farms (or 11.4 percent) had sales in excess of $50,000.

Large Farm Sample

More than twice as many farms in the large farm sample were classified as apple farms, with apple and cherry farms combined accounting for over 75 percent of the total. On a percentage basis, there were almost four times as many grape farms in the area sample as in the large farm sample (see Table II.6).

Average fruit sales for all large farms were $57,399 in 1966, more than two and one-half times larger than in the area sample. Strawberry farms, with $86,780 in total sales, had by far the highest fruit sales, followed by cherry and apple farms (see Table II.6).

Table II.6. Number of Farms and Average Sales per Farm by Type Fruit Farms.

Item	Cherry	Apple	Pear	Peach	Grape	Rasp-berry	Straw-berry	Blue-berry	Mixed	All
Area Sample										
Number of Farms	34	16	3	0	17	2	4	2	9	87
Percent of Total	39.1	18.4	3.4	0.0	19.5	2.3	4.6	2.3	10.3	100
Average sales per farm	$23,449	23,873	13,228	---	4,773	28,110	17,732	5,228	51,290	$21,831
Large Farm Sample										
Number of Farms	51	78	1	2	9	0	12	2	14	169
Percent	30.2	46.2	.6	1.2	5.3	0.0	7.1	1.2	8.3	100
Average sales	$58,038	57,903	47,608	42,946	19,486	---	86,780	57,751	54,173	$57,399

Table II.7. Number and Percent of Farms by Level of Fruit Sales.

Total Fruit Sales	Area Sample Farms Number	Area Sample Farms Percent	Large Farm Sample Farms Number	Large Farm Sample Farms Percent
Less than $1,000	8	9.2	1	.6
$1,001-10,000	27	31.0	8	4.7
$10,001-20,000	23	26.4	27	16.0
$20,001-30,000	12	13.8	12	7.1
$30,001-40,000	3	3.4	26	15.4
$40,001-50,000	4	4.6	21	12.4
$50,001-75,000	6	6.9	33	19.5
$75,001-100,000	2	2.3	20	11.8
$100,001-200,000	1	1.1	18	10.6
$200,001 and over	1	1.1	3	1.8

While all type farms had higher sales in the large farm sample, the largest differences were in the grape, strawberry, and blueberry farms.

Since, by definition, the large farms had higher sales than the area sample farms, it was not surprising that less than six percent of the large farms had fruit sales of less than $10,000. Over 43 percent of the farms had sales in excess of $50,000, and 21 farms (or 12.4 percent) had sales in excess of $100,000. There was a smaller percentage of large farms in each sales category up to $30,000 than in the area sample, but for each larger category there was a larger percentage of large farms (see Table II.7).

Percent Sold Fresh

The percentage of each fruit crop sold fresh is shown in the last column of Table II.1. These figures must be used with care, however, since they represent essentially what growers delivered to a fresh market outlet. It seems likely that these percentages overstate the quantity actually sold fresh, particularly for apples. Fruits with high percentages sold fresh included strawberries and peaches in the area sample and apricots and peaches in the large farm sample. Relatively few cherries, grapes, or raspberries were sold fresh in either sample. Farms in the area sample appeared to sell significantly lower percentages of apples and pears and higher percentages of plums, strawberries, and blueberries in the fresh market than did the farms in the large farm sample.

General Characteristics

To gain a better perspective of the overall organization of Michigan fruit farms, data were collected on the sources of total farm sales, fruit storage and packing facilities used by growers and recent and anticipated changes in farm practices and organization.

Source of Total Farm Sales

Each grower was asked to indicate the percentage of total farm sales derived from each of the following categories: fruits and berries, vegetables, field crops, and livestock. The information was provided by 236 growers, 80 in the area sample and 156 in the large farm sample. The data are reported in Table II.8.

Fruits and Berries

The average percentage of total farm sales derived from fruit was 84.16 percent in the area sample and 88.78 percent in the large farm sample. Farm sales composed entirely of fruit and berry sales were reported by 60 percent of the area sample farms and 63 percent of the large farms. Less than six percent of the large farms reported that fruit sales were less than 50 percent of total sales, compared to 10 percent of the area sample farms.

Vegetables

Vegetable sales accounted for 21.93 percent of total farm sales for the 15 area sample farms reporting vegetable sales. Only 25 (or 14.7 percent) of the large farms reported vegetable sales, but the average percentage of total sales derived from vegetables was 26.2 percent. Six of the 25 large farms and only two area sample farms

Table II.8. Number of Farms with Sales from Different Sources.

Source of Farm Sales	Percent of Gross Sales					Total Farms Reporting Sales	Average Percent Sales for Farms With Sales in Category
	1-24	25-49	50-74	75-99	100		
Area Sample							
Fruits and berries	2	6	11	13	48	80	84.16
Vegetables	10	3	2	--	--	15	21.93
Field Crops	7	4	2	1	--	14	29.57
Livestock	10	4	2	2	--	18	27.44
Large Farm Sample							
Fruits and berries	2	7	15	34	98	156	88.78
Vegetables	15	4	6	--	--	25	26.12
Field Crops	9	2	--	--	--	11	16.27
Livestock	10	7	1	3	--	21	31.05

reported that vegetable sales accounted for more than 50 percent of total farm sales. This would account for the higher average percent of sales derived from vegetables in the large farm sample.

Field Crops

Both the percentage of farms reporting field crops and the average percentage of total sales derived from field crops were smaller in the large farm sample.

Livestock

Livestock sales were reported by 18 of 78 (or 23.1 percent) of the area sample farms, compared to 21 (or 13 percent) of the large farms. The average percent of total sales derived from livestock was 27.44 percent in the area sample, compared to 31.05 percent of the large farms.

Since not all growers responded to the question on source of total farm sales, it seems likely that the reported percentage of farms deriving sales from the categories other than fruit overstates the actual percentage. The growers most likely to fail to indicate the percentage of total sales derived from vegetables, for example, would be the growers with no vegetable sales. In any case, a smaller percentage of the large farms reported sales from each source other than fruits and berries. The large farms appear less likely to have a non-fruit enterprise; but, with the exception of field crops, the non-fruit enterprise makes a larger contribution to total farm sales.

There appears to be a tendency for the percent of total sales derived from fruit to increase as fruit acreage increases (see Table

II.9). Column 1 of Table II.9 shows that, of the 49 area sample farms with less than 50 acres of fruit, 26 farms (or 53.1 percent) derived 100 percent of their sales from fruit. The comparable figure was 54.2 percent for the large farm sample. Column 2 indicates that of the 18 area sample farms with 50-99 acres of fruit, 72.2 percent derived 100 percent of their total sales from fruit. The comparable figure was over 70 percent in each of the next two largest acreage categories. The same general pattern was evident in the large farm sample.

The majority of farms in both samples derive 100 percent of their total farm sales from the sale of fruit. Less than 25 percent of the farms in either sample reported farm income from sources other than fruits and berries. While the large farms were less likely to have a non-fruit source of farm income, the non-fruit enterprise made a larger contribution to total sales when it did exist.

Fruit Storage and Packing House Facilities

Growers provided information on packing house facilities and the type and capacity of fruit storage used. The data are reported in Table II.10.

Area Sample

Only 14 growers reported owning a packing house, with an average daily capacity of 720 bushels of fruit. The capacity figure is an average for all fruits packed, but represents primarily peaches and apples. No growers reported that they rented or were members of a cooperative packing house.

Table II.9. Number and Percent of Farms with Different Percentages of Gross Sales from Fruit by Acres of Fruit.

Percent Of Gross Sales From Fruit		Acreage of Fruit												
		1-49 (1)		50-99 (2)		100-149 (3)		150-199 (4)		200-299 (5)		300-over (6)		Total Of All Farms (7)
		No. of Farms	Percent of Farms	No. of Farms	Percent of Farms	No. of Farms	Percent of Farms	No. of Farms	Percent of Farms	No. of Farms	Percent of Farms	No. of Farms	Percent of Farms	Total All Farms
Area Sample														
1-49	(1)	6	12.24	2	11.11	--	---	--	---	--	---	--	---	8
50-74	(2)	9	18.36	2	11.11	--	---	--	---	--	---	--	---	11
75-99	(3)	8	16.32	1	5.5	2	25.	1	25.	--	---	1	100	13
100	(4)	26	53.1	13	72.2	6	75.	3	75.	--	---	--	---	48
Total	(5)	49	100.1	18	100.0	8	100.0	4	100.0	--	---	1	100	80
Large Farm Sample														
1-49	(1)	4	18.2	4	8.3	--	---	1	4.5	--	---	--	---	9
50-74	(2)	3	13.6	7	14.6	2	6.1	1	4.5	2	10.0	--	---	15
75-99	(3)	3	13.6	8	16.7	6	18.2	7	31.8	4	20.0	6	54.6	34
100	(4)	12	54.15	29	60.4	25	75.8	13	59.1	14	70.0	5	45.4	98
Total	(5)	22	100.0	48	100.	33	100.	23	100.	20	100.	11	100.	156

Table II.10. Storage and Packing Facilities: Number of Farms Reporting and Average Capacity by Type Facility.

Item	Type Facility							
	Packing House		Common Fruit Storage		Refrigerated Fruit Storage		C. A. Fruit Storage	
	Number of Farms	Capacity bu./day	Number of Farms	Capacity in Bushels	Number of Farms	Capacity in Bushels	Number of Farms	Capacity in Bushels
Area Sample								
Own	14	720	3	4,830	4	22,000	--	---
Rent	--	---	--	---	--	---	--	---
Coop.	--	---	--	---	--	---	--	---
Total	14	---	3	---	4	---	--	---
Large Farm Sample								
Own	48	924	18	9,490	55	19,690	12	35,790
Rent	--	---	--	---	--	---	3	12,500
Coop.	3	400	--	---	3	6,000	5	18,660
Total	51	---	18	---	58	---	20	---

The three types of fruit storage were used primarily for apples and were reported by a total of only seven farms. Three farms owned common fruit storage with an average capacity of 4,830 bushels. Only three farms reported refrigerated fruit storage, with an average capacity of 22,000 bushels. There were no area sample farms reporting controlled atmosphere fruit storage.

Large Farm Sample

A much higher percentage of large farms reported storage and packing facilities. Packing houses were reported by 51 large farms, with 48 owning their own and three being members of a cooperative. The average daily capacity of the owned packing houses was 924 bushels, 204 bushels more than in the area sample.

Eighteen large farms reported owning common fruit storage facilities with an average capacity of 9,490 bushels, almost double the capacity in the area sample.

There was even more difference between samples in the more expensive types of storage, with 55 large farms owning refrigerated storage facilities and 12 farms owning controlled atmosphere storage facilities. The capacities of the refrigerated and controlled atmosphere storage facilities were 19,690 and 35,790 bushels, respectively. Including all types of access, 58 large farms had access to refrigerated storage and 20 had access to controlled atmosphere storage.

The majority of the packing houses and an even higher percentage of the fruit storage facilities were found among the large farms, particularly the refrigerated and controlled atmosphere types of storage. This was not surprising in view of the relatively larger apple orchards and higher percentage of farms growing apples in the large farm sample.

Changes in Farm Size and Organization

Growers were asked if they had made any important changes in the size or organization of their farm in the past five years and if they planned to make any significant changes in the next five years. Since these were open-ended questions, the answers had to be categorized prior to tabulation. In order to make comparisons, the same categories were used for both completed and planned changes.

Changes Completed in the Past Five Years

The changes completed by the growers prior to the survey in the winter of 1966-67 are categorized in Table II.11. The first 11 items in Table II.11 refer to changes that tended to increase the fruit operation relative to other segments of the farm business. Items 12 and 13 are changes that would have decreased the fruit operation relative to other parts of the business.

Increasing fruit acreage on the existing farm was reported by 23 percent of the area sample growers, and over 32 percent of the large farm growers. The second method of increasing fruit acreage was to buy established orchards or to buy land and plant new trees. Almost twice as many large farm growers expanded their acreage in this manner as did area sample growers, 29.6 percent compared to 16.1 percent. Although the percentages are not additive in that any one farm could be in both categories, it seems clear that a substantially higher percentage of the large farm growers increased their fruit

Table II.11. Completed Changes in Sample Farm Organization and Size, 1962-1966.

Item	Area Sample		Large Farm Sample	
	No. Farms	%	No. Farms	%
(1) Increased acreage on present farm	20	23.0	55	32.5
(2) Purchased orchard or new land	14	16.1	50	29.6
(3) Changed varieties	11	12.6	26	15.4
(4) Purchased harvest equipment	6	6.9	34	20.1
(5) Purchased pruning aids	-	--	3	1.8
(6) Expanded irrigation facilities	4	4.6	6	3.6
(7) Joined cooperative or bargaining association	1	1.1	3	1.8
(8) Decreased acreage of other enterprises	-	--	1	.6
(9) Updating packing or storage facilities	3	3.4	15	8.9
(10) Used chemical weed control	2	2.3	9	5.3
(11) Other	5	5.7	12	7.1
(12) Decreased acreage of fruit	13	14.9	13	7.7
(13) Increased acreage of other enterprises	2	2.3	-	--
(14) No change	32	36.8	23	13.6

acreage. While many growers did not report on which fruit crop they had expanded acreages, it seems significant that no growers in either sample reported increasing raspberry or apricot acreage. Most of the known increases were in apples, cherries, peaches, pears, and plums.

Only a slightly higher percentage of the large farm growers reported changing fruit varieties, 15.4 percent compared to 12.6 percent in the area sample. Changes in apple varieties were reported more than any other fruit, followed by cherries (most likely sweet cherries).

Over 20 percent of the large farm growers reported purchasing advanced harvest equipment, compared to only 6.9 percent of the area sample growers. Where specified by the grower, all of the harvest equipment was for cherries.

Relatively few growers reported purchasing advanced pruning equipment, with only three large farm growers and no area sample growers so reporting.

Only 10 growers reported expanding their irrigation system, four in the area sample and six in the large farm sample.

Less than two percent of the growers in either sample reported joining a cooperative or bargaining association.

Almost 9 percent of the large farm growers reported expanding or updating their packing and storage facilities, compared to only 3.4 percent of the area sample growers.

Only 11 growers reported chemical weed control, nine in the large farm and two area sample growers. It appears that many growers do not consider this and other cultural practices as major changes, since chemical weed control is widely used in the fruit industry.

In the categories that implied a decrease in the relative importance of the fruit operations, items 12 and 13, there was a higher percentage of area sample growers in each category. Almost 15 percent of the area sample growers reported decreasing their fruit acreage, compared to only 7.7 percent of the large farm growers. No large farm growers reported increasing their acreage of other enterprises, while 2.3 percent of the area sample growers increased their acreage of other enterprises.

While the answers to these open-ended questions do not necessarily give the complete story, it does appear significant that 36.8 percent of the area sample growers reported making no major changes in size or organization of their farm, while only 13.6 percent of the large farm sample growers reported making no major changes. More of the large farm sample growers have made changes, and most of the changes have been in the direction of increasing their fruit operation relative to other segments of the farm business.

Planned Changes

When asked what changes in size and organization they planned for the next five years, more growers in both samples reported plans to purchase advanced harvest equipment (see item 4, Table II.12). Over one-third of the large farm growers and 24.1 percent of the area sample growers were planning to purchase harvest equipment. Many of

Table II.12. Planned Changes in Sample Farm Organization and Size, 1967-1971.

Item	Area Sample		Large Farm Sample	
	No. Farms	%	No. Farms	%
(1) Increase acreage on present farm	12	13.8	31	18.3
(2) Purchase orchard or new land	3	3.4	16	9.5
(3) Change varieties	6	6.9	17	10.1
(4) Purchase harvest equipment	21	24.1	57	33.7
(5) Purchase pruning aids	--	--	1	.6
(6) Expand irrigation equipment	3	3.4	7	4.1
(7) Join cooperative or bargaining association	--	--	2	1.2
(8) Decrease acreage of other enterprises	--	--	2	1.2
(9) Update packing or storage facilities	2	2.3	15	8.9
(10) Use chemical weed control	1	1.1	2	1.2
(11) Other	2	2.3	2	1.2
(12) Decrease acreage of fruit	5	5.7	4	2.4
(13) Decrease acreage of other enterprises	7	8.0	8	4.7
(14) No change	36	41.4	29	17.2

the growers hedged their plans, however, reporting plans to buy "if feasible", "if developed", "if available", etc.

A higher percentage of the large farm growers were planning to increase their fruit acreage, either by planting or purchasing established orchards, than in the area sample (see items 1 and 2, Table II.12). In fact, a higher percentage of large farm growers were found in all the categories that imply an increase in the fruit operation relative to other segments of the farm business (items 1-11, Table II.12).

Only nine growers were planning to decrease their fruit acreage, four in the large farm sample and five in the area sample. Eight percent of the area growers planned to increase their other enterprises compared to 4.7 percent of the large farm growers.

Again, it appears significant that over 40 percent of the area sample growers planned no changes in farm size or organization compared to only 17.2 percent of the large farm growers.

Not only have the large farm growers made more changes tending to increase their fruit operations in past years, but they plan to make more changes in the years ahead.

Summary

The objective of this chapter was to describe certain characteristics of Michigan fruit farms with particular emphasis on the characteristics that could affect future labor use patterns. The smaller fruit farms, as characterized by the area sample, tended to be single fruit enterprise farms and more likely to have a non-fruit enterprise. Fruit yields tended to be lower on the smaller farms, particularly for cherries, apples, peaches and pears. The large farms appeared to have higher fruit yields, tended to be more diversified with respect to fruit enterprises, but were less likely to have a non-fruit enterprise. In both samples, the percentage of sales derived from fruit tended to increase as fruit acreage increased. This supported the hypothesis that the larger farms tend to be specialists in fruit crop production.

Not only were the large farms larger, as measured by both acres of fruit and total sales, but they appear to have been increasing their fruit operations relative to non-fruit operations and relative to the smaller area sample farms. In addition, a much larger percentage of the large farm growers were planning to make changes that would emphasize their fruit operation. A larger percentage of the large growers reported plans to purchase advanced harvest equipment when it became feasible. This one item could have a tremendous impact on future labor use patterns.

CHAPTER III

LABOR USE ON MICHIGAN FRUIT FARMS

An appraisal of the economic impact of developments in the fruit industry requires reliable knowledge of the use of agricultural labor. One of the objectives of this study was to determine the labor use patterns on Michigan fruit farms in 1966. At the aggregate farm level, data were collected on operator, wife and other unpaid family labor, as well as for all hired labor. Since the family and hired labor data were for the total farm operation and were not limited to the fruit enterprises, some of the data were tabulated separately for the farms that derive all of their sales from fruits and berries.

The first section of this Chapter deals with the operator and other family labor inputs, with brief sub-sections on operator characteristics such as age and extent of multiple jobholding. The second major part of the Chapter is concerned with the hired labor input. Major sub-sections include number of farms reporting hired workers, number of workers employed, hours of hired labor input, and methods and rates of renumeration.

Operator and Family Labor

At the aggregate farm level, data were collected on operator, wife and other unpaid family labor. Each grower was asked, "How many hours did you (your wife and other family members) work on your farm last year during an average week in January?" The question was repeated for each month in the year. In addition the number of workers in each category was determined.

It is the opinion of the author that the data on operator, wife and other family labor probably overstates the actual labor input. This is partly the result of the recall nature of the questionnaire, but more likely due to the natural tendency of growers to overstate their working hours.

Operator Labor

A total of 257 farms reported operator labor, 87 in the area sample and 170 in the large farm sample. A smaller proportion of the area sample farms were multiple operator farms, 15 percent compared to 21 percent of the large farms. A total of 13 area sample and 40 large farms reported more than one operator.

Farm Labor Input of Operators

In the area sample, operators reported working an average of 2,295 hours during the year. The peak month was July with an average of 262 hours per operator, 214 percent higher than the monthly low of 112 hours in December (see Appendix Table C-1). In only eight months, April through October, would the operators be considered fully employed on the farm. For November through March, the operators reported working less than 153 hours per month. Almost 12 percent of the area sample operators reported an annual labor input of less than 1,000 hours per operator, while one-half as many reported working over 4,000 hours (see Table III.1). A labor input of 4,000 hours annually is equivalent to 50 eighty-hour weeks.

Table III.1. Operator Labor: Number and Percent of Farms Reporting Different Total Labor Inputs.

Item	Operator Hours					
	Total	Less than 1,000	1,000-1,999	2,000-2,999	3,000-3,999	4,000 & over
Per Operator						
Area Sample						
Number of Operators	103	12	32	31	22	6
Percent		11.6	31.1	30.1	21.4	5.8
Large Farm Sample						
Number of Operators	216	14	29	98	70	5
Percent		6.5	13.4	45.4	32.4	2.3
Per Farm						
Area Sample						
Number of Farms	87	10	22	24	19	12
Percent		11.5	25.3	27.6	21.8	13.8
Large Farm Sample						
Number of Farms	170	7	19	66	50	28
Percent		4.1	11.2	38.8	29.4	16.5

The average number of hours per area sample farm per month followed essentially the same distribution as hours per operator, with the peak occurring in July and the months on either side of July getting progressively smaller (see Appendix Table C-1). The average number of operator hours per farm was 2,717 hours with one farm reporting in excess of 10,000 hours.

In the large farm sample, the operators reported working an average of 2,599 hours, 11.3 percent more than the area sample operators. The average number of hours worked per operator followed essentially the same seasonal pattern as in the area sample with the peak of 268 hours occurring in July. The difference between samples was relatively small during the peak labor months, June to October, but increased toward each end of the year. The large farm operators reported working more hours in the months October to April, with the largest difference in January. A smaller percentage of the large farm operators reported working less than 1,000 or more than 4,000 hours annually. Over 91 percent reported working between 1,000 and 3,900 hours, compared to 82.6 percent of the area sample operators (see Table III.1).

Again in the large farm sample, the number of operator hours per farm follows the same monthly pattern as hours per operator.

The operators of the large farms appeared to be more nearly fully employed than did the area sample operators with a more even distribution throughout the year. The major differences in hours per operator occurred in the months November through March.

Off-farm Work

A total of 255 growers responded to the question regarding extent and type of off-farm work, 87 in the area sample and 168 in the large farm sample. Off-farm work or multiple jobholding in this context means work off the farm being operated.

Area Sample

Multiple jobholding appears to be a common practice among area sample fruit growers, with 46 percent or 40 growers reporting off-farm work.[6] There appeared to be significant differences between single and multiple jobholders with the latter being characterized by smaller average acreages of fruit, total cropland and total acres operated (see Table III.2). In addition, the multiple jobholders had lower average fruit sales and were younger by 6.9 years, a substantial difference. These differences were consistent with expectations and with previous studies concerning multiple jobholding.[7]

Not only did 46 percent of the area sample growers report working off the farm which they operated, but 70 percent of the multiple jobholders were employed off the farm at least 150 days, with almost 50 percent employed 250 days or more (see Appendix Table C-2). While the classification of multiple jobholders by type work was not an exact one, it appears significant that only 15 percent were in farm related jobs, compared to 75 percent in non-farm work. Only 15 percent of the multiple jobholders were considered self-employed, with 75 percent considered employees. The type work of the remaining 10 percent was unknown.

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[6]The percentage of multiple jobholders appeared to be less among area sample fruit growers than the 56 percent of all Michigan farm operators reported in the 1964 Census of Agriculture. The figures are not directly comparable, however, since the survey data were for 1966, and the Census data were collected for 1964. In addition, a farm by Census definition was any place of more than 10 acres with agricultural sales of more than $50 or if less than 10 acres, agricultural sales of more than $250.

[7]Arley D. Waldo, The Off-Farm Employment of Farm Operators in the United States, (unpublished Ph.D. dissertation, Michigan State University, 1962), pp. 154-159.

Table III.2. Selected Characteristics for Single and Multiple Jobholders.

Item	Multiple Jobholders	Single Jobholders
	Area Sample	
Number	40	47
Percent	46	54
Total Acres Fruit	54.0	64.6
Total Acres Cropland	85.8	101.4
Total Acres Operated	143.5	176.6
Total Fruit Sales ($)	19,249	24,028
Age	46.8	53.7
	Large Farm Sample	
Number	55	113
Percent	32.5	77.5
Total Acres Fruit	128.5	142.9
Total Acres Cropland	192.8	204.0
Total Acres Operated	309.0	323.4
Total Fruit Sales ($)	49,473	61,342
Age	43.5	48.1

It appears that multiple jobholding is a common practice among fruit growers, and while no earnings figures are available from the survey data, off-farm work apparently constitutes a significant source of income. Off-farm earnings might be significant both in terms of the number of fruit growers with an off-farm source of income and as a percentage of total earnings of fruit growers.

Large Farm Sample

While only 32.5 percent of the large farm operators were multiple jobholders, they exhibited essentially the same general characteristics as the area sample multiple jobholders. Total sales, average acreages of fruit, total cropland, and total acres operated were larger for the single jobholders, although not by as much as in the area sample (see Table III.2). The same held true for average age where single jobholders were only 4.6 years older, compared to 6.9 years in the area sample.

Slightly over 25 percent of the multiple jobholders worked off-farm as much as 150 days, compared to 70 percent in the area sample. In addition, over 36 percent of the multiple jobholders were in farm related jobs and over 29 percent were self-employed.

A chi square analysis was run to test the hypothesis that the number of days worked was independent of the type work. To provide a sufficient number of observations per cell, it was necessary to combine the two samples and to reduce the number of cells to nine. The chi square test data are shown in Appendix Table C-3. The calculated chi square value of 4.88 was not significant at the .05 level, thus the data supported the hypothesis. That is, at the .05 level there is no statistically significant dependence between number of days worked and type of work.

In summary, the area sample growers are more likely to be multiple jobholders, more likely to work at least 150 days off-farm and to be employed in a non-farm job than are the large farm growers. In short, off-farm work appears to be a more important source of income for area sample growers than for the large farm growers.

<u>Age of Operator</u>

The age of farm operators was obtained on 255 farms, 87 in the area sample and 168 in the large farm sample. On multiple operator farms, the average operator age was used in computing overall averages.

The mean age of the area sample growers was 50.52 years compared to 46.58 years for the large farm operators. While the difference between sample means was substantial, a "t" test indicated no statistically significant difference at the .05 level.

Perhaps more important than averages, however, were the relative age distributions (see Appendix Table C-4). The large farm sample had a substantially higher percentage of operators in the 40-44 and 45-49 age categories and a much smaller percentage in each older age category, with the exception of the 60-64 age group. Over 20 percent of the area sample operators were 60 years old with more than 18 percent 65 or over. The relative age distributions were reflected by the median ages with the large farm median age six years less than that of the area sample.

Generally, there was a larger percentage of area sample operators in the age categories toward each end of the distribution. Over 65 percent of the large farm operators were between 35 and 54 years old, compared to 54 percent of the area sample operators.

Wife and Other Family Labor

Hours worked were reported for 65 wives on 60 area sample farms and for 118 wives by 111 large farms. Generally, the wives on large farms worked less than did the wives on area sample farms in the peak labor months, June to October (see Appendix Table C-1). The average hours worked per month was an average for all reported wives whether they all worked each month or not and was lower by 11 percent in the large farm sample, 759 hours compared to 827 hours.

The other unpaid family category contains adults working full time all year and minor children working only in certain harvest operations. The peak month was July, with June, July, August and September the major months. The distribution around the peak month was similar to that of other types of family labor. The average number of hours worked per individual per year was 735 in the area sample compared to 958 in the large farm sample (see Appendix Table C-1).

The wife appeared to be a more important source of labor in the area sample, particularly during the harvest months, with other family workers contributing more labor in the large farm sample.

Hired Labor

Hired workers were enumerated on the basis of how they were paid -- either monthly, weekly, daily, hourly, or piece rate. For each month, the respondent was asked the number of workers, rate of pay, number of hours worked, total wages paid, and value of other items supplied, including housing and meals or food items.

The data on number of workers, rate of pay and total wages paid are probably most accurate, since these items could be taken directly from the records of the grower. Hours worked per month are probably most accurate for hourly workers and least accurate for piece rate workers, with the other types of workers somewhere in between. Since the value of other items supplied was estimated by each grower, considerable variation was expected.

The classification of hired workers as reported by the growers proved cumbersome, and only a very limited analysis was completed using that classification. All hired labor was regrouped by the author, on an expost basis, into either regular hired, seasonal hired, or harvest hired. Workers were considered regular hired if they could be identified as being employed for as many as seven months on the same farm. It was not necessary that the workers be employed full time in all these months, only that they worked part of the month for at least seven different months. Harvest workers were most easily classified, since many were paid on a piece rate basis and their work was limited to the harvest operation. Seasonal hired workers represent essentially all the hired labor that could not otherwise be classified.

Since the classification of workers was on an expost basis, and the categories were not mutually exclusive, i.e., regular hired workers could and did work in the harvest operation, it seemed not only desirable but prudent to analyze hired labor use for all types combined, as well as for each type separately.

In aggregating the different types of hired labor, total hours worked were considered too inaccurate to allow aggregation. Hired labor was therefore aggregated on a cost basis, either total wage paid or total cost of labor including wages and value of other items received.

Farms Reporting Hired Labor

A total of 236 farms reported hired labor in 1966, 78 in the area sample and 158 in the large farm sample.

Regular Hired Workers

Regular hired workers, as previously defined, were reported by 27 area sample farms in July and August, but by only 19 farms in

December. The percentage of area sample farms employing regular workers ranged from 21.84 to 31.03 percent, with over one-half of the reporting farms employing only one regular worker.[8]

Regular hired workers were reported by over 50 percent of the large farms, almost twice the percentage in the area sample (see Table III.3). Not only do a substantially higher percentage of the large farms employ regular workers, but they appear to employ more workers per farm. In addition, there was less monthly variation in the percentage of large farms employing regular workers, implying that more large farms used regular workers throughout the year.

Seasonal Hired Workers

Seasonal hired workers, as previously defined, were reported by 26 area sample farms in April and July, but only six farms in December. The range in percentage of farms employing seasonal workers was much greater than for regular workers (see Table III.3). Well over 75 percent of the farms reporting seasonal workers employed from one to five workers, with only three farms employing as many as 11 seasonal workers in any one month (see Appendix Table C-6).

The range in the percentage of large farms employing seasonal workers was greater than in the area sample, although in all months a higher percentage of large farms employed seasonal workers (see Table III.3). From 13.60 to 43.79 percent of the farms reported seasonal workers, depending on the month. As in the area sample,

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[8]The number of farms employing different numbers of regular workers are shown in Appendix Table C-5.

Table III.3. Number of Farms Employing Hired Labor by Type Worker, by Month.

Item	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Area Sample												
Farms employing regular labor												
Number	22	21	23	26	26	26	27	27	25	26	22	19
Percent	25.29	24.14	26.44	29.88	29.88	29.88	31.03	31.03	28.74	29.88	25.29	21.84
Farms employing seasonal labor												
Number	11	13	19	26	20	25	26	21	14	15	7	6
Percent	12.64	14.94	21.84	29.88	22.99	28.74	29.88	24.14	16.09	17.24	8.05	6.90
Farms employing harvest labor												
Number	0	0	0	0	3	13	55	42	57	35	6	2
Percent	0.00	0.00	0.00	0.00	3.45	14.94	63.22	48.27	65.52	40.23	6.90	2.29
Large Farm Sample												
Farms employing regular labor												
Number	85	86	92	94	94	93	97	95	96	94	86	81
Percent	50.29	50.88	54.43	55.62	55.62	55.02	57.39	56.21	56.80	55.62	50.88	47.92
Farms employing seasonal labor												
Number	29	30	43	67	68	74	73	62	49	34	30	23
Percent	17.16	17.75	25.44	39.64	40.24	43.79	43.20	36.68	28.99	20.11	17.75	13.60
Farms employing harvest labor												
Number	0	0	0	0	6	26	117	95	124	120	18	0
Percent	0.00	0.00	0.00	0.00	3.55	15.38	69.23	56.21	73.37	71.00	10.65	0.00

well over 75 percent of the farms employing seasonal workers reported from one to five workers, although ten farms employed over ten workers in May.

As expected, a higher percentage of the large farms employed seasonal workers, and there appeared to be more monthly variation in seasonal labor use among the large farms.

Harvest Workers

Harvest workers, as previously defined, were not reported by any area sample farms from January through April. The two farms reporting harvest workers in December were thought to be engaged in Christmas tree operations. Over 63 percent of the farms reported harvest workers in July and September. In July, the peak cherry harvest period, 19 farms reported 11 to 25 workers, 15 farms reported 26 to 50 workers and eight farms reported over 50 workers (see Appendix Table C-7). Since the average acreage of cherries, as reported by the area sample growers, was almost 38 percent larger than the average apple acreage, larger harvest crews were expected during the cherry harvest period. This pattern would change substantially, however, if a high percentage of the cherries were mechanically harvested.

In the large farm sample, essentially the same pattern was evident as in the area sample, except that in each month that harvest workers were reported in this sample, a higher percentage of the large farms were employing harvest workers (see Table III.3). There were major differences in September and October, the peak apple harvesting months, when over 70 percent of the large farms reported harvest labor. In all harvest months, a higher percentage of the large farms reported crews of over ten workers. In July over 82 percent of the large farms reported employing more than ten harvest workers (see Appendix Table C-7).

All Hired Labor

When all types of hired labor were combined the influence of harvest labor was clearly evident, particularly in the area sample (see Appendix Table C-8). The percentage of farms employing workers was highest in July for both samples, 73.6 percent in the area sample and 89.4 percent of the large farms. A larger percentage of the large farms employed workers in all months than in the area sample, and the range in percent of farms employing workers was much less in the large farm sample.

In summary, not only do more of the large farms employ labor, but they are more than twice as likely to employ regular workers. Since regular workers could obviously work in the harvest operation, the differential in harvest labor employment was less than otherwise might have been expected. The major difference between samples appears to have been in the percentage of farms employing regular workers.

Number of Workers Employed

The total number of workers must be interpreted with care since it was possible in the classification scheme for the same worker to be employed on more than one farm. The full extent of the interfarm movement of labor was impossible to determine from the data. It is the opinion of the author, after examination of the raw data, that while interfarm movement of regular and seasonal workers was likely to occur within the year, there was little interfarm movement within a given month. The average number of workers per farm is a valid figure, however, even if substantial interfarm movement did occur. The average number of workers per farm indicates that in any given month, there was an average of some number of workers per farm.

Regular Hired Workers

The number of regular hired workers in the area sample ranged from a low of 38 in December to a peak of 54 in July (see Appendix Table C-9). Based on the sampling procedure outlined in Chapter I, there would have been approximately 4,804 regular workers employed in the Michigan fruit industry in July of 1966, but only 3,381 employed in December. These figures assume there was no interfarm movement of regular workers. Since the figures on the average number of workers per farm in Table III.4 are only for those farms that employed hired workers, a confidence interval could not be calculated using the numbers making up the average. An additional complicating factor was the number of farms reporting regular workers but not indicating the number of workers. The average number of workers per area sample farm was very close to two in all months, ranging from 1.85 in October to 2.14 in February.

The number of regular workers employed by the large farms was approximately four times as large as in the area sample. The peak numbers were employed in August and September compared to July in the area sample (see Appendix Table C-9). The average number of workers

Table III.4. Average Number of Workers per Farm, by Type Worker.

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Area Sample												
Regular Hired	2.09	2.14	2.09	1.96	2.00	2.04	2.00	1.92	2.00	1.85	2.04	2.00
Seasonal Hired	2.27	2.08	3.16	3.81	4.50	4.40	3.77	4.10	4.00	2.00	2.28	2.17
Harvest	0	0	0	0	30.33	50.62	28.93	22.98	12.47	7.86	7.67	2.00
Large Farm Sample												
Regular Hired	2.18	2.16	2.18	2.24	2.23	2.26	2.25	2.38	2.35	2.35	2.19	2.23
Seasonal Hired	3.28	2.60	2.95	4.28	6.15	5.99	4.34	4.13	3.65	3.15	2.87	2.96
Harvest	0	0	0	0	20.14	84.30	43.21	32.84	20.67	18.31	10.79	0

per farm was higher for all months in the large farm sample, but by a surprisingly small percentage. The largest difference occurred in August, when the large farms employed 2.38 workers per farms compared to 1.92 in the area sample, a difference of only 24 percent.

Seasonal Hired Workers

The total number of seasonal workers in the area sample ranged from 13 in December to 110 in July, with the peak months being March through September (see Appendix Table C-9). The average number of workers per farm was lowest in February and highest in May, 2.08 compared to 4.50 workers per farm. Interfarm movement and hence double counting was likely to be more serious for seasonal than for regular workers.

As expected, more seasonal workers were employed by the large farms than by the area sample farms. The average number of workers per farm was also higher for the large farms, with the exception of March and September. The author attaches no economic significance to the area sample farms employing more seasonal workers per farm in March and September.

Harvest Workers

Interfarm movement of harvest workers was so commonplace, even within a given month, that the figures on total number of workers were meaningless by themselves. Again it was the average number of harvest workers per farm that was relevant. Discounting the large average size crew in May when only three farms reported harvest workers and June when one farm reported 400 harvest workers, the largest average size crews were in July with 28.93 workers per farm (see Table III.4).

The average size harvest crew in the large farm sample exceeded that in the area sample, in all months but May and June by at least 41 percent. The largest difference between samples occurred in October, when the average large farm crew of 18.31 workers was 133 percent larger than in the area sample.

In summary, the number of workers employed in the large farm sample was larger than in the area sample. While the average number of workers employed per farm was also larger in the large farm sample, the difference was not as large as expected, particularly for regular and seasonal hired workers. The major difference appeared to be in the average number of harvest workers employed per farm. This reinforces the opinion that family labor was relatively more important in the area sample, particularly during the peak harvest months.

Hours of Hired Labor

The average number of hours per worker and per farm were tabulated for the three different types of hired labor. The tabulations were necessarily limited to those farms that reported both the number of workers and the number of hours worked. This was not a major problem for the regular and seasonal hired workers, but appeared to be for harvest workers. A substantial number of growers, in both samples, failed to report the number of hours of harvest labor, and in some cases the number of hours reported appeared so unreasonable as to be excluded from the tabulations. The harvest labor hours, therefore, must be used with care.

Regular Workers

The number of hours worked per worker in the area sample ranged from a low of 130 hours in December to a high of 204 hours in July (see Appendix Table C-10). The extent of regular worker participation in the harvest operation was pointed up by the relatively high number of hours worked during the peak harvest season, July through September. There was a monthly difference of over 56 percent both in number of hours worked per worker and per farm in the area sample. Underutilization of regular hired workers appeared to have been a problem in the area sample, with the average number of hours worked per month exceeding 175 in only six of 12 months. With the exception of November, December and January, at least 300 hours of regular labor were used per area sample farm per month.

Regular hired workers worked an average of 171 to 197 hours per worker in the large farm sample (see Appendix Table C-10). The variation in hours worked per month of 16 percent was substantially less than in the area sample. The minimum number of regular hired hours per farm was 366 hours in January. The data indicate that the large farms were better able to utilize their regular hired labor throughout the year than were the area sample farms. While this was not surprising, it did tend to support conventional wisdom.

Seasonal Workers

In the area sample, hours of seasonal labor per worker and per farm exhibited the same general pattern as did regular labor, with the peak months being July through September (see Appendix Table C-10). At most, the seasonal workers averaged 126 hours per worker per month on any one farm. As expected, the variation in average monthly hours per worker was greater for seasonal than for regular workers, ranging from a low of 74 hours to a high of 126 hours, a difference of 70 percent.

While there was no clearly different pattern for seasonal labor between samples, it was interesting to note that in March and May both the number of hours per worker and per farm in the large farm sample was less than in the area sample. One of the problems that limits even the most tentative conclusions about this type labor was the failure to more clearly specify the seasonal labor. It was and remains a heterogeneous category.

Harvest Labor

In the area sample, July was the peak month in harvest labor hours, both hours per worker and per farm (see Appendix Table C-10). The difficulty in obtaining and keeping harvest labor was indicated by the widely differing labor requirements per farm on a monthly basis. For the entire harvest period, the hours of harvest labor hours differed by more than 2,000 percent, and even for the peak months, July through October, it varied by as much as 280 percent. While it was impossible to determine the total number of hours per month per harvest worker, the data in Appendix Table C-10 understates the actual hours of employment because of interfarm movement. It is the opinion of the author that the hours per harvest worker reported understates the actual hours worked per worker by at least 25 percent, and possibly by up to 50 percent.

With the exception of May and June, where a relatively small number of large strawberry farms dominate the harvest labor averages, the number of hours worked per harvest worker was fairly close for the two samples. The largest difference in the major harvest months was in September, when the hours per worker in the large farm sample exceeded those in the area sample by over 30 percent. As expected, the harvest labor hours per farm were substantially larger in the large farm sample in all harvest months. In the harvest period, July through October, the large farms appeared to have about the same variation in harvest hours per farm as did the area sample farms.

In summary, the large farms used more hours of all types of hired labor per farm than did the area sample farms. The sample differentials in per farm averages were largest for harvest labor and smallest for seasonal labor. Generally, the large farms appeared to be better utilizing their regular hired labor throughout the year.

It should be kept in mind that the average hours per worker, for all types of workers, was in fact the average number of hours per worker only if no interfarm movement occurred. The per worker figures in Appendix Table C-10 indicates the average number of hours that employees worked on any given farm.

Method of Renumeration

The number and percent of farms employing labor on a method of payment basis, monthly, weekly, daily, hourly and piece rate are shown in Appendix Table C-11. The data were collected in this fashion to facilitate the use of grower records. As such, it was successful, but provided only limited economic meaning. It should be kept in mind that the figures refer only to the numbers and percent of farms, not number and percent of workers, and also that the method of payment discussed refers to how wages were computed and not when workers were paid.

Area Sample

Only in July did any significant number of farms pay workers on a monthly basis, and then only 6.81 percent did so (see Appendix Table C-11). No farm reported paying workers on a monthly basis for all 12 months.

Weekly rates were not commonplace, with a minimum of two and a maximum of six farms, depending on the month, reporting workers on that basis.

Daily rates were even less in evidence, with no farms reporting hiring workers on that basis in five of 12 months.

Hourly rates appeared to dominate the fruit industry, with a minimum of 20 and a maximum of 42 farms reporting hiring workers on that basis. Over 47 percent of the area sample farms reported hourly employees in June. The peak months were April through October.

As expected, the peak months in number and percentage of farms employing piece rate workers were July through October. The piece rate workers employed prior to May were probably engaged in the pruning operation.

It should be kept in mind that the percentages in any given month do not sum to any significant figure. The same farm could have been, and in many cases was, using different methods of payment within the same month.

Large Farm Sample

Not only did a much higher percentage of the large farms compute wages on a monthly basis, but the percentage of large farms was approximately the same in each month (see Appendix Table C-11). As such, the number of farms paying workers on a monthly basis probably represents fairly accurately the number of farms with full-time regular workers. If so, then the major portion of the full-time regular workers in the fruit industry are likely to be found on the large farms.

A significantly higher percentage of the large farms were computing wages on a weekly basis. Again, the monthly variation in percent of farms was much less than in the area sample, ranging from 16.47 percent in July to 10.58 percent in December.

Daily wage rates were not reported by very many large farms, a maximum of 5.29 percent of the farms in June.

As in the area sample, more large farms reported hourly employees than any other type worker.

Generally, the large farm sample had about the same percentage of farms employing piece rate workers as the area sample. The only major difference was in October, when 63.52 of the large farms were employing piece rate workers compared to 38.63 percent of the farms in the area sample. Again, this was a reflection of the more numerous and larger apple enterprises in the large farm sample.

In summary, the most common method of computing wages for hired workers was on an hourly basis. This was true for both samples. There appeared to be a significantly higher percentage of the large farms paying workers on a monthly and weekly basis with neither sample reporting a significant number of farms employing daily workers.

Rate of Renumeration

From data provided by growers, it was possible to compute hourly wage rates for both regular and seasonal hired workers. In addition, the total cost of labor on both a per worker and per farm basis was computed for all three types of hired workers.

Hourly Wage Rates

The weighted average hourly wage was computed for regular and seasonal workers on a monthly and annual basis. The estimates of harvest worker hours was considered too inaccurate to allow computation of a meaningful hourly wage.

Area Sample

On an annual basis the weighted average hourly wage was $1.36 for both regular and seasonal hired workers in the area sample (see Table III.5). On a monthly basis, however, the hourly wage rates were quite different for the two types of workers. In periods of peak labor use, June through August, hourly wages were higher for seasonal workers. In all other months, hourly wages were higher for regular workers. If the worker classification scheme has any merit, then more of the regular workers would have been paid on a monthly or weekly basis. This would tend to lower the hourly wage of regular workers, since the number of hours worked per month was highest from June through September. The hourly rates for seasonal workers

Table III.5. Weighted Average Hourly Wages for Regular and Seasonal Hired Workers.

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Weighted Average Hourly Wage
(Dollars)													
Area Sample													
Regular Hired	1.44	1.38	1.40	1.35	1.33	1.31	1.23	1.33	1.33	1.36	1.51	1.45	1.36
Seasonal Hired	1.25	1.27	1.31	1.25	1.26	1.45	1.29	1.66	1.30	1.28	1.35	1.39	1.36
Large Farm Sample													
Regular Hired	1.54	1.55	1.51	1.47	1.53	1.44	1.44	1.45	1.45	1.46	1.57	1.60	1.50
Seasonal Hired	1.34	1.35	1.34	1.27	1.26	1.26	1.33	1.29	1.29	1.36	1.32	1.33	1.30

fluctuated more on a monthly basis, reflecting, in part, the fluctuating demand for seasonal labor.

Large Farm Sample

The hourly wage of regular workers averaged $1.50 per hour over the year, 10 percent higher than in the area sample (see Table III.5). In addition, the monthly variation in hourly wages was not as great in this sample, 11.1 percent compared to over 22 percent in the area sample. Among large farm employers, much of the increased stability in hourly earnings of regular workers can be attributed to the much higher percentage paid on a monthly basis, and to the relatively small fluctuation in hours worked per month.

The wage of seasonal workers on large farms averaged $1.30 per hour over the year, lower than for any other group of workers in either sample. The monthly variation in hourly wages paid seasonal workers was less in the large farm sample, although the annual hourly wage was probably not significantly different between samples. Within the large farm sample there appeared to be a significant difference between the hourly wage for regular and seasonal workers.

In summary, there was no difference in annual hourly wage rates between regular and seasonal workers within the area sample, although on a monthly basis the hourly wage of the seasonal workers fluctuated more than did the wage of the regular workers. The hourly wage of the regular workers in the large farm sample appeared to be higher than that of any other group of workers in either sample. The largest difference in annual hourly wages was between regular and seasonal workers within the large farm sample.

Total Labor Costs

The average monthly grower costs of labor, including both wages and perquisites, were computed for the three types of labor on both a per worker and a per farm basis. The monthly costs, both per worker and per farm, were computed using only those farms that provided complete information on the number of workers and the wage and perquisite cost. It should be remembered that grower costs per worker do not necessarily reflect the total monthly income per worker because of the interfarm movement of labor, particularly seasonal and harvest workers.

Regular Workers

In the area sample, the weighted annual average wage cost per worker was \$3,084, and exceeded \$250 per month in only seven months (see Appendix Table C-12). The total grower cost per worker, including wages and \$516 in perquisites, was \$3,600 on an annual basis. This figure was probably a fairly accurate measure of total income per worker, since interfarm movement appeared to be minimal for this type worker.

The total cost of regular hired workers on area sample farsm was \$7,248 per farm, \$6,216 in wage costs and \$1,032 in perquisites. While peak labor costs per farm occurred from May through October, the total cost of regular workers was distributed fairly evenly throughout the year. A more uneven distribution of monthly costs would raise serious questions regarding the validity of the classification scheme, however.

In the large farm sample, the weighted annual average grower cost per worker, including wages and perquisites, was $3,876, 7.6 percent greater than in the area sample (see Appendix Table C-12). Grower wage cost, representing a cash outlay, was 11 percent greater in the large farm sample. In addition to higher annual total costs per worker, there was less monthly variation, reflecting the larger number of workers paid on a monthly basis.

The average wage bill per large farm was higher, due not only to a higher wage per worker, but also to more workers per farm. The average annual wage bill of $7,776 was 25 percent higher than in the area sample. There was no difference between samples in the value of perquisites per farm. The total cost per farm of regular labor was $8,724, 20.3 percent greater than in the area sample.

Generally, the large farms appeared to pay their regular workers a slightly higher wage and the income of workers did not fluctuate as much on a monthly basis. Regular workers on the large farms appeared to be more fully employed than did those in the area sample.

Seasonal Workers

As expected, the variation in grower wage cost per seasonal worker was greater than for regular workers in both samples. The variation was larger in the area sample, ranging from $211 in August to $100 in November, a difference of 110 percent (see Appendix Table C-13). The annual total grower cost per worker, including wages and perquisites, was slightly higher in the area sample, $1,812 compared to $1,728 in the large farm sample. There were larger differences between samples in wage costs per worker, however, since the value of perquisites per worker was more than twice as high in the large farm sample.

The total cost of seasonal workers per farm in the area sample was $6,348, with the bulk of the expense occurring from May through September. As expected, the large farms had a higher cost per farm. The average annual large farm cost of $7,524 was 18.5 percent larger than in the area sample. There was less monthly variation in total cost per large farm, although there was a definite peak in costs from May through September (see Appendix Table C-13).

As expected, the large farms had a higher cost per farm for seasonal workers and used seasonal workers more evenly throughout the year. While the difference in income per worker was probably not significant between samples, it was higher in the area sample.

Harvest Workers

The average grower costs per worker were less meaningful for harvest workers than for other types of labor. Not only was there considerable interfarm movement of harvest labor, but several of the smaller farms did not report the number of harvest workers and could not be used in computing per worker averages. In addition, a few very large farms employing harvest workers in June distorted the per farm averages considerably, particularly in the area sample where one farm employed 400 workers and had a monthly wage bill of $237,500.

In the area sample the total cost of harvest labor per worker was $1,113, slightly higher than in the large farm sample (see Appendix Table C-14). The value of perquisites was surprisingly low in both samples, averaging only \$7 per month in the area sample and \$15 per month in the large farm sample.

Total wage costs per farm were higher by only \$4,000 in the large farm sample (see Appendix Table C-14). This was in part due to the exclusion of several of the smaller area sample farms from the averages. For the period of employment, there was less monthly variation among the large farm in wage cost, value of perquisites and total costs per farm. This would appear to be a reflection of the diversification of the large farms and the ability to keep harvest workers more fully employed over a sustained period of time. The annual grower costs per farm of harvest labor was almost 22 percent higher in the large farm sample, \$31,794 compared to \$26,136 in the area sample.

All Hired Workers

Since the classification of hired workers was somewhat arbitrary, it seemed desirable to examine the total cost of all hired labor per farm. The data were tabulated only for those farms that provided complete information on all three types of workers. If a farm reported employing seasonal workers, but failed to report the wages or perquisites of these workers, the farm was excluded from the tabulations.

Area Sample. The average annual total wage bill per farm was \$15,204, which was strongly influenced by the large expenditure in June (see Table III.6). As expected, wage cost per farm was highest in the period May through October, averaging more than \$1,000 per month.

Table III.6. All Hired Workers: Average Grower Costs per Farm.

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Weighted Annual Average
						(Dollars)							
						Area Sample							
Wages	382	386	467	476	616	4,474	1,851	1,156	1,077	944	476	424	15,204
Perquisites	62	56	58	50	90	125	255	144	83	69	92	75	1,368
Total Cost	444	441	525	525	706	4,599	2,106	1,301	1,161	1,014	568	499	16,572
						Large Farm Sample							
Wages	567	584	534	607	698	1,484	2,361	1,737	1,768	2,613	800	601	17,148
Perquisites	64	65	57	68	94	207	294	262	157	193	67	66	1,896
Total Cost	631	650	591	675	791	1,690	2,653	1,996	1,923	2,804	866	664	19,032

The value of perquisites per farm followed essentially the same pattern as wage costs, being highest in the period June through August and tapering off toward each end of the year.

The total cost of hired labor, including wages and perquisites, was $16,572 per farm. This is not an average for the 87 area sample farms, but only for those that employed labor and reported all of the data necessary for the tabulations. These two restrictions, plus the one very large farm, tend to overstate the use of hired labor and make the averages more representative of the larger farms in the area sample.

Large Farm Sample. The wages, perquisites and total cost of labor per farm were all higher in this sample (see Table III.6). The total cost of labor was 14.8 percent higher, but the average wage, representing cash costs, was only 12.7 percent higher. While the peak months in labor cost remained June through October, there was less monthly variation, on a percentage basis, in this sample. Only in June did the average cost per farm in the area sample exceed that in the large farm sample.

As expected, labor costs per farm were higher in the large farm sample for each type of worker and for all hired labor combined. Since only the larger of the area sample farms employed labor, the difference between samples was less than if all farms had been used to compute the averages.

Summary

The primary objective of this chapter was to describe the labor use patterns on Michigan fruit farms. As expected, there are major variations in labor use on a monthly basis and between samples.

Large farm operators reported working more hours per month than the area sample operators, particularly in the non-peak labor months. The area sample operators may have been maximizing their returns, however, since a larger proportion reported off-farm employment. On the average, area sample operators were older than large farm operators and worked off-farm more days. In general, the wife and other family labor contributed approximately the same number of hours in both samples, but the work appeared more closely related to the harvest operation in the area sample. The outstanding difference between samples was the more even distribution of hours worked per month in the large farm sample. This was true for all types of family labor.

As expected, the large farms were much larger employers of hired labor. This was particularly true for what was classified as regular hired workers. Not only did a much higher percentage of the large farm growers employ regular workers, but they employed more workers per farm and appeared to pay their regular workers a higher wage. Labor utilization appeared less of a problem in the large farm sample, where there was considerably less monthly variation in hours worked per individual. This is in part a reflection of the more diversified nature of the large farm fruit operation. The large farms appear to have a much greater potential for offering continuous full time employment opportunities. This was supported by the much higher percentage of large farm growers paying monthly and weekly wage rates.

There was considerable variation in both samples in seasonal worker employment, both in number of farms employing seasonal workers and the number of hours worked per month per individual. Even with a considerable number of regular workers, as in the large farm sample, there apparently is still a need for a substantial number of seasonal workers.

The importance of family labor in the harvest operation was pointed up by the smaller percentage of area sample growers reporting harvest workers in any one month. It is further evidenced by the relatively small differences between samples in the hours and expenditures on harvest workers per farm. In the area sample, the large expenditure per farm means that the averages are much more reflective of the large area sample farms and that more of the smaller area sample farms were getting by with family harvest labor. Perquisites such as housing and food items, were generally about 10 percent of the total cost of harvest labor in both samples.

One of the major problems of fruit growers is pointed up by the tremendous variation in harvest worker employment on a monthly basis. From June through October, the peak harvest months, there was considerable variation in the percent of farms employing harvest workers, the hours worked per individual and per farm and in the apparent number of workers employed. The peak employment of harvest workers appeared to be in July, the major cherry harvest period. There were a substantial number of harvest workers employed in June, engaged primarily in strawberry harvest. Mechanization of the cherry harvest could be an important factor affecting the ability of strawberry growers to attract interstate harvest workers.

It appears evident that the continuous employment opportunities now available to harvest workers, however tenuous, would become even more uncertain with the advent of mechanical harvesting of a major crop. The growers least likely to be adversely affected will be those with a high dependence on family harvest labor. Growers most adversely affected will be those with crops that have harvest dates just before or just after the crop mechanized. Elimination of a major portion of the harvest labor force in one major crop could lead to substantial reorganization of fruit farms, especially with respect to specialization and enterprise combination.

CHAPTER IV

MACHINE INVENTORY

Growers provided information on the principal items of machinery and equipment used in fruit and berry production in 1966. Information was collected on the number of items of different types of machinery and equipment and the model year of each item. The present value of each item was determined after the data were collected.

In order to place a value on the 1966 inventory of machinery and equipment the following procedure was used:

1) New and used tractor prices were obtained from the Tractor and Farm Equipment Guide of the National Farm and Power Equipment Dealers Association.

2) New and used truck prices were obtained from the October, 1966 NADA Official Used Car Guide for those years listed. For earlier models not included in the Guide, a depreciated 1966 new price was used as in (4) below.

3) Since the price of certain fruit equipment was not available in published form, estimates were obtained from interviews with farm equipment dealers in the fruit growing area.[9]

4) In cases of an inadequate used equipment market, a 1966 value was estimated using the double declining balance depreciation

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[9]To obtain the necessary prices, twelve farm equipment dealers were interviewed in southwestern Michigan. The dealers were asked to estimate the trade-in value of various items of machinery and equipment, representing essentially the on-farm value of the equipment. The dealers provided estimates for major items of equipment on a model year basis, or at most on a three year interval basis. They also indicated the age at which annual depreciation became negligible for many items. From the information provided by dealers it was possible to construct a series of prices indicating the present value of major items of machinery and equipment. Some of the major items estimated in this manner included orchard disks and drags, orchard sprayers, fork lifts, tree hoes, mowers and transplanters.

> method. It was necessary to assume that the 1966 value of equipment purchased in the year 1966-n was equivalent to the depreciated value of a new 1966 item of comparable equipment in the nth year after purchase.[10]

It is the opinion of the author that the values obtained for equipment and machinery closely correspond to the salvage value.

Total Machinery and Equipment Inventory

A total of 255 growers reported usable machinery and equipment inventory data, 87 in the area sample and 168 in the large farm sample.

All Farms

In the area sample, the mean value of all machinery and equipment was $10,793 in 1966 (see Table IV.1). The mean value was heavily influenced by the three farms reporting more than $40,000 in inventory value. Almost 69 percent of the farms reported less than $10,000 in total inventory value, while almost one-third of the farms reported over $10,000 in machinery inventory. A further influence of the very highly capitalized farms was the median value of the machinery and equipment inventory of $6,963, over $3,800 less than the mean value.

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[10]For items of equipment with essentially no established used market, it was necessary to depreciate the new price. Items included in this category were special harvesting equipment, primarily cherry harvesters, irrigation equipment, pruning aids, and bulk tanks.

The double declining balance depreciation method was used in an effort to more closely approximate the salvage value of equipment. The double declining balance method works as follows: if the productive life of an item of equipment is estimated at five years, the normal straight line depreciation would be 20 percent per year; with the DDB method the first year depreciation is 40 percent of the new price, the second year depreciation is 40 percent of the remaining balance, etc., until the salvage value is reached. This type depreciation allows a much faster write-off in the earlier years. It is the opinion of the author that this method of depreciation most closely approximated salvage values.

Table IV.1. Total Value of Machinery and Equipment Inventory on all Reporting Farms.

Item	Area Sample		Large Farm Sample	
	Number Farms	Percent	Number Farms	Percent
Number of observations	87		168	
Less than $5,000	29	33.3	8	4.8
$5,000-$9,999	31	35.6	32	19.0
$10,000-$19,999	21	24.1	57	33.9
$20,000-$29,999	3	3.4	46	27.4
$30,000-$39,999	-	--	16	9.5
$40,000-$49,999	1	1.1	3	1.8
$50,000-$99,999	1	1.1	5	3.0
$100,000 and over	1	1.1	1	.6
Mean value ($)	$10,793		$19,660	
Median value ($)	$6,963		$16,710	

The mean value of the machinery and equipment inventory of $19,660 on the large farms was 82 percent higher than in the area sample, while the median value of $16,710 was 140 percent higher. Less than 24 percent of the large farms reported less than $10,000 in total inventory value, compared to almost 69 percent of the area sample farms. The majority of the large farms, 61.3 percent, reported from $10,000 to $30,000 in machinery and equipment inventory. There was little difference between samples in the percentage of farms reporting more than $40,000 in total inventory value with one farm in each sample reporting over $100,000 in machinery and equipment inventory.

Farms With 100 Percent Sales From Fruit

There were a total of 146 farms that derived 100 percent of their sales from fruit and berries, 48 in the area sample and 98 in the large farm sample. Because of certain limitations in the data, only 39 farms in the area sample and 95 farms in the large farm sample were used in this analysis.[11]

On the average, the large farms had more than double the inventory value of machinery and equipment as the area sample farms (see Table IV.2). Only one area sample farm had an inventory value of over $20,000, compared to 33.7 percent of the large farms. Two-thirds of the area sample farms had inventory values of less than $10,000, compared to 29.5 percent of the large farms. In both samples,

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[11]For purposes of later analysis, it was necessary for the farms to have complete information on hired labor use, machinery inventory and total fruit sales. Incomplete information in one or more of these categories eliminated 12 farms from the analysis.

Table IV.2. Total Value of Machinery and Equipment on Farms with Total Sales from Fruit.

Item	Number of Obser-vations	Less than $5,000	$5,000 to $9,999	$10,000 to $19,999	$20,000 to $29,999	$30,000 to $39,999	$40,000 to $49,999	$50,000 and over	Mean Value (Dollars)
				Area Sample					
All farms -									
Number	39	12	14	12	1	--	--	--	$8,231
Percent		30.8	35.9	30.8	1.1				
				Large Farm Sample					
All farms -									
Number	95	6	22	35	20	7	2	3	$17,576
Percent		6.3	23.2	36.8	21.0	7.4	2.1	3.2	
				All Farms					
Type farm -									
Cherries	53	8	19	16	6	3	--	--	$13,183
Apples	48	5	8	19	10	4	--	--	$16,993
Mixed	13	1	2	5	4	--	1	--	$16,964
Grape	9	2	4	3	--	--	--	--	$ 8,981
Strawberry	4	--	--	2	1	--	--	1	$29,110
Blueberry	4	1	2	1	--	--	--	--	$ 8,679

the inventory values for farms with 100 percent sales from fruit were lower than for all farms within each sample.

Although the number of farms was somewhat limiting, it was possible to combine the farms from both samples and compute inventory values by type of fruit farm.[12] The largest inventory values were found on the four strawberry farms, an average of $29,110 per farm (see Table IV.2). A major portion of this high value could be accounted for by irrigation equipment. Grape and blueberry farms had relatively low inventory values, both less than $9,000. The average machinery and equipment inventory value appeared to be significantly higher for apple farms than for cherry farms, $16,993, compared to $13,183. While there were more cherry than apple farms, the cherry farms appeared to have lower average sales and acres and in general tended to be smaller farms with the bulk of the apple farms found in the large farm sample. Over 80 percent of the cherry farms had inventory values of less than $20,000, compared to 66 percent of the apple farms. In addition to being larger farms, the apple farms were more likely to have fork lifts and bulk boxes than were the cherry farms (a new fork lift can cost several thousand dollars).

The mixed farms also had relatively high machinery and equipment inventory values, but as pointed out earlier were likely to be growing both apples and cherries in addition to other fruit enterprises.

As expected, the large farms had a significantly higher machinery and equipment inventory value. With the exception of the

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[12]See page 17 for explanation of how farms were classified.

four strawberry farms, apple farms had higher inventory values than other types of farms.

Tractor Inventory

A total of 255 growers reported the number and model year of tractors, 87 in the area sample and 168 in the large farm sample.

All Farms

The average value of all tractors per area sample farm was \$2,870, with 65.4 percent of the area sample farms reporting less than \$3,000 in tractor capital. The relatively high average value was strongly influenced by the 12.5 percent of the farms with over \$5,000 in tractor capital (see Table IV.3). A relatively high proportion of the area sample growers appeared to be single tractor owners, with 39 percent reporting less than \$2,000 in tractor capital.

In the large farm sample the average value of tractors was \$4,207 per farm, 46.5 percent higher than in the area sample. Over 30 percent of the large farms reported \$5,000 or more in tractor capital, compared to only 12.5 percent of the area sample farms. Relatively more of the large farm growers were multiple tractor owners.

At the mean values of tractor and total machinery and equipment inventories, tractor capital accounted for 21.5 percent of total inventory value in the large farm sample and over 26 percent in the area sample. At the median values, the percentage changed only very slightly in the large farm sample, but increased up to 33 percent for the area sample farms.

Table IV.3. Tractor Capital on all Reporting Farms.

Item	Area Sample		Large Farm Sample	
	Number Farms	Percent	Number Farms	Percent
Number of observations	87		168	
Less than $1,000	21	24.1	7	4.2
$1,000-$1,999	13	14.9	25	14.9
$2,000-$2,999	23	26.4	32	19.0
$3,000-$3,999	10	11.5	31	18.4
$4,000-$4,999	9	10.3	22	13.1
$5,000-$7,499	9	10.3	35	20.8
$7,500-$10,000	-	--	10	6.0
$10,000 and over	2	2.3	6	3.6
Mean value of tractors ($)	$2,870		$4,207	
Median value of tractors ($)	$2,313		$3,538	

Even with the predominance of single tractor owners in the area sample, tractor capital appears to account for a significantly higher proportion of total machinery and equipment inventory.

Farms With Total Sales From Fruit

The large farms had 52 percent more tractor capital than did the area sample farms, $3,034 compared to $2,367 (see Table IV.4). Almost 49 percent of the area sample farms had less than $1,000 in tractor capital, compared to only 24.2 percent of the large farms. Again for this group of farms, tractor capital was a higher percentage of total machinery and equipment inventory in the area sample.

Tractor values by type farm followed essentially the same pattern as did total value of all machinery and equipment (see Table IV.4). Apple farms had higher tractor inventory values than did cherry farms, with the mixed farms having higher tractor values than either cherry or apple farms.

A relatively small percentage of the difference between apple and cherry farm total machinery inventory value can be accounted for by tractor capital, with the apple farms having over $300 more tractor capital than cherry farms. Tractor capital on the average, however, accounted for a larger percentage of total machinery inventory for the apple farms than for the cherry farms.

Since the strawberry farms had less than an average amount of tractor capital, their very high value for all machinery and equipment was found in items other than tractors. Irrigation equipment used primarily on strawberry farms could make such a difference in inventory values.

Table IV.4. Tractor Capital for Farms with Total Sales from Fruit.

Item	Number of Obser-vations	Less than $1,000	$1,000 to $1,999	$2,000 to $2,999	$3,000 to $3,999	$4,000 to $4,999	$5,000 to $7,499	$7,500 and over	Mean Tractor Capital (Dollars)
				Area Sample					
All farms -									
Number	39	9	10	9	4	4	3	--	$2,367
Percent		23.1	25.6	23.1	10.2	10.2	5.1	--	
				Large Farm Sample					
All farms -									
Number	95	6	17	21	18	13	16	4	$3,499
Percent		6.3	17.9	22.1	18.9	13.7	16.8	4.2	
				All Farms					
Type farm -									
Cherries	53	5	12	11	10	8	7	--	$3,034
Apples	48	6	7	14	7	5	5	4	$3,342
Mixed	13	--	1	3	2	2	5	--	$4,192
Grape	9	2	2	1	2	2	--	--	$2,481
Strawberry	4	--	2	--	1	--	1	--	$3,108
Blueberry	4	1	2	--	--	--	1	--	$2,356

Specialized Machinery and Equipment

The pruning and harvest operations have traditionally required large labor inputs on Michigan fruit farms. Over the past few years, several pruning aids have been in use, and more recently the tree hedger, a self-propelled pruning unit, has been developed. In addition, the harvest of certain fruits, primarily tart cherries and blueberries, has become partially mechanized in the past few years. To determine the extent of this specialized machinery and equipment, the number of pruning aids and harvesters were tabulated and average values per farm computed.

Pruners

Aside from hand-operated tools, there have been three basic types of pruning aids: electric, pneumatic and hydraulic pruners. A variation of the hydraulic pruner is the mechanized pruning platform. All of these pruning aids require a motor driven air compressor or hydraulic pump to operate the pruning aid. The tree hedger is a relatively new self-propelled pruning unit.

A total of 19 area sample growers (or 21.8 percent) reported one or more of the power-type pruners (see Table IV.5). The average value of all power pruners was $322 per farm. More farms reported pneumatic pruners than any other type, followed by electric pruners. The most expensive type pruner was the mechanized platform, valued at $1,877, but reported by only one area sample farm. One farm reported a tree hedger, but the value of only $500 raises serious questions as to the exact type of hedger. It obviously was not a self-propelled unit, and was most likely a tractor drawn hedger.

Table IV.5. Special Pruning Equipment: Number of Farms Reporting and Average Value per Farm.

Item	Type Pruning Equipment					
	Electric	Pneumatic	Hydraulic	Mechanized Platform	Hedger	All Types*
Area Sample						
Number of farms reporting	6	8	4	1	1	19
Average value per farm ($)	223	211	180	1,877	500	322
Large Farm Sample						
Number of farms reporting	17	52	27	8	1	90
Average value per farm ($)	166	290	268	1,458	9,000	538

*Since one grower can own more than one type of pruner, the number of farms reporting all types can be less than the sum of the different types.

Over twice as high a percentage of the large farms reported power pruners, 52.7 percent compared to 21.8 percent of the area sample farms. Of the farms reporting, a higher percentage in the large farm sample reported each separate type, with the exception of the electric pruner. A much higher percentage of the large farms reported the relatively more expensive mechanized platforms, with one large farm reporting a self-propelled hedger valued at $9,000. The mechanized platform, probably of greatest use in older apple orchards, was reported by eight large farms and only one area sample farm. Of the nine farms in both samples reporting a mechanized platform, six farms were classified as apple farms, two farms as mixed, and one cherry farm.

It seems clear that a larger percentage of the large farms are using pruning aids, particularly the more expensive types. Although not a major factor perhaps, the value of pruning aids does account for some of the sample difference in total machinery and equipment inventories.

Harvesters

The major types of harvesters found were cherry harvesters, either self-propelled or tractor-mounted.

Only four of the area sample farms reported the self-propelled cherry harvester (see Table IV.6), but one of these farms reported three harvesters. The average value per farm was $10,381, not including tanks. Three of the four farms reporting the self-propelled harvesters were the large mixed farms, while one farm was classified as a cherry farm.

Table IV.6. Selected Harvest Equipment: Number of Farms Reporting and Average Value per Farm.

Item	Type Equipment			
	Cherry Shaker, Self-propelled	Cherry Shaker, Tractor-mounted	Blue-berry Har-vester	Hand Vi-brators
Area Sample				
Number farms reporting	4	5	0	0
Average value per farm ($)	$10,381	$1,958	--	--
Large Farm Sample				
Number farms reporting	26	19	1	2
Average value per farm ($)	$8,821	$2,337	$25,000	$1,135

Five different farms in the area sample reported the tractor-mounted cherry harvester with an average value of $2,376 per farm.

A much higher percentage of the large farms reported both types of cherry harvesters. The self-propelled harvester was reported by 26 large farms, with an average value of $8,821. Since one large farm reported two self-propelled harvesters, the large farms appeared to have older harvesters than did the area sample farms. This would imply that the large farms were relatively early adopters as far as self-propelled cherry harvesters were concerned. The mounted cherry harvesters were reported by 19 large farms compared to only four area sample farms, but the average value per farm was practically the same for both samples. No farm in either sample reported more than one mounted harvester per farm, although one large farm reported both a self-propelled and a mounted type cherry harvester.

Of the 30 farms with self-propelled cherry shakers, 18 were cherry farms, seven were apple farms and five were mixed farms. The 24 farms reporting tractor mounted shakers were classified as follows: eight apple farms, seven cherry farms, six mixed farms and three other fruit farms.

In addition to the cherry harvesters, one large farm reported a $25,000 blueberry harvester, although it was not in use in 1966. Hand vibrators, used in blueberry harvest, were reported by two large farms with an average value of $1,135 per farm. All of the farms with special blueberry harvest equipment were classified as blueberry farms.

There appeared to be a substantial difference between the two samples in specialized machinery and equipment found on the farms. The large farms were much more likely to have mechanical pruning aids, particularly the more expensive types. Of the 30 self-propelled cherry shakers in both samples, 26 (or 86.6 percent) were found in the large farm sample.

Machine Hire or Lease

To determine the extent and type of machine hiring or leasing in the fruit industry, growers were asked three questions: "(1) Did you rent or lease from others any type of farm equipment in 1966? (2) Did you hire any custom machine work on your farm in 1966, including spraying and dusting? and (3) Did you do any custom work for others in 1966?" Growers were asked for information on type operation performed, equipment used, cost per unit and total cost of operation. Only the data on type operation and total cost of operation were reported by a sufficient number of growers to compute meaningful averages. Unfortunately, the data were insufficient to allow computation of a per unit cost.

Renting or Leasing Equipment from Others

Columns 1 and 2 of Table IV.7 show the number of farms renting or leasing equipment from others and the average cost per farm by type operation performed. Equipment renting did not appear to be a common practice among the area sample farms, with only 12 farms reporting any rental equipment. The average cost per farm was $132 for the twelve farms reporting.

Equipment rental was slightly more common among the large farms, with 30 farms reporting an average expenditure of $440 per farm. Four farms reported an average expenditure of $2,072 per farm for the rental of harvest equipment. The large farms reported renting equipment for all of the operations shown in Table IV.7, while the area sample farms rented equipment only for the other fruit and non-fruit operations. The other fruit category reported by the most farms included such items as tree hoes, trucks, brush choppers and bulk spreaders.

Hired Custom Machine Work

Hiring custom work was fairly common in the area sample, with 55 farms reporting some type custom work (see Table IV.7, Columns 3 and 4). More farms reported custom land preparation, which included

Table IV.7. Machine Hire or Lease: Number of Farms and Average Value per Farm by Type Operation Performed.

Type Operation	Renting or Leasing Equipment		Hiring Custom Machine Work		Perform Custom Work for Others	
	Number of Farms (1)	Average Cost Per Farm ($) (2)	Number of Farms (3)	Average Cost Per Farm ($) (4)	Number of Farms (5)	Avg. Income Per Farm ($) (6)
Area Sample						
Land preparation	0	0	28	482	0	0
Pruning	0	0	1	230	0	0
Chemical application	0	0	6	246	3	113
Harvest	0	0	4	2,532	4	1,625
Other fruit	10	174	4	78	2	350
Non-fruit	2	8	22	212	5	278
All operations	12	132	55	564	13	715
Large Farm Sample						
Land preparation	1	560	51	431	2	182
Pruning	1	12	5	130	2	3,015
Chemical application	5	200	27	368	8	704
Harvest	4	2,072	6	1,325	8	8,972
Other fruit	13	284	3	493	4	3,722
Non-fruit	7	63	33	864	7	568
All operations	30	440	99	700	28	3,781

Note: The number of farms shown for all operations will not necessarily be the sum of the number of farms by type operation. Some of the farms will be in more than one type operation.

general bulldozing and tree removal, than any other operation. The average expenditure per reporting farm was $482 for land preparation and $564 per farm for all operations combined. The largest expenditure per farm was for custom harvesting, where farms reported an average expenditure per farm of $2,532. The non-fruit category was large, with 22 farms reporting an average expenditure of $212 per farm on non-fruit custom work.

For all operations combined, custom machine work was only slightly less common in the large farm sample, 58.5 percent of all farms, compared to 63 percent of the area sample farms. While the average expenditure per farm of $700 was higher than in the area sample, the major differences were in the chemical application and non-fruit operations. A substantially higher percentage of the large farms reported custom chemical application, 15.9 percent compared to 6.8 percent of the area sample farms. The average expenditure per farm for custom non-fruit operations was $864 for the large farms compared to $212 for the area sample farms. The larger average acreages of fruit in the large farm sample could account for the higher charges for custom chemical application.

Performing Custom Work for Others

Only 13 of the area sample farms performed custom machine work for others in 1966 (see Table IV.7, Columns 5 and 6). The largest income per farm was $1,625 for the four farms reporting custom harvesting for others. The average income per farm from custom work was $715, scarcely a major source of income.

About the same percentage of large farms reported doing custom work for others in 1966, although the averages in Table IV.7 cover up wide variations within the large farm sample. In custom harvesting, for example, the total custom income of all eight farms was $71,775, with one farm receiving $52,000, another farm receiving $10,400 and the remaining six farms receiving a total of $9,375. Two farms, thus, accounted for almost 87 percent of the total income reported from custom harvesting. The variations are equally as wide in the pruning and other fruit operations. The average income from pruning was $3,015 per farm with one farm receiving $6,000 and the other farm receiving only $30. In the other fruit operation, one farm received over 82 percent of the total income reported from custom work. The average income per farm was $3,781 from all operations combined. It appeared that the custom work for others was dominated by a very few large farms.

In summary, renting or leasing equipment is not a very common practice in either sample, although the average expenditure per farm is substantially higher in the large farm sample. Hiring custom machine work appears to be a fairly common practice in both samples, with land preparation being the most common operation. Custom application of chemicals was much more common in the large farm sample. The large farm sample had a slightly higher percentage of farms doing custom work for others, although on a dollar volume basis, the custom work was clearly dominated by a very few large farms.

Summary

Information was obtained from growers on the principal items of machinery and equipment used in fruit production in 1966. By methods explained in the text, a total value of machinery and equipment was estimated for each farm.

On the average, the large farms had over twice the inventory value of machinery and equipment as the area sample farms. The large farms appeared to have more of most items of machinery, including more tractors. Even though a higher percentage of the area sample farms were single tractor farms, tractor capital accounted for a higher proportion of total machinery and equipment capital (more evidence of the lumpiness of certain capital items).

In addition to more tractor capital, the large farms were much more likely to have pruning aids and mechanical harvesters. In fact, 86.6 percent of the self-propelled and 79.1 percent of the tractor-mounted cherry harvesters were in the large farm sample. There were also more fork lifts and irrigation equipment found in the large farm sample.

Strawberry farms had the highest machinery inventory value of any type farm. The apple and mixed farms had about the same amount of machinery capital and both had substantially more than the cherry farms. The lowest levels of machinery and equipment were found on the grape and blueberry farms (the $25,000 blueberry harvester was not included in the averages since it was not used in 1966).

There was relatively little machinery and equipment rental in either sample. Hiring custom work was a fairly common practice in both samples with a fairly higher percentage of the area sample farms reporting hired custom work. More of the area sample growers reported custom land preparation and non-fruit work than any other type operation. Relatively more of the large growers reported custom chemical application. Only four area sample growers and six large farm growers reported custom harvest work.

A slightly higher percentage of the large farm growers reported doing custom work for others, although on a dollar volume basis, the custom work was dominated by a few very large farms.

CHAPTER V

FUNCTIONAL ANALYSIS

The major objective of the statistical analysis was to determine how the factors of production, land, labor and capital, in the form of machinery and equipment investment, affect total fruit sales. In order to provide partial answers to questions concerning economics of size, resource adjustments and factor substitution, it was necessary to estimate parameters such as resource elasticities, size or scale coefficients and marginal value products. Estimates of these parameters should provide a reasonable basis for suggesting fruit farm adjustment potentials.

Method of Analysis

The statistical function fitted to the sample data is of the form

$$Y = \alpha X_1^{\beta_1} X_2^{\beta_2} \ldots X_n^{\beta_n} \epsilon_i$$

where Y is the dependent variable, α is a constant, $X_1 \ldots X_n$ are independent factors of production, $\beta_1 \ldots \beta_n$ are parameters measuring the elasticity of Y with respect to the corresponding X_i and the log of ϵ_i is the random component.

A method of estimation which may be used to obtain estimates of the structural parameters of the single equation model is the method of least squares. This method of estimation consists of minimizing the sum of the squared deviations from the regression line.

To obtain best unbiased estimates by the method of least squares the ϵ's and X's must meet certain rather rigid specifications.[13] The usual assumptions concerning the ϵ's are: (1) the ϵ's must follow some (not necessarily normal) probability distribution, (2) that the mean or expected value is zero, and (3) that the variance of ϵ is finite and independent of the particular values of the X's.

An important assumption regarding the X's is that they be a known set of numbers or predetermined variables in contrast to a random variable. Any errors of measurement are assumed to be associated with the dependent variable and are reflected by the disturbance factor ϵ_i. The effects of ommitted variables are also assumed to be reflected in ϵ_i.

While strong economic assumptions are required to use this particular model, commonly referred to as the "Cobb-Douglas", its properties make it particularly useful in diagnostic analysis, since it reflects marginal resource productivities at mean level of inputs and also permits decreasing returns, i.e., declining marginal physical products (MPP).[14]

One of the more important economic assumptions is that the elasticities of production (the β_i) are constant over all ranges of

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[13] A best estimate is obtained when the variance of the estimate is as small as possible for a given set of estimating procedures. An unbiased estimate exists when the expected value of the estimate equals the value that would be obtained from a similar calculation based on the combined evidence of all possible samples. For further elaboration, see R. J. Foote, Analytical Tools for Studying Demand and Price Structure, Agricultural Handbook No. 146, USDA, AMS (Washington, D.C., August, 1958), pp. 57-58.

[14] Earl O. Heady and John L. Dillon, Agricultural Production Functions (Ames Iowa State University Press, 1961), p. 228.

output, while the marginal physical products (or marginal value product when Y is value of output) changes with corresponding changes in the inputs.

If all relevant inputs were included in the analysis, an unlikely event in most economic analysis, the sum of the elasticities would correspond to the elasticity of production or the scale coefficient. Since the inclusion of all relevant inputs is unlikely, it is more appropriate to view the sum of the elasticities as indicating returns to size.

It does not appear fruitful to recount the long standing debate over inter-firm, intra-firm production relationships.[15] In the present study, the Cobb-Douglas function is being fit to different observations on different farms at one point in time (cross section). Obviously, the functions in this study will be the loci of input-output quantities of all the farms used in the study, and the resulting estimates of the marginal value products will be "averages" for the sample. While these estimates of elasticities and marginal value products do not correspond to the intra-firm concepts of production theory, they do provide estimates that are useful for diagnostic purposes.

The Cobb-Douglas function was chosen for basically four reasons: (1) it represents the data adequately; (2) it permits diminishing returns to factors; (3) it is computationally simple; and (4) it is a relatively efficient user of degrees of freedom.

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[15]For a discussion of this problem see Martin Brenfenbrenner, "Production Function: Cobb-Douglas, Interfirm, Intrafirm", Econometrica, Vol. 12, (1944), pp. 35-44.

The Variables in the Production Function

The variables used in the aggregate farm production function analysis are as follows:

Y. The dependent variable -- an estimate of the total value of fruit produced on the farm -- was obtained for each farm by multiplying the production of the individual commodities by the 1966 average price for the season received by Michigan growers. Since most products were marketed for both fresh and processed use, it was necessary to use a fresh price for known production sold fresh, and a processed price for known production going into a processed use. When the end use was unknown a blend price was used. This split price was used for all commodities except apples, where both the estimate of quantities sold fresh and the fresh market price were considered unreliable.

X_1. Acres of bearing fruit is the sum of the bearing acres of each fruit found on the farm.

X_2. Capital stock is defined as the 1966 inventory value of all machinery and equipment associated with the fruit enterprises. An attempt was made to limit this variable to the value of machinery and equipment used in the physical production of the fruit crops. Buildings and equipment used in packing or in storage operations were excluded from this variable. It was felt that grading, packing and/or storage by transforming the utility of the product constitutes a different production process. It is the opinion of the author that value of the capital stock was probably underestimated in the enumeration process. This appeared to be especially true for those large farms with many items of machinery and equipment. There was no practical way to avoid using the stock concept, since at the aggregate farm level it was impossible to determine the hours of use of any of the items.

X_3. Family labor is in operator hour equivalents. Three categories of family labor were reported in the data, operator hours, wife hours and other unpaid family labor. There were obvious problems in any method of aggregating these three categories, and no obvious best solutions. The categories were aggregated on the basis of adding 100 percent of the reported operator hours, 80 percent of the reported wife hours and 65 percent of the other family hours. These percentages are somewhat arbitrary since there might be cases where the wife and other family workers are more productive than the operators, such as in harvesting certain fruits. On the average, however, it seems reasonable to expect women and children to be somewhat less productive than operators.

In the case of family labor, it is the opinion of the author that the data overestimates the actual input. This is partly due to the nature of the questionnaire but more likely due to the natural tendency of growers to overestimate their labor inputs.

X_4. Cost of regular hired workers is defined as total wage payments plus the value of other items such as housing and utilities. Workers were considered regular hired if they could be identified as being employed for as many as seven months on the same farm. It was not necessary that they be employed full time in any of these months, only that they worked part of the month for at least seven different months.

X_5. Cost of seasonal hired workers is defined as total wage payments plus the value of other items for all workers who were not considered regular hired or who were not obviously harvest workers. This category essentially represents all the hired labor that could not otherwise be classified.

X_6. Cost of hired harvest labor is the total wage or piece rate payment plus value of other items for workers who could clearly be identified as working only in the harvest operation.

X_7. Cost of all hired labor is defined as total wage payments plus the value of any other items received by all hired workers, i.e., the sum of X_4, X_5, and X_6.

Data Adjustments and Limitations

The aggregate farm production function analysis was limited to those farms that derived 100 percent of their sales from fruits and berries, 48 in the area sample and 95 in the large farm sample. This was considered necessary, since the survey data on the family labor input and the hired labor input was collected for the total farm operation and not limited to the fruit enterprises. By limiting the analysis to farms with 100 percent sales from fruit and berries, the total labor inputs were applicable to fruit production.

It was necessary, however, to adjust the family and hired labor inputs for acreages of non-bearing fruit. Since the measure of output is applicable only to bearing acres, the labor inputs had to be adjusted accordingly. Several important assumptions were necessary to get the job done, however. First, it was necessary to estimate the actual labor requirements for an acre of non-bearing fruit. This had to be done for each fruit crop in the analysis.[16] Next it was assumed that all farms with non-bearing apple acreage, for example, would have the same labor requirements per acre of non-bearing apples. This was an unrealistic but necessary assumption. An additional assumption was that the labor inputs on non-bearing acreage were in the same proportion regarding type of labor used as the total labor inputs on the farm. That is, if family labor contributed 50 percent of the total labor input, it was assumed that family labor contributed the same percentage to the non-bearing acreage requirements. Harvest labor was not included in determining the relative proportions. In summary, the family, regular hired, and seasonal hired labor inputs were adjusted downward to more nearly reflect inputs on bearing acreages.

It was reasoned that the stock of machinery and equipment would probably remain about the same whether there was non-bearing acreage or not. In addition, there was no practical method of allocating capital stock between bearing and non-bearing acreage.

The Statistical Results

Since one of the objectives of the study was to determine if there were any significant economics of size, several regression equations were fit with the same basic data, but with each equation representing a different subgrouping of the farms or a different combination of the variables. In order to test for returns to size, indicated by the sum of the regression coefficients in the particular model used, it was necessary to fit each equation with the Σbi

[16] Consultation with Horticultural and Agricultural Economic Staff personnel was invaluable in developing these labor requirements.

unrestrained and to refit the equation with the constraint that the $\Sigma bi = 1$.[17] An "F" statistic could then be computed and compared to a tabulated "F" to determine if the sum of the coefficients was significantly different from one.[18] Increasing, decreasing or constant returns to size are indicated, depending on whether the sum of the coefficients is greater, less than or equal to one.

All Farms with Total Sales from Fruit

Model I-A

In this model, only the wage cost of hired labor was used as a measure of X_4, X_5, and X_6 (regular, seasonal and harvest labor, respectively). The complete equation and related statistics are reported in Appendix Table D-1. The regression coefficients or elasticities and levels of significance are shown in Table V.1.

The coefficient of multiple determination, indicating the percentage of the variation in the independent variable accounted for by the dependent variables, was .869 and .815 for the area sample and the large farm sample respectively. The elasticities indicate the percentage change in fruit sales as a result of a one percent change in the dependent variable. For example, the elasticity of bearing acres of .70 in the area sample, indicates that if bearing acres are

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[17]The sum of the regression coefficients (Σbi) in a Cobb-Douglas type function is equivalent to the elasticity of production or scale coefficient. It indicates the percentage change in the dependent variable as a result of a one percent change in all of the independent variables. Since all of the relevant inputs are unlikely to be included in this analysis, it seems appropriate to regard the bi as indicating returns to size or the size coefficient.

[18]The procedure for making this test is found in Gerhard Tintner, Econometrics (New York: John Wiley & Sons, Inc., 1952), pp. 89-91.

increased by one percent, fruit sales will increase by .7 of one percent. The other elasticities are interpreted in the same manner.

Table V.1. Regression Coefficients or Elasticities for Model I-A, Hired Labor Measured as Wage Cost.

Resource	Elasticity	
	Area Sample	Large Farm Sample
Acres	.700^{xxx}	.285^{xxx}
Machinery	.124	.172^{xx}
Family Labor	-.012	-.018
Regular Labor	-.008	.023^{xx}
Seasonal Labor	.009	-.006
Harvest Labor	.341^{xxx}	.474^{xxx}
Sum of Elasticities	1.15	.930

^{xxx}Significant at the .01 level.

^{xx}Significant at the .05 level.

In the area sample, only the elasticities of acres and harvest labor were significantly different from zero. The elasticity of both family labor and regular labor was negative, though not significantly different from zero. The sum of the elasticities of 1.15 is not significantly different from one. On the basis of present evidence the hypothesis of constant returns to size cannot be rejected.

In the large farm sample, the elasticities of acres, machinery, regular and harvest labor were statistically significant, and appeared to be different from the corresponding elasticities in the area sample. All of the significant coefficients, in both samples, had a sign consistent with economic expectations. The sum of the coefficients in the large farm sample was not significantly different from one, although it was less than in the area sample.

Part of the explanation for the insignificant machinery coefficient in the area sample might lie in the intercorrelations between the independent variables (shown in Appendix Table D-2). The simple correlation between acres and machinery was .765, and the correlation between harvest labor wages and acres was .679. High intercorrelations or multicollinearity tend to increase the standard errors of the estimates. It appears that acres, machinery and harvest labor are fairly close complements in the production of fruit.

The intercorrelations were not as high in the large farm sample, particularly between acres and machinery and machinery and harvest labor wages.

Model I-B

The only difference between this model and the previous model is that all types of hired labor (X_4, X_5 and X_6) have been combined into one variable, X_7 (all hired labor). The hired labor variable is again measured as wage cost. The elasticities and levels of significance are shown below in Table V.2 (see Appendix Table D-1 for complete statistical results).

Table V.2. Regression Coefficients or Elasticities for Model I-B, Hired Labor Measured as Wage Cost.

Resource	Elasticity	
	Area Sample	Large Farm Sample
Acres	.639^{xxx}	.256^{xx}
Machinery	-.038	.183^{xx}
Family Labor	-.030	-.017
All Hired Labor	.446^{xxx}	.500^{xxx}
Sum of Elasticities	1.02	.922

^{xxx}Significant at the .01 level.

^{xx}Significant at the .05 level.

The R^2's were essentially the same as in the previous model, and again, the sum of the coefficients was not significantly different from one in either sample. The elasticities of both acres and all hired labor were positive and highly significant in the area sample. In the large farm sample, the elasticities of acres, machinery and hired labor were all significant and had the expected sign. The family labor coefficient was negative in both samples, although not significant at the .05 level. The magnitude of the significant elasticities changed only slightly from the previous model, with harvest labor clearly dominating the elasticity of all hired labor.

Essentially the same multicollinearity problems were evident in this model as in Model I-A (see Appendix Table D-2 for simple correlations).

Model II-A

Since wage costs represent only a part of the total cost of labor, and the perquisites are as much an economic cost as wages, the total cost of labor including wages and perquisites, was used as a measure of variables X_5, X_6 and X_7 in this model. In addition, eight farms were excluded from the area sample analysis on the basis of having total fruit sales of less than $1,000. It was reasoned that these farms were not commercial farms and would distort the resource use picture. One other area sample farm was eliminated when it was discovered that total sales were not from fruit sales. The elasticities and levels of significance are shown in Table V.3 (see Appendix Table D-1 for complete statistical results).

Table V.3. Regression Coefficients or Elasticities for Model II-A, Hired Labor Measured as Total Cost.

Resource	Elasticity	
	Area Sample	Large Farm Sample
Acres	.592xxx	.286xxx
Machinery	.174	.176x
Family Labor	-.049	-.016
Regular Labor	-.009	.023
Seasonal Labor	.019	-.005
Harvest Labor	.419xxx	.450xxx
Sum of Elasticities	1.15	.91

xxxSignificant at the .01 level.

xxSignificant at the .05 level.

xSignificant at the .15 level.

The respective R^2's in the area sample and large farm sample were .804 and .816. The elasticities of both acres and harvest labor were highly significant and the elasticity of machinery investment in the large farm sample was positive and significant at the .13 level. Family labor had a negative coefficient in both samples, although neither coefficient was significantly different from zero. Again the sum of the elasticities was not significantly different from one in either sample, although it was considerably smaller in the large farm sample.

Using the total cost of the three types of hired labor rather than wage cost, as in Model I-A, had the effect of reducing the elasticity of acres and increasing the elasticity of harvest labor in the area sample. Although the magnitudes were much smaller, the directions of change were reversed in the large farm sample, with the elasticity of acres and machinery increasing and the elasticity of harvest labor decreasing. Before speculating on these changes in elasticities, it seems prudent to examine the next model.

Model II-B

The only difference between this model and Model II-A is that the three types of hired labor have been combined into one variable. The hired labor variable is again measured as total cost, including wages and perquisites. The elasticities and levels of significance are shown in Table V.4 (see Appendix Table D-1 for complete statistical results).

Table V.4. Regression Coefficients or Elasticities for Model II-B, Hired Labor Measured as Total Cost.

Resource	Elasticity	
	Area Sample	Large Farm Sample
Acres	.564xxx	.263xx
Machinery	-.006	.184x
Family Labor	-.070	-.012
All Hired Labor	.511xxx	.480xxx
Sum of Elasticities	.99	.92

xxxSignificant at the .01 level.
xxSignificant at the .05 level.
xSignificant at the .15 level.

The elasticity of both acres and hired labor was highly significant in both samples. The elasticity of family labor was negative, although not significant in either sample. The machinery coefficient was significant in the large farm sample but only at the .15 level. The sum of elasticities, although lower in the large farm sample, was not significantly different from one in either sample.

The R^2's of .822 and .786 for the area sample and large farm sample respectively were of the same magnitude as in previous models.

Again, the result of measuring the hired labor variable as total cost was to decrease the elasticity of acres and increase the elasticity of hired labor in the area sample. The effect was reversed in the large farm sample where the elasticities of acres and machinery increased and the elasticity of hired labor decreased. The sum of the elasticities changed only very slightly from Model I-B, where hired labor was measured as wage cost. In effect, the sum of the elasticities has been redistributed among the independent variables.

If there is any economic significance to the changing elasticities, the elasticity of hired labor increasing in the area sample, but decreasing in the large farm sample, it is that the value of perquisites is a smaller percentage of total labor cost for the small farms in the area sample. Practically all of the larger farms in both samples, but particularly in the large farm sample, had a significant perquisite cost. If the value of perquisites was not distributed evenly throughout the samples, changing elasticities would be expected. The changes that did occur would be consistent with the larger farms spending proportionately more on perquisites, such as housing, utilities and food items.

An alternative explanation is related to the intercorrelations among the independent variables. Although the intercorrelations are generally not as high in either sample as in Models I-A and I-B, they are still high enough to substantially affect the confidence one can place in the relative magnitudes of the elasticities. Again, the intercorrelations are higher in the area sample than they are in the large farm sample (see Appendix Table D-3).

Model II-C

In this model, the area sample observations were combined with the large farm sample observations. Hired labor was considered one variable and measured as total cost, including wages and perquisites. The elasticities or coefficients are shown in Table V.5 (see Appendix Table D-1 for complete statistical results).

Table V.5. Regression Coefficients or Elasticities for Model II-C, Hired Labor Measured as Total Cost.

Item	Resource				
	Acres	Machinery	Family Labor	Hired Labor	Sum of Elasticities
Elasticity	.354[xxx]	.175[xxx]	-.028	.354[xxx]	.988

[xxx]Significant at the .01 level.

An R^2 value of .827 was obtained and the elasticities of acres, machinery and hired labor were highly significant. The elasticity of family labor was negative, although not significantly different from zero at the .05 level. The sum of the elasticities, .988, was not significantly different from one, indicating approximately constant returns to scale.

Again, the intercorrelations were relatively high (see Appendix Table D-4).

Farms Subdivided by Type Fruit Farm

Since each farm deriving 100 percent of its sales from fruit was classified according to type fruit farm, it seemed desirable to estimate the elasticities and returns to size for as many different types of farms as degrees of freedom would allow. It was possible to estimate elasticities for cherry farms in the area sample and for both cherry and apple farms in the large farm sample. In addition, the cherry farms in both samples were combined and the apple farms in both samples were combined to provide estimates for all cherry and all apple farms. In all of the analyses by type farm, the hired labor was combined into one variable and measured as total cost, including both wages and perquisites.

Model III-A

This model is restricted to those farms that derive more than 50 percent of their fruit sales from the sale of cherries (either tart or sweet). The coefficients or elasticities and their level of significance are shown in Table V.6 (see Appendix Table D-1 for complete statistical results).

The R^2's were .846, .764 and .812 for the area sample, large farm sample and all cherry farms respectively. In the area sample, only the hired labor coefficient was significant at the .05 level. The sum of the elasticities of 1.39 was significantly larger than one at the .10 level. The hypothesis of constant returns to size is rejected, and increasing returns to size are indicated. In the large farm sample, the elasticity of hired labor was significant at the .01 level and near constant returns to size were indicated. When the cherry farms from both samples were combined, the elasticities of acres, machinery and hired labor were significant. The sum of the elasticities for all cherry farms of 1.08 was not significantly different from one at the .05 level. By coincidence the elasticities of machinery were the same for all cherry farms and for the large farm sample cherry farms.

Table V.6. Regression Coefficients or Elasticities for Model III-A, Cherry Farms.

Resource	Elasticities		
	Area Sample	Large Farm Sample	All Cherry Farms
Acres	.447^{x}	.212	.326^{xx}
Machinery	.593^{x}	.301^{x}	.301^{x}
Family Labor	.058	.008	.019
All Hired Labor	.290^{xx}	.515^{xxx}	.432^{xxx}
Sum of Elasticities	1.39[1]	1.04	1.08

^{xxx}Significant at the .01 level.

^{xx}Significant at the .05 level.

^{x}Significant at the .15 level.

[1]Significant at the .10 level, by F test.

The elasticity of both acres and machinery appeared substantially higher in the area sample than in the large farm sample or for all cherry farms combined. On the other hand, the elasticity of all hired labor appeared substantially lower in the area sample.

Intercorrelations remained high in this model although the size coefficient was significantly larger than one for the area sample cherry farms (see Appendix Table D-4). The hypothesis of constant returns to size was rejected for area sample cherry farms.

Model III-B

This model was limited to those farms that derive more than 50 percent of their fruit sales from apples.

There was a total of 46 apple farms, eight in the area sample and 38 in the large farm sample. Due to degrees of freedom restriction the analysis was completed only for the large farm sample apple farms and for all apple farms combined. In both analyses, hired labor was considered one variable and measured at total cost, including wages and perquisites.

The elasticities and levels of significance are shown below in Table V.7 (for more complete statistical results see Appendix Table D-1).

Table V.7. Regression Coefficients or Elasticities for Model III-B, Apple Farms.

Resource	Elasticities	
	Large Farm Sample	All Apple Farms
Acres	-.022	.137^{x}
Machinery	.046	.091
Family Labor	.028	-.018
All Hired Labor	.717^{xxx}	.665^{xxx}
Sum of Elasticities	.769[1]	.875[2]

^{xxx}Significant at the .01 level.

^{x}Significant at the .05-.15 level.

[1]Significant at the .01 level, by F test.

[2]Significant at the .10 level, by F test.

The R^2 values were .943 and .878 for the large apple farms and all apple farms respectively. In the large farm sample only the elasticity of hired labor was significantly different from zero. The sum of the elasticities of .769 was significantly different from one at the .01 level, indicating decreasing returns to size. When all apple farms were combined the elasticity of hired labor was highly significant and the elasticity of acres was significant at the .14 level. The family labor coefficient was negative, although neither it or the machinery coefficient were significantly different from zero. The sum of the elasticities of .875 was higher than for the large apple farms, but significantly less than one at the .10 level. Decreasing returns to size were indicated even when all apple farms were combined. The simple correlations for Model III-B are shown in Appendix Table D-5.

Depending on how size is measured, apple farms were generally larger than any other major type of farm. Only in gross sales (arithmetic mean) were apple farms smaller than cherry farms. The geometric mean of fruit sales, which is the relevant mean in this model, was over 25 percent higher for all apple farms than for all cherry farms. In all other measures of size, acres and levels of factor use, the apple farms were substantially larger than the cherry farms.

Farms Subdivided by Level of Hired Labor

Model IV

The farms in both samples that derived 100 percent of their sales from fruit were subgrouped into two categories, the 68 farms with a hired labor cost of less than $10,000, and the 66 farms with a hired labor cost of more than $10,000. The elasticities and levels of significance are shown in Table V.8 (for more complete statistical results see Appendix Table D-1).

Table V.8. Regression Coefficients or Elasticities for Model IV, Sample Farms Subgrouped by Level of Total Cost of Hired Labor.

Resource	Elasticity	
	Farms spending less than $10,000	Farms spending more than $10,000
Acres	.451xxx	.301xxx
Machinery	.109	.270xxx
Family Labor	-.140x	-.006
All Hired Labor	.405xxx	.258xxx
Sum of Elasticities	.825	.823[1]

xxxSignificant at the .01 level.

xSignificant at the .15 level.

[1]Significantly different from one at the .10 level, by F test.

The elasticities of both acres and hired labor were highly significant in both groups of farms. In addition, the elasticity of machinery was significant for those farms spending more than $10,000 for hired labor. The sum of the elasticities for the larger farms, as measured by hired labor, was significantly different from one at the .10 level. This means that unless a one in ten chance event has occurred that decreasing returns to size are indicated. The elasticities of both acres and hired labor appear substantially lower for the larger farms, while the elasticity of machinery appears to be significantly higher.

The R^2 values in this model of .658 and .580, for the area and large farm sample respectively are lower than for previous models. The intercorrelations between the independent variables were not as high as in previous models, particularly for the farms with more than $10,000 expenditure for hired labor (see Appendix Table D-5).

If expenditures for hired labor are considered as a measure of size then the hypothesis of constant returns to size is rejected for the largest group of farms. The indications are that decreasing returns to size prevail.

Farms Subgrouped by Level of Machinery Investment

Model V

All farms in both samples deriving 100 percent of their total sales from fruit were subgrouped by level of machinery investment into three groups: (1) 53 farms with less than $10,000 machinery investment, (2) 48 farms with $10,000 to $20,000 machinery investment, and (3) 33 farms with machinery investment of over $20,000. Hired labor was considered one variable and measured as total cost. The elasticities and levels of significance are shown in Table V.9 (for more complete statistical results see Appendix Table D-1).

For the farms with less than $10,000 in machinery investment, the coefficients of acres and hired labor were highly significant, while the machinery coefficient was significant at the .15 level. The sum of elasticities of 1.10 was not significantly different from one, indicating approximately constant returns to size. An R^2 value of .691 was obtained.

In the category of $10,000 to $20,000 machinery investment only the coefficient of hired labor was highly significant. Again, the sum of the coefficients was not significantly different from one.

For the farms with over $20,000 investment in machinery, the coefficient of both acres and hired labor was highly significant.

The sum of the elasticities was substantially smaller than in the other two categories, but was not significantly different from one at the .15 level. The hypothesis of constant returns to size cannot be rejected.

Table V.9. Regression Coefficients or Elasticities for Model V, Sample Farms Subgrouped by Level of Machinery Investment.

Resource	Elasticity		
	Farms with less than $10,000 investment	Farms with $10,000-$20,000 investment	Farms with less than $20,000 investment
Acres	.414^{xxx}	.333^{x}	.350^{xxx}
Machinery	.252^{x}	.119	.080
Family Labor	-.030	.034	-.192^{xx}[1]
All Hired Labor	.459^{xxx}	.495^{xxx}	.555^{xxx}
Sum of Elasticities	1.10	.981	.793

^{xxx}Significant at the .01 level.

^{xx}Significant at the .05 level.

^{x}Significant at the .15 level.

[1]Since a negative elasticity is economically irrational, i.e., that total sales would actually decrease with an increase in family labor, it appears that a one in 20 chance event has occurred.

Intercorrelations did not appear to be a problem in this analysis (see Appendix Table D-6).

Farms Subdivided by Acres of Bearing Fruit

<u>Model VI</u>

All farms deriving 100 percent of their sales from fruit were subgrouped into three categories based on their acreage of bearing fruit: (1) 36 farms with less than 50 acres, (2) 44 farms with 50-100 acres, and (3) 54 farms with over 100 acres of fruit. The elasticities and levels of significance are shown below in Table V.10 (see Appendix Table D-1 for more complete statistical results).

Table V.10. Regression Coefficients or Elasticities for Model VI, Sample Farms Subgrouped by Acreage of Bearing Fruit.

Resource	Elasticity		
	Farms with less than 50 acres	Farms with 50-100 acres	Farms with over 100 acres
Acres	.592[xxx]	.420	.436[xxx]
Machinery	.265[xxx]	-.052	.314[xxx]
Family Labor	-.038	.011	-.084
All Hired Labor	.373[xxx]	.697[xxx]	.368[xxx]
Sum of Elasticities	1.19	1.08	1.03

[xxx]Significant at the .01 level.

For the farms with less than 50 acres of bearing fruit the elasticities of acres, machinery and all hired labor were highly significant. The sum of the elasticities of 1.19 was not significantly different from one, indicating approximately constant returns to size.

The functional form used did not appear to fit the data for those farms with 50-100 acres of bearing fruit. An R^2 value of only .58 was obtained, and the coefficient of only hired labor was significant. Again, the sum of the elasticities of 1.08 was not significantly different from one.

The regression equation for the farms with over 100 acres of bearing fruit yielded an R^2 of .690 and highly significant coefficients for acres, machinery and all hired labor. The sum of the elasticities was not significantly different from one, indicating approximately constant return to size. When acres are considered as a measure of size, there does not appear to be any significant economics of size.

Intercorrelations did not appear to be a problem in this analysis (see Appendix Table D-7).

Farms Subgrouped by Special Harvest Equipment

Model VII

In an attempt to determine the impact of special harvest equipment, the farms were subgrouped into two categories, the 30 farms with cherry harvesters and the 104 farms without cherry harvesters. Ideally the levels of all inputs other than the one under consideration would be the same for both groups. This was impossible, since the farms with special harvest equipment had higher sales, larger acreages and used more hired labor. There were, however, larger differences in machinery investment between the two groups than for any other factor (see Appendix Table D-8 for simple correlations).

The elasticities and levels of significance are shown in Table V.11 (see Appendix Table D-1 for more complete statistical results).

The R^2 values for these two equations exceeded .82 and the elasticities of both acres and hired labor were highly significant. Only for the farms without the special harvest equipment was the elasticity of machinery significant. The sum of the coefficients was not significantly different from one for either group of farms.

The elasticity of acres was considerably higher for those farms with special harvest equipment, while the elasticities of machinery and hired labor were considerably higher for those farms without special harvest equipment. This is consistent with expectations, however, particularly if the harvest equipment was not used to capacity. This appeared to be the case in 1966, when there was a short cherry crop.

Table V.11. Regression Coefficients or Elasticities for Model VII, Farms Subgrouped by Special Harvest Equipment.

Resource	Elasticity	
	Farms with Special Harvest Equipment	Farms Without Special Harvest Equipment
Acres	$.620^{xxx}$	$.288^{xxx}$
Machinery	-.005	$.184^{xx}$
Family Labor	$-.010^{x}$	-.023
All Hired Labor	$.319^{xxx}$	$.552^{xxx}$
Sum of Elasticities	.924	1.00

^{xxx}Significant at the .01 level.

^{xx}Significant at the .05 level.

^{x}Significant at the .15 level.

Farms Subgrouped by Level of Total Fruit Sales

<u>Model VIII</u>

The level of total fruit sales was considered, a priori, as an appropriate measure of size. The farms were subgrouped into three sales categories: (1) 42 farms with less than $20,000 in fruit sales, (2) 46 farms with $20,000 to $50,000 in total sales, and (3) 46 farms with over $50,000 in sales. The results of this analysis were considered unreliable and are not reported here (for statistical results, see Appendix Table D-1). The R^2's for the three equations ranged from a low of .36 to a high of .69. More damaging, however, were the very low sum of elasticities found for all groups. It was concluded that sales were not an appropriate measure of size.

Farms Subgrouped by Level of Off-Farm Work

Model IX

Since one of the most consistent things in the analysis has been the negative elasticity of family labor, an attempt was made to determine if the elasticity of family labor might be different on those farms where the operator works off-farm. The farms from both samples were divided into two groups: (1) 30 farms with the operator working off-farm more than 75 days, and (2) the 104 farms with the operator working off-farm less than 75 days or not at all. The elasticities and levels of significance are shown in Table V.12 (for complete statistical results see Appendix Table D-1).

Table V.12. Regression Coefficients or Elasticities for Model IX, Farms Subgrouped by Level of Off-Farm Work of the Operator.

Resource	Elasticity	
	Operator Works Off-farm more than 75 days	Operator Works Off-farm less than 75 days
Acres	.469[xxx]	.304[xxx]
Machinery	.178	.183[xx]
Family Labor	-.005	-.031
All Hired Labor	.463[xxx]	.500[xxx]
Sum of Elasticities	1.10	.956

[xxx]Significant at the .01 level.

[xx]Significant at the .05 level.

There was essentially no significant difference in the elasticity of family labor between the two groups. In both cases the elasticity was negative but not significantly different from zero. The level of family labor input (geometric mean) was substantially different for the two groups, 1,622 hours for the farms with the operator working off-farm more than 75 days, compared to 2,690 hours for the remaining farms. Unfortunately, the level of other inputs were also substantially different for the two groups of farms. In any case, however, the elasticity of family labor appears to be near zero, regardless of the basis for subgrouping the farms.

Summary

The major purpose of this chapter was to estimate parameters such as resource elasticities and size coefficients that would be useful in suggesting farm adjustment potentials. A Cobb-Douglas type function was used to estimate the parameters.

While there were differences in resource elasticities between the area and large farm samples, near constant returns to size were indicated for both samples. Without exception, the elasticity of bearing acres was higher for the area sample farms while the elasticity of all hired labor was generally higher in the large farm sample although not by much. The elasticity of machinery was near zero in the area sample, but positive and significantly different from zero in the large farm sample. Without exception the elasticity of family labor was negative in both samples, although not significantly different from zero. The model appeared to fit the data reasonably well with R^2 values generally exceeding .80.

When the farms were subgrouped by type of fruit farm, increasing returns to size were indicated for the area sample cherry farms while decreasing returns to size were indicated for the large farm sample apple farms and for all apple farms. Degrees of freedom restrictions prevented an analysis of other types of farms.

When the farms from both samples were subgrouped on the basis of factor use, decreasing returns to size were indicated only when the level of hired labor was used as a measure of size. When machinery investment and acres of fruit were used as measures of size, the hypothesis of constant returns to size could not be rejected.

There were substantial differences in elasticities between the farms with and without cherry harvesters (Model VII). The elasticity of acres was substantially higher for the farms with harvesters, while the machinery and all hired labor elasticities were considerably higher for the farms without harvesters. Constant returns to size were indicated for both groups of farms.

The elasticity of family labor was approximately zero in all of the models including Model IX. Even for the farms with the operator working off-farm more than 75 days, the elasticity of family labor was negative although not significantly different from zero.

CHAPTER VI

IMPLICATIONS OF THE FUNCTIONAL ANALYSIS

The purpose of this chapter is to integrate the results of the statistical analysis and examine in more detail the returns to factors of production and the rates of factor substitution. Tentative conclusions with respect to resource adjustment potentials are drawn and the impacts of increased labor costs and mechanization on future labor use patterns are assessed. The general procedure in this chapter is to examine the resource mix on the different types of farms in the analysis and note adjustments that might profitably be made by individual growers. In addition the scale or size adjustment potentials are examined. Resource use is first examined for the area sample and for the large farm sample growers. Particular attention is given to differences in adjustment potentials of the two samples. The same relationships are then examined by type of fruit farm and by the alternative measures of size.

It should be pointed out that any adjustment potentials in either factor proportions or size are applicable only to the "average grower" and do not take into account the aggregate effect.[19]

[19]Adjustments in the use of agricultural resources that appear to be profitable for an individual grower may not be profitable if a large group of growers producing a given product make similar adjustments. If many growers make output increasing adjustments, total output may be increased to the extent that the increased supply results in lower prices for all growers producing the product. Lower product prices will change the relative profitability of resource adjustments. Depending on the elasticity of demand for the product, the total industry revenue from the product might be reduced as a result of the increased supply.

Although resource adjustments can be suggested from elasticities, it is often more meaningful to compare the marginal value products (MVP) of the various resources. In the absence of capital rationing, resources are combined optimally when the ratio of MVP to marginal factor cost (MFC) is equal for all resources and equal to one. This condition is as follows:

$$\frac{MVP_{xi}}{MFC_{xi}} = 1, \text{ for all } i.$$

In the case of the Cobb-Douglas model and when the independent variable is measured as value of output, the MVP_{xi} is simply the elasticity of X_i, multiplied by the ratio $\frac{\hat{Y}}{X_i}$. It is thus possible to evaluate the MVP_{xi} at different levels of X_i. In the analysis that follows the MVP's are generally evaluated at the geometric means of the X_i, since this is where the standard error of the estimate is minimum.

MVP's were computed only for those resources with positive regression coefficients or elasticities. The MVP's in parentheses were computed from regression coefficients that were not significant at the .15 level, with the significance of the regression coefficients noted for those MVP's. In no case was an MVP computed for a resource with a negative coefficient. A negative coefficient means a negative MVP, which by definition is outside the range of rational economic use. It is hardly conceivable that the addition of one more unit of family labor, for example, would actually cause total fruit sales to decrease; and this is the implication of a negative MVP. It is assumed, therefore, that the negative elasticities are approximately equal to zero.

Adjustments on Area and Large Farm Sample Farms

Table VI.1 shows the MVP's and average quantities of inputs for Model I-A (hired labor measured as wage cost and by type of hired labor). The MVP's in Table VI.1 are evaluated at the arithmetic mean level of inputs. This was considered necessary since several of the farms did not employ any regular or seasonal hired labor, but because this model allows no zero level observations, they were assigned a level of one. With several observations close to zero and the remainder a substantial size, the geometric mean was substantially less than the arithmetic mean. Computing the MVP's at the geometric mean would have yielded unrealistically high MVP's for the variables with a low geometric mean.

The MVP of an acre of bearing fruit of $211 in the area sample indicates that at the mean levels of inputs, an additional acre of fruit would increase fruit sales by $211. Since the MVP, in this context, represents an annual return, the added value of an additional acre of fruit would be determined by capitalizing the $211, less any fixed costs such as taxes, at an appropriate rate of interest for an appropriate number of years. For example, if the expected productive life of a fruit orchard is 15 years and the opportunity cost of capital is 8 percent, the present value of an annual return of $211 would be $1,806.[20] If the $211 annual return is adjusted downward to take

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[20]The present value of an annuity of 1 per period is given by the formula

$$a = \frac{1 - (1 \text{ plus } i)^{-n}}{i}$$

Table VI.1. Marginal Value Products and Average Quantities of Inputs and Gross Sales, Model I-A, Hired Labor Measured as Wage Cost.

Item	Gross Fruit Sales	Bearing Acres	Machinery	Family Labor	Regular Labor	Seasonal Labor	Harvest Labor
	(Dollars Per Unit of Input)						
	Area Sample						
Average MVP for 48 farms (Evaluated at arithmetic means)		211	$(.21)^{.62}$	0	0	$(3.82)^{.79}$	2.17
Means of inputs and gross sales (48 farms)							
Geometric	9,792	32.47	5,699	2,113	10	22	1,547
Arithmetic	20,714	46.10	7,447	2,734	1,014	534	4,478
	Large Farm Sample						
Average MVP for 95 farms (Evaluated at arithmetic means)		131	.50	0	7.66	0	2.61
Means of inputs and gross sales (95 farms)							
Geometric	41,307	90	14,169	2,448	124	161	7,494
Arithmetic	54,102	110	17,566	3,113	2,930	1,269	11,125

account of taxes and other fixed costs associated with owning fruit acreage, the present value of an additional acre of fruit is reduced accordingly. If fixed costs amounted to $25 per acre, for example, the annual return would be $186, and the present value of an additional acre of fruit would be $1,592.

The MVP's of machinery and seasonal labor are both positive although there is little confidence that the regression coefficients from which they were computed are different from zero (see Table VI.1).

The MVP of harvest labor indicated than an additional dollar spent on harvest labor wages would return the grower $2.17. The $2.17 is not a return per hour but per dollar spent on wages. While there are additional costs associated with harvest workers such as housing and transportation, the $2.17 return represents a 217 percent return on wage expenditures.

Since the MVP of family labor is approximately equal to zero, for the ratio of MVP/MFC to equal one, the MFC must also be approximately equal to zero. This is probably not as unrealistic as it may appear, particularly for those growers with no alternative source of income. This would even more likely be true for a particular period of time rather than over time. If in fact the MFC approaches zero, then family labor could profitably be employed up to the point where the MVP approached zero. This, in turn, implies that other resources should also be used up to the point where MVP/MFC is equal to one. In the case of hired labor, this is where the MVP of a dollar expenditure is equal to $1. Since it is impossible to estimate very accurately the MFC of machinery investment and acres of bearing fruit, only the more tentative kinds of adjustments can be suggested, and then only in direction, not magnitude.

Preliminary indications are that area sample growers could probably increase their gross returns by increasing their fruit acreage and harvest labor relative to other inputs. The extent to which acreage and harvest labor could be increased relative to other inputs depends on the existing use of other inputs and the complementary relationships that exist among inputs.

In the large farm sample, the MVP of an acre of orchard was $131, considerably less than in the area sample (see Table VI.1). If $131 were capitalized without adjusting for fixed costs an additional acre of fruit would have a value of $1,121 to the large farm growers.

The MVP of machinery investment was 50 cents for the large growers, indicating that for an additional dollar invested in machinery, an annual return of 50 cents would be available to cover depreciation, interest, insurance and operating expense. Since the machinery variable is a heterogeneous one, no definite statements can be made regarding the adequacy of the return, although for most types of machinery, this return would probably more than cover additional expenses.

The MVP of regular hired labor is quite high, $7.66 for each dollar spent on wage cost, and reflects the fact that growers either employed essentially no regular hired labor or a substantial quantity. The MVP of harvest labor of $2.61 is also quite high. Since the coefficient of seasonal labor was negative, it is the opinion of the author that the classification of workers, ex post facto, was in part responsible for the substantial differences in MVP's of the different types of labor.

Tentative conclusions appear to be that the area sample growers could profitably increase their acreage and harvest labor wage bill. They appear to have sufficient and perhaps too much machinery as well as all kinds of labor except harvest. The large growers would not get as high a return on additional acres, but might increase their returns by investing in additional machinery and hiring more regular and harvest workers. Since the size coefficient or sum of elasticities was not significantly different from one in either sample, no size adjustments are suggested on the basis of Model I-A.

The MVP's and mean levels of factors are shown in Table VI.2, for Model I-B, where hired labor was considered one variable.

In the area sample, the MVP of an acre of orchard was $193 and, capitalized as before, indicates that the value of an additional acre would be $1,652. The MVP for all hired labor of $2.11 was quite high. The MVP's of both machinery and family labor were considered to be approximately zero.

In the large farm sample, the MVP of an acre of orchard was $118, indicating that the value of an additional acre would be $1,010. The MVP of machinery of 53 cents appears adequate to cover expenses for most types of machinery. All hired labor was returning, on the average, $1.98 for each dollar spent on wage bills.

Based on the wage cost of labor, it appears that the area sample growers could profitably expand their acreage and increase hired labor use relative to the large growers. On the other hand, the large farm growers are getting a positive return on machinery investment, probably more than enough to cover expenses, while the area sample growers did

Table VI.2. Marginal Value Products and Average Quantities of Inputs and Gross Sales, Model I-B, All Hired Labor One Variable Measured as Wage Cost.

Item	Gross Fruit Sales	Bearing Acres	Machinery	Family Labor	All Hired Labor
	(Dollars Per Unit of Input)				
	Area Sample				
Average MVP for 48 farms (Evaluated at geometric means)		193	0	0	2.11
Means of inputs and gross sales (48 farms)					
Geometric	9,792	34	5,699	2,113	2,070
Arithmetic	20,714	46	7,447	2,734	6,025
	Large Farm Sample				
Average MVP for 95 farms (Evaluated at geometric means)		118	.53	0	1.98
Means of inputs and gross sales (95 farms)					
Geometric	41,307	90	14,169	2,448	10,443
Arithmetic	54,102	110	17,566	3,113	15,324

not receive a positive return. In effect, this means a negative return to additional machinery for the area sample growers since there will be some costs involved in owning and operating the machinery. The area sample farms, thus, appear to have too much machinery for their acreage of fruit. Again, no size adjustments can be suggested from the size coefficients or sum of the elasticities.

It did not appear that the classification of hired labor by type was particularly useful in examining resource use adjustments for two reasons. First, only for harvest labor was a significant coefficient obtained for both samples; and second, harvest labor clearly dominates hired labor use. For these reasons, MVP's were not computed for Model II-A but are shown for Model II-B in Table VI.3.

Including the value of perquisites in the labor variable had the expected effect of increasing slightly the MVP of acres and decreasing the MVP of hired labor. The MVP's in Table VI.3 generally support the conclusions reached earlier; area sample growers could probably increase their returns by expanding acreage and increasing the use of hired labor and that they have too much machinery for their present fruit acreage. It would appear profitable for the large farm growers to increase their machinery investment and hired labor use.

In an attempt to determine the machinery-labor substitution possibilities, the different combinations of machinery investment and hired labor cost required to produce the mean level of fruit sales were computed for the 95 farms in the large farm sample. These combinations are shown in columns 1 and 2 of Table VI.4 and essentially represent points on an isoquant. While all of the points are well within the range of the data, more confidence can be placed in the estimates

Table VI.3. Marginal Value Products and Average Quantities of Inputs and Gross Sales, Model II-B, All Hired Labor One Variable Measured as Total Cost.

Item	Gross Fruit Sales	Bearing Acres	Machinery	Family Labor	All Hired Labor
	(Dollars Per Unit of Input)				
	Area Sample				
Average MVP for 39 farms (Evaluated at geometric means)		220	0	0	1.75
Means of inputs and gross sales (39 farms)					
Geometric	17,602	45	7,328	2,293	5,130
Arithmetic	25,131	54	8,442	2,949	8,227
	Large Farm Sample				
Average MVP for 95 farms (Evaluated at geometric means)		121	.54	0	1.71
Means of inputs and gross sales (95 farms)					
Geometric	41,307	90	14,169	2,448	11,607
Arithmetic	54,102	110	17,566	3,113	17,485

nearest the geometric mean. The figures indicate that \$41,307 in fruit sales can be produced with \$14,000 in machinery investment and a \$11,770 expenditure for hired labor, with other inputs at their mean levels. If machinery investment is increased by \$2,000, the required expenditure for hired labor is reduced by \$600. Column 3 of Table VI.4 shows the average rate of substitution between machinery and labor, when the level of machinery is changed by \$2,000. The rate of substitution has a negative sign, but it is omitted for convenience. The average rate of substitution of machinery investment for hired labor declined over the range of the data, i.e., as the level of machinery investment increases the amount of hired labor replaced declines.

Column 5 of Table VI.4 indicates the value of labor that is replaced by each \$2,000 increase in machinery investment. Since this value is a direct function of the average rate of substitution, it also declines throughout the range of the data. The importance of the value of labor replaced is not that it decreases, but that if the cost of machinery investment were known, the optimum combination of the two resources could be determined. If it is assumed that growers need at least a 25 percent return on machinery investment to cover costs, then it would not pay to increase machinery investment beyond \$16,000.[21] While the 25 percent cost figure is an arbitrary one,

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[21]The last (marginal) increase in machinery investment of \$2,000 decreased labor costs by \$600. If there was an annual ownership cost of 25 percent associated with machinery investment, then the \$2,000 investment cost the grower \$500, but \$600 in labor was replaced, a profitable adjustment. If an additional \$2,000 were invested in machinery, up to a total of \$18,000, the annual cost would remain \$500, but only \$440 of labor would be replaced, an unprofitable adjustment. If all resources were perfectly divisible, the growers would continue

Table VI.4. Mean Isoquant and Average Rates of Substitution for Machinery Investment and Hired Labor in Fruit Production, 95 Large Farm Sample Farms.

Isoquant (Combination of Machinery Investment and Hired Labor) to Produce Average Fruit Sales of $41,307		Average Rate of Substitution, Machinery Investment for Hired Labor	Value of Labor Replaced by $2,000 Machinery Investment	
Input of Machinery	Hired Labor in Dollars		1966 Wages	50 Percent Greater Than 1966
(1)	(2)	(3)	(4)	(5)
$8,000	$14,620			
		.615	$1,230	$1,845
10,000	13,390			
		.455	910	1,365
12,000	12,480			
		.355	710	1,065
14,000	11,770			
		.300	600	900
16,000	11,170			
		.240	440	660
18,000	10,690			
		.210	420	630
20,000	10,270			
		.135	270	405
22,000	10,000			

it does not appear to be unreasonable. The cost of machinery investment will vary depending on the system of machinery, but on general farms, an annual ownership cost of 20 percent is generally considered adequate. Since fruit farms generally have a higher proportion of a specialized harvest equipment, which has a relatively short depreciation period, plus other specialized equipment, increasing the annual ownership cost to 25 percent seemed appropriate. To determine the exact optimum combination of machinery and hired labor, the marginal rate of substitution of machinery for labor must be equated to the inverse price ratio. If, as assumed, the cost of machinery is 25 percent of investment, and the cost of hired labor is $1 then the inverse price ratio is .25. From column 3 of Table VI.4, the average rate of substitution is .24 between $16,000 and $18,000 of machinery investment. Thus the optimum level of machinery is somewhere between $16,000 and $18,000. This is the optimum level of machinery investment for the fixed level of fruit sales, $41,307, but says nothing about the optimum level of output. A partial indication of optimum level of output is the absence of any significant returns to size. If there are no increasing or decreasing returns to size, then there is no single discrete optimum output level. If the right combination of resources is used, one level of output is as profitable as any other.

Column 5 of Table VI.4 indicates the value of labor replaced by $2,000 in machinery investment if the price of labor were 50 percent

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to invest in machinery until the added costs were just offset by the decrease in labor costs. It should be pointed out that these resource adjustments refer only to adjustments for a given output level, and say nothing about the most profitable level of output.

higher than in 1966. If the price of labor increased by 50 percent and the ownership cost of machinery remained at the 1966 level, then the optimum level of machinery investment would increase to between $20,000 and $22,000. While this represents an increase in machinery investment of almost 25 percent, the level of labor use has decreased by less than 10 percent. This is only another indication of how critical hired labor is to a successful fruit operation.

To summarize, it appears that the area sample farms could profitably expand their fruit acreage and level of hired labor use with levels of other factor use unchanged. The area sample growers appear to have too much machinery investment for their fruit acreage. If fruit acreage is not increased, then it would appear profitable to sell some machinery and do more leasing or custom hiring where necessary. Successful custom hiring depends on timeliness of the operation, however, and the time factor could limit a major expansion in custom hiring. The analysis indicates that the large farm growers could profitably expand their machinery investment and use of hired labor. Both resources appear to be used at less than optimum levels. The general impact of a 50 percent increase in the cost of hired labor would make machinery investment even more profitable. The optimum level of machinery investment would increase by about 25 percent, while the level of labor expenditures would decrease by approximately 10 percent.

Adjustments by Type of Fruit Farm

Cherry Farms

Model III-A indicated that the hypothesis of constant returns to size could be rejected at the .10 level for the area sample cherry farms and that increasing returns to size were evident. The MVP's of the factors in Table VI.5 are consistent with increasing returns to size.

In the area sample, the MVP of an acre of fruit of $208 is equivalent to $1,780 present value without adjustment for fixed costs. The MVP of machinery at $1.77 per dollar investment is the highest return to machinery of any group of farms. It may be recalled that cherry harvesters were the only kind of special harvesting equipment found in any significant quantity, and four of the area sample farms had cherry harvesters. The MVP of hired labor of $1.11 per dollar expenditure is considerably lower than in other models. While the MVP of family labor is positive, there is little confidence that the coefficient from which it was computed is different from zero.

These relatively high returns to the individual factors are consistent with the indications of increasing returns to size. It appears that the area sample cherry growers could profitably increase the size of their operation, that is, increase the use of all factors in the same proportion, and that further profitable adjustments could be made in factor proportions, increasing machinery investment and acres relative to labor use. Again, these adjustments do not take into account the aggregate effect. If all producers made similar adjustments, increased supplies would likely decrease product prices and make the adjustments less profitable. Attention is also called to the prices used in the analysis in Appendix Table B-1. Cherry prices were quite high in 1966 and lower cherry prices would reduce considerably the estimated returns to factors.

Table VI.5. Marginal Value Products and Average Quantities of Inputs and Gross Sales, Model III-A, Cherry Farms.

Item	Gross Sales	Bearing Acres	Machinery	Family Labor	All Hired Labor
Area Sample Cherry Farms					
Average MVP for 21 farms (Evaluated at geometric means)		208	1.77	$(.70)^{.53}$	1.11
Means of inputs and gross sales (21 farms) Geometric	19,961	43	6,682	1,645	5,194
Large Farm Sample Cherry Farms					
Average MVP for 33 farms (Evaluated at geometric means)		105	.92	$(.16)^{.94}$	1.77
Means of inputs and gross sales (33 farms) Geometric	41,473	84	13,628	2,225	12,036
All Cherry Farms					
Average MVP for 54 farms (Evaluated at geometric means)		158	.91	$(.30)^{.79}$	1.55
Means of inputs and gross sales (54 farms) Geometric	31,208	65	10,329	1,978	8,681

An interesting contrast is found among the large farm sample cherry farms where the MVP of acres at $105 per acre is substantially below that found in the area sample, but represents an unadjusted present value of $899, capitalized as in previous models. The average acreage is also much higher in the large farm sample, 84 acres compared to 43. The return to machinery investment of 92 cents is less than in the area sample, while the MVP of labor is substantially larger, $1.77 compared to $1.11. The increase in the MVP of hired labor is even more significant, since on the average, more than twice as much labor was employed in the large farm sample. The average machinery investment is also twice as large in the large farm sample. The indications are that the large cherry farms could profitably increase machinery investment and hired labor relative to other factors.[22] Again, it should be pointed out that the MVP's are calculated for one point on the production surface, the geometric mean levels of all variables. The MVP's thus computed are averages for the sample.

The MVP's of all cherry farms indicate a relatively high return to machinery investment and to hired labor. Since only for all cherry farms combined were the elasticities of both machinery and labor

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[22] It may appear inconsistent to suggest that both machinery investment and hired labor expenditures could profitably be expanded when one considers that a self-propelled cherry harvester can replace 40-70 hand pickers. In the first place, this aggregate analysis does not permit a distinction between items of machinery; what is suggested is that an increase in machinery investment of the same make-up as found on the farms in 1966 would be profitable. In the second place, there may not have been enough expenditure on hired labor to start with. Perhaps more hired labor should be substituted for family labor. Furthermore, if the factors are complementary, the MVP of labor would be expected to increase as machinery investment is increased. In addition it should be pointed out that even though the farms are classified as cherry farms, other fruit enterprises are found on the farm.

significant at .05 level, the rates of factor substitution were computed only for this group. Columns 1 and 2 of Table VI.6 indicate the different combinations of machinery investment and hired labor expenditure that would be required to produce $31,208 in gross sales. Column 3 shows the average rate of substitution of machinery for labor which is negative and decreasing throughout the range of the data (the minus sign is omitted for convenience). Column 4 is the value of labor replaced by $1,000 of machinery investment at the 1966 wage rate and is the average rate of substitution multiplied by $1,000.

If it is again assumed that the annual ownership cost of machinery is 25 percent per dollar investment, then cherry growers could profitably increase their machinery investment up to around $17,000. This would represent an increase in machinery investment of almost 70 percent. This would, in turn, reduce the labor input by about 30 percent. In theory, machinery investment should be increased up to the point where the added cost of the machinery is just offset by the value of labor replaced by the machinery. Since exact costs of machinery investment are not available, and would be impossible to obtain for such a heterogeneous category, pointing out the direction of movement in factor use is as much as can legitimately be done. Column 5 indicates the value of labor replaced by machinery investment if wages are 50 percent greater than in 1966, while other costs remain constant. As expected, this has the effect of making additional machinery investment profitable.

Again, it should be pointed out that these data only represent the 54 cherry farms and are averages for these farms. Even so, it appears that increases in size, particularly among the smaller growers,

Table VI.6. Mean Isoquant and Average Rates of Substitution for Machinery Investment and Hired Labor in Fruit Production, 54 Cherry Farms.

Isoquant (Combination of Machinery Investment and Hired Labor) to Produce Average Fruit Sales of $31,208		Average Rate of Substitution, Machinery Investment for Hired Labor	Value of Labor Replaced by $1,000 Machinery Investment	
Input of Machinery	Input of Hired Labor		1966 Wages	50 Percent Greater Than 1966
$7,086	$11,285			
		1.005	$1,006	$1,509
7,949	10,417			
		.820	820	1,230
9,008	9,549			
		.657	657	986
10,329	8,681			
		.514	514	771
12,017	7,813			
		.392	392	588
14,233	6,945			
		.288	288	432
17,243	6,076			
		.203	203	304
21,517	5,208			

is a strong possibility in the years ahead. It would appear to be profitable to increase the size of operation and at the same time increase machinery investment relative to other factors. To make more definite statements regarding adjustment potentials, more information is needed on the costs of the machinery investment and what type machinery is most profitable, although on this latter point it is commonly assumed that cherry harvesters with a large labor replacing potential are the most profitable type.

It seems appropriate at this point to consider Model VII, where the farms were subgrouped on the basis of having a cherry harvester. It may be recalled from Table V.11 that the elasticity of acres was quite high for the farms with cherry harvesters, but the elasticity of machinery was not significantly different from zero. Approximately constant returns to size were indicated for both groups of farms. The MVP's and average quantities of inputs are shown in Table VI.7.

As expected, the MVP of machinery was substantially lower for those farms with cherry harvesters (approaching zero) than for the farms without cherry harvesters. This decrease in the MVP of machinery is consistent not only with theory, but with the practical fact that the farms with cherry harvesters had more than twice the machinery investment as the farms without harvesters. Normally one would expect the addition of harvesters to increase the MVP of labor, whereas the MVP of labor for farms with harvesters is lower than for farms without harvesters. This is not difficult to rationalize, however, when considering the mean levels of the inputs as well as gross sales.

Table VI.7. Marginal Value Products and Average Quantities of Inputs and Gross Sales for 134 Sample Farms, Subgrouped by Special Harvest Equipment.

Item	Gross Sales	Bearing Acres	Machinery	Family Labor	All Hired Labor
Farms With Special Harvest Equipment					
Average MVP for 30 farms (Evaluated at geometric means)		282	0	0	1.27
Means of inputs and gross sales (30 farms)					
Geometric	46,227	102	20,661	2,398	11,576
Farms Without Special Harvest Equipment					
Average MVP for 104 farms (Evaluated at geometric means)		125	.54	0	1.87
Means of inputs and gross sales (104 farms)					
Geometric	29,040	67	9,926	2,403	8,552

The farms with harvesters are much larger farms by any measure of size other than family labor. The smallest difference between samples is in the hired labor input, indicating that cherry harvesters do replace a substantial quantity of labor.

The indications are that the farms with harvesters could profitably increase their acreage and hired labor use, with existing levels of machinery investment. This is not inconsistent when it is realized that fruit enterprises other than cherries are being grown, and that in some cases cherries do not account for as much as 50 percent of total fruit sales. The very high MVP of acres, equivalent to $2,414 present value indicates not only that acreage could be expanded, but that the machinery on the farm was more than adequate for the number of acres.

For the 104 farms without cherry harvesters, the MVP's in Table VI.7 indicate that machinery investment could profitably be increased and that if machinery and other inputs were held constant, increased hired labor use would be profitable.

To summarize, it appears that increasing returns to size prevail for the area sample cherry farms. In addition to increasing the use of all factors, it would appear profitable to increase machinery investment and acres relative to hired labor. For the large farm sample cherry farms, increases in machinery investment and hired labor would appear profitable. Depending on the market price of fruit acreage and the fixed costs associated with fruit acreage, expansion of acreage could be profitable for the large farm sample cherry farms.

Apple Farms

It will be recalled from Model III-B that decreasing returns to size were indicated for the large farm apple farms and for all apple farms combined, and that apple farms were generally the largest farms of any type by almost any measure of size. For the large farm apple farms, only the elasticity of hired labor was significantly different from zero at the .15 level. The elasticity of machinery and family labor was positive, but there is little confidence that they are positive. For all apple farms combined, the elasticities of acres and hired labor were significant.

The marginal value products and mean levels of inputs and gross sales are shown in Table VI.8.

The MVP of hired labor of $2.70 is the highest found in any analysis included in this study, but this is also the only analysis where significant decreasing returns to size were in evidence. Apparently, because of the relatively large acreage and the high machinery investment, the productivity of hired labor is quite high. Of the two adjustment possibilities, increasing hired labor or decreasing the size of the operation, the latter possibility appears most attractive, particularly since other factors not included in the analysis, such as management, might be limitational factors, and because labor is relatively scarce.

The same general picture was in evidence for all apple farms combined. The MVP of an acre of bearing fruit was $58 per year, probably not enough to enable growers to expand their acreage. In fact, it appears that several acres could be sold before the capitalized value of the annual return would be as high as the market price of

Table VI.8. Marginal Value Products and Average Quantities of Inputs and Gross Sales for Apple Farms.

Item	Gross Sales	Bearing Acres	Machinery	Family Labor	All Hired Labor
Large Farm Sample Apple Farms					
Average MVP for 38 apple farms (Evaluated at geometric means)		0	$(.13)^{.40}$	$(.54)^{.22}$	2.70
Means of inputs and gross sales (38 farms)					
Geometric	44,068	103	15,429	2,310	11,713
All Apple Farms					
Average MVP for 46 apple farms (Evaluated at geometric means)		58	$(.25)^{.26}$	0	2.35
Means of inputs and gross sales (46 farms)					
Geometric	39,228	92	14,083	2,541	11,117

an acre of bearing fruit. The MVP of hired labor remains quite high, and so do the mean levels of inputs and gross sales. A reduction in size of operation would appear to be a profitable adjustment for the 46 apple farms considered in this analysis.

Adjustments Under Alternative Measures of Size

Hired Labor as a Measure of Size -- Model IV

The farms were subdivided into two groups, the 68 farms with a hired labor cost of less than $10,000 and the 68 farms with a hired labor cost of more than $10,000. Model IV indicated decreasing returns to size for the largest group of farms as measured by level of hired labor use.

Table VI.9 shows the MVP's and the mean levels of the variables for Model IV. With the exception of family labor, the means of the variables for the large farms were more than twice the size of the smaller farms with very large differences in the level of fruit sales and expenditures for hired labor.

The MVP's for the smaller farms appear to be reasonable, and little can be said regarding adjustment potential. On the other hand, even with the restrictions imposed by theoretical considerations, it appears that the large farms are using hired labor beyond the economic optimum. The MVP of .78 indicates that an additional dollar spent for hired labor at the mean level will return the grower 78 cents in additional product. Clearly, too much labor is being used relative to other factors of production. The MVP of machinery is fairly high and at .97 per dollar invested indicates positive returns to machinery investment.

Table VI.9. **Marginal Value Products and Average Quantities of Inputs and Gross Sales, Model IV, Farms Subgrouped by Level of Hired Labor.**

Item	Gross Sales	Bearing Acres	Machinery	Family Labor	All Hired Labor
Farms with less than $10,000 Hired Labor					
Average MVP for 68 farms (Evaluated at geometric means)		155	(.23)[.24]	0	1.69
Means of inputs and gross sales (68 farms) Geometric	16,777	49	7,907	2,264	4,028
Farms with more than $10,000 Hired Labor					
Average MVP for 66 farms (Evaluated at geometric means)		170	.97	0	.78
Means of inputs and gross sales (66 farms) Geometric	63,139	112	17,505	2,553	20,822

If level of hired labor is considered as a measure of size, then it appears that decreasing returns to size exist for the larger farms. The least that can be said is that too much hired labor is being used relative to other factors; and when hired labor is considered a measure of size, this is equivalent to saying that size should be reduced. Substituting machinery investment for hired labor would appear to be a profitable adjustment.

Machinery Investment as a Measure of Size -- Model V

The marginal value products and mean levels of the variables are shown in Table VI.10. Only for the farms with less than $10,000 machinery investment was the MVP of machinery computed from a significant regression coefficient. At $.75 per dollar investment it represents a fairly high return and additional machinery investment appears profitable. The MVP of machinery is smaller for each larger group of farms, even though they are less reliable estimates. The MVP's of bearing acres are highest for the largest farms. For all three groups, the MVP of hired labor exceeds $1.60.

In the absence of any significant returns to size, little can be said regarding adjustment potentials, although it does not appear that the larger farms, as measured by machinery investment, should increase their investment. In fact, they appear to have sufficient machinery to handle more acres and more hired labor. More hired labor would appear to be profitable for all three groups of farms.

Acres of Bearing Fruit as a Measure of Size -- Model VI

In Model VI, the farms were subgrouped into three categories based on acres of fruit, less than 50 acres, 50 to 100 acres and over

Table VI.10. Marginal Value Products and Average Quantities of Inputs and Gross Sales for Model V, Farms Subgrouped by Level of Machinery Investment.

Item	Gross Sales	Bearing Acres	Machinery	Family Labor	All Hired Labor
Farms with less than $10,000 Investment					
Average MVP for 53 farms (Evaluated at geometric means)		159	.75	0	1.76
Means of inputs and gross sales (53 farms) Geometric	17,192	45	5,786	1,937	4,479
Farms with $10,000 - $20,000 Investment					
Average MVP for 48 farms (Evaluated at geometric means)		149	$(.32)^{.69}$	$(.50)^{.64}$	1.63
Means of inputs and gross sales (48 farms) Geometric	33,318	83	13,681	2,586	11,341
Farms with more than $20,000 Investment					
Average MVP for 33 farms (Evaluated at geometric means)		184	$(.20)^{.71}$	0	1.88
Means of inputs and gross sales (33 farms) Geometric	71,413	136	28,824	3,049	21,104

100 acres. Only for the smallest and the largest groups of farms were the elasticities of acres, machinery and hired labor significant.

Marginal value products and mean levels of variables are shown in Table VI.11.

The smallest group of farms, those with less than 50 acres, appeared to be getting a fairly high return on all resources except family labor, where the MVP approached zero. The MVP of an acre of bearing fruit was $258; and when capitalized at 8 percent for 15 years represents $2,209 present value. The MVP of machinery investment of $.51 is probably more than enough to cover ownership costs. Hired labor contributes $1.41 for an additional one dollar spent for hired labor. Profitable adjustments appear to include increasing acres of fruit and expanding hired labor use.

An expansion of acreage and hired labor appears to be a profitable adjustment for the second largest group of farms. With the MVP of machinery approximately zero, machinery investment appears adequate for additional acres and hired labor.

For the largest group of farms, those with over 100 acres of fruit, the MVP of an acre of bearing fruit was $183, substantially below that found for the smallest farms but representing a present value of $1,566. The MVP of machinery investment of $1.02 is high enough to warrant increased machinery investment. Hired labor had an MVP of $1.21, lower than for the smaller farms. Expansion of all inputs other than family labor appears to be profitable.

When acres of bearing fruit are used as a measure of size, there does not appear to be any significant economies of size within the

Table VI.11. Marginal Value Products and Average Quantities of Inputs and Gross Sales for 134 Sample Farms, Subgrouped by Acreage of Bearing Fruit.

Item	Gross Sales	Bearing Acres	Machinery	Family Labor	All Hired Labor
Farms with less than 50 Acres Bearing Fruit					
Average MVP for 36 farms (Evaluated at geometric means)		258	.51	0	1.41
Means of inputs and gross sales (36 farms) Geometric	13,177	30	6,850	2,005	3,490
Farms with 50 - 100 Acres Bearing Fruit					
Average MVP for 44 farms (Evaluated at geometric means)		$(195)^{.16}$	0	$(.14)^{.84}$	2.61
Means of inputs and gross sales (44 farms) Geometric	29,620	64	9,769	2,238	7,912
Farms with over 100 Acres Fruit					
Average MVP for 54 farms (Evaluated at geometric means)		184	1.02	0	1.21
Means of inputs and gross sales (54 farms) Geometric	62,658	149	19,344	2,871	19,044

range of the data. It does appear, however, that the smaller farms could profitably expand their acreage relative to the larger farms. The larger farms on the other hand would get twice as high a return on an additional dollar of machinery investment as the small farms. This reinforces the tentative conclusion reached earlier; that the smaller farms, however defined, are probably over capitalized with respect to machinery investment.

Summary

There appear to be substantial differences in resource adjustment potentials between the area and large farm sample, although approximately constant returns to size were indicated for both samples. The area sample growers appeared to have too much machinery investment relative to the levels of other factors. The same might be said for family labor depending on how the growers perceive their opportunity cost. It appears profitable for the area sample growers to either reduce their machinery investment and do more equipment rental and custom hiring or to increase their acreage of fruit and hired labor input.

The large growers were getting a positive return on machinery investment and additional machinery investment appeared profitable. Even with added machinery investment, additional hired labor appeared profitable. In both samples the level of complementarity between acres of fruit, machinery investment and hired labor expenditures was quite high. The rate of substitution between machinery investment and hired labor, although decreasing over the range of the data, was relatively low. That is, a substantial quantity of machinery investment was required to substitute for a relatively small quantity of hired labor. Given the state of technology in 1966, it generally appeared that if a grower increased his fruit acreage, hired labor expenditures would be increased at the same time.

The hypothesis of constant returns to size was rejected for the area sample cherry farms, although not for the large farm sample cherry farms. Increased use of all factors, particularly machinery investment, appeared profitable for area sample cherry farms. Profitable adjustments for the large farm sample cherry growers included additional machinery investment and hired labor use. These conclusions were generally supported by the analysis where farms were subgrouped on the basis of owning or not owning a cherry harvester. For the farms with cherry harvesters, the MVP of machinery was near zero, while the MVP of hired labor was quite high.

The hypothesis of constant returns to size was rejected for apple farms and decreasing returns to size were indicated. Decreasing the fruit acreage appeared to be the most reasonable of the alternatives available.

There are alternative measures of size and only when hired labor was used as a measure of size were decreasing returns to size indicated.

The most consistent thing in the analysis was the near zero MVP of family labor. This was true even for the farms where the operators worked off-farm more than 75 days. If operators view their family labor as having near zero opportunity cost, then using operator and family labor to the point where the MVP approaches zero represents rational economic use. A zero opportunity cost is difficult to rationalize, however, given the extent of off-farm employment. Part of the problem may be in the aggregation of operator, wife and other family labor. The opportunity cost might be different, not only for the different categories of family labor but also for different seasons of the year. In periods of heavy farm labor inputs, June through September, the opportunity cost might well approach zero. There is also the practical fact that during peak labor periods, if an operator is putting in eight hours a day for five days, the opportunity cost of the marginal hour or day is viewed by the operator as having zero marginal cost. The same rationale would apply to other family labor. In effect, the operator and other family labor are considered fixed factors of production for certain seasons of the year.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The primary objectives of this study were: (1) to describe the characteristics of Michigan fruit farms with particular emphasis on factors affecting present and future labor use patterns, (2) analyze resource productivities and rates of factor substitution, (3) determine the economics of size relationships, and (4) to suggest on-farm adjustment potentials and assess the probable impact on future labor use patterns.

Tabular analysis was used in the descriptive sections and a production function model (Cobb-Douglas type) was used to estimate resource productivities and size coefficients. From the estimated parameters in the production function analysis, marginal value products and rates of factor substitution were computed. In all of the analysis, a comparison was made between the area sample growers, presumably characteristic of the fruit industry, and the large farm sample growers, representing the largest growers as measured by volume of fruit sales.

In the descriptive sections, an attempt was made to isolate those factors that could have an important influence on future labor use patterns as well as provide a better description of the fruit industry. In addition to the primary data provided by growers, secondary data was developed and used in both the descriptive and functional analysis. For example, total fruit sales per farm were estimated from production data obtained from growers and secondary price data. Each farm was then classified as to type of fruit farm based on the source of estimated fruit sales. The inventory value of machinery and equipment was also estimated for each farm from an equipment inventory provided by growers and secondary price data developed from various sources.

In addition to the development of secondary data, a considerable portion of the primary data was classified and categorized. For example, the types of off-farm employment of the operators were categorized by the author. The classification of hired workers into regular, seasonal and harvest labor was done ex post facto. All of these steps were taken in an attempt to develop a better description of the fruit industry and to facilitate the functional analysis.

Although a summary section is included in the individual chapters, the main findings from both the descriptive and functional analysis are presented in this section.

Descriptive Analysis

The average acreage of fruit was 138.64 acres in the large farm sample compared to only 59.05 acres in the area sample. Average fruit sales were $57,399 in the large farm sample compared to $21,831 in the area sample. Fruit sales were also compared by type of fruit farm, with large farm strawberry farms having the highest sales of $86,780 and area sample grape farms the lowest average sales of $4,773.

Not only were the large farm sample farms larger, as measured by both acres of fruit and fruit sales, but there were marked differences between the two samples in characteristics of the fruit enterprises. Although practically all farms in both samples were multiple fruit enterprise farms, the large farms tended to be more diversified in their fruit operation. Fruit acreages, yields and percentage of fruit sold on the fresh market generally tended to be higher in the large farm sample. Although some yield differentials were negligible, there was a tendency for yields to increase as fruit acreage increased in both samples. The large farms were less likely to have a non-fruit enterprise indicating that they were relatively more specialized in fruit production. This specialization was further pointed up by the majority of the packing houses and an even larger percentage of the fruit storage facilities, particularly the refrigerated and controlled atmosphere types, being found among the large farms.

In general, the large farm operators were more nearly fully employed on the farm than were the area sample operators. Findings that supported this conclusion include: (1) the large farm operators reported working more hours per month on the farm, particularly in the non-peak labor months, (2) the large farm operator work load was more evenly distributed throughout the year, and (3) there was much less multiple jobholding among the large farm operators.

Family labor appeared to be more important in the harvest operation on area sample farms, although family labor contributed about the same number of total hours in both samples.

As expected, the large farm growers were much larger employers of hired labor than were the area sample growers. Each type of hired labor, regular, seasonal and harvest, was reported by a larger percentage of the large farm growers, and the average total labor bill per farm was higher in the large farm sample. The problem of the area sample growers offering continuous employment opportunities, even for non-harvest labor, was pointed up by the substantial monthly variation in hours worked per individual worker and per farm. While hourly wage rates dominated the wage rate structure of regular and seasonal workers in both samples, a much higher percentage of the large farm growers were paying monthly and weekly wage rates. This was a further reflection of the large growers diversification and ability to offer more continuous full-time employment opportunities. Wage rates varied by type of worker and by month, but were highest for regular workers in the large farm sample and lowest for seasonal workers in the large farm sample. The weighted average hourly wage rate was $1.50 for regular workers and $1.30 for seasonal workers in the large farm sample. In the area sample, the weighted average hourly wage rates were $1.36 for both regular and seasonal workers. Piece rates dominated the harvest labor wage structure, but the data were too incomplete to compute averages.

One of the major problems of all growers was indicated by the tremendous variation in harvest worker employment on a monthly basis. From June through October, the peak harvest months, there was considerable variation in the percent of farms employing harvest workers, the hours worked per individual and per farm and in the apparent number of workers employed. The peak employment of harvest workers appeared to be in July, the major cherry harvest period, although there were a substantial number of harvest workers employed in June, engaged primarily in strawberry harvest.

On the average, the large farms had over twice the inventory value of machinery and equipment as the area sample farms. Even though a higher percentage of the area sample farms were single tractor farms, tractor capital accounted for a higher proportion of total machinery and equipment capital on the area sample farms. In addition to more total tractor capital, the large farms were much more likely to have pruning aids and mechanical harvesters. In fact, 86.6 percent of the self-propelled and 79.1 percent of the tractor mounted cherry harvesters were in the large farm sample.

Strawberry farms had the highest machinery and equipment inventory value of any type farm. The apple and mixed farms had about the same amount of capital and both types had substantially more than the cherry farms. The lowest inventory values of machinery and equipment were found on the grape and blueberry farms.

There was relatively little machinery and equipment rental in either sample, although hiring custom work was a fairly common practice in both samples. A slightly higher percentage of the large farm growers reported doing custom work for others, although on a dollar volume basis, the custom work was clearly dominated by a few of the very large farms.

Functional Analysis

In the functional analysis, the data were reasonably well represented by the Cobb-Douglas model. Elasticities and size coefficients were estimated for several subsets of farms including area sample farms, large farm sample farms, cherry farms, apple farms and all farms from both samples subgrouped by alternative measures of size.

Harvest labor so completely dominated the hired labor situation that the classification of labor into regular, seasonal and harvest did not prove fruitful in the functional analysis. All of the adjustment potentials were suggested considering all hired labor as one variable, measured as total grower costs including wages and perquisites.

There were substantial differences in resource returns and adjustment potentials between the area and large farm sample, although approximately constant returns to size were indicated for both samples. The area sample growers were receiving a very low return (near zero) from machinery investment, while the large farm growers' return to machinery investment appeared to exceed the marginal cost of additional machinery investment. The returns from expenditures on hired labor were quite high in both samples, generally exceeding $1.70 for each dollar expenditure. The returns to operator and family labor were approximately zero in both samples. Acres of fruit had a much higher return in the area sample than in the large farm sample.

It was questionable whether the area sample growers had sufficient fruit acreage to make efficient use of their present machinery investment or to take full advantage of known technology. Suggested adjustments for the area sample growers included reducing their machinery investment and doing more equipment renting and custom hiring or increasing their fruit acreage and hired labor input.

Additional machinery investment was suggested for the large farm growers. Even with added machinery investment, additional hired labor appeared profitable. In both samples the level of complementarity between acres of fruit, machinery investment and hired labor expenditures was quite high. Given the state of technology in 1966, it generally appeared that if a grower increased his fruit acreage, hired labor expenditures should be increased at the same time.

While there were differences between farms in the two samples, there was no overwhelming evidence that farm size and organization in one sample was clearly superior to the other. This was given the state of technology in 1966, however. The ability and willingness to adjust to meet new conditions will ultimately determine who survives in the fruit industry. Perhaps the most important clue to the potential ability to adjust to meet changing conditions was in the tabulations on completed and planned changes in farm size and organization. While completed changes do not necessarily imply future changes, they do imply a past willingness to change and the ability to recognize needed changes. A much larger percentage of the large farms had made changes that tended to increase their fruit operation, both in size and in level of technologies being applied. Over 36 percent of the area sample farms had made no major changes in farm size or organization in the past five years, compared to less than 14 percent of the large farms. Even more important were the planned changes. Over 41 percent of the area sample farms planned no major changes in farm size or organization in the next five years compared to only 17 percent of the large farms. A substantially larger percentage of the large farms were planning to increase their fruit acreage, purchase advance harvest equipment and update their packing and storage facilities. It appeared clear that the large farm growers were placing more emphasis on their fruit operations than were the area sample growers.

The functional analysis by type of fruit farm was completed only for cherry and apple farms.

The hypothesis of constant returns to size was rejected for the area sample cherry farms and increasing returns to size were indicated. Increased use of all factors, particularly machinery investment, appeared profitable for area sample cherry farms. Profitable adjustments for large farm sample cherry growers included additional machinery investment and hired labor use. These conclusions were generally supported by the analysis where farms were subgrouped on the basis of owning or not owning a cherry harvester.

The hypothesis of constant returns to size was rejected for all apple farms and decreasing returns to size were indicated. Decreasing the fruit acreage appeared to be the most reasonable of the alternatives available.

When all farms from both samples were subgrouped by alternative measures of size, only for the largest farms as measured by level of hired labor expenditures were decreasing returns to size indicated. Generally, the economies of size question did not appear to be critical, although a more detailed analysis on an enterprise basis is needed to fully settle the question.

Adjustments in the fruit industry over the next several years will have differential impacts on different segments of the industry. The mechanization of the harvest operation in a major crop such as cherries could have a substantial impact on labor use and availability, and farm structure and organization. The large farm growers, more dependent on large crews of harvest labor, would be more seriously affected than would the smaller area sample growers. Growers with crops having harvest dates just before or after cherry harvest could have considerable difficulty in obtaining interstate harvest labor.

It appears evident that the continuous employment opportunities available to harvest workers in the past, however tenuous, will become even more uncertain with the advent of mechanical harvesting of a major crop. In the past, handpicking operations have been available to harvest workers with various levels of skills. The future holds even less promise for workers with low levels of skill. The advent of mechanical harvesting will reduce the number of workers needed, require more skills of the remaining workers and impair even further the limited opportunities for continuous employment.

Growers need to remain alert to the possibilities of reducing their dependence on interstate labor by changing varieties, more use of mechanical aids or by the elimination of certain enterprises. If sufficient mechanical aids are developed, growers should consider the possibilities of arranging their enterprise combinations so that a base crew of workers could be employed on a year-round basis. Since labor availability is highly dependent on the sequence of crop activities, growers should also remain alert to developments in crop activities outside their immediate geographic area.

APPENDICES

APPENDIX A

SAMPLE ALLOCATION FOR MICHIGAN FRUIT FARM SURVEY

Appendix A-1. Sample Allocation for Michigan Fruit Farm Labor Survey

Since it was expected that the largest fruit growers would account for most of the variances of a farm labor survey, one-third of the sample was allocated to this group. It was estimated that these 100 largest growers, in terms of gross sales, represented about 1.6 percent of all the Michigan fruit growers. Compilation of a list of largest fruit growers was made from the Fruit Fly inspection reports, pesticide survey, and the various fruit grower association lists. The relative values of different fruit acreages were calculated based upon the number of acres necessary to provide sales of $40,000 per year. From this, points were assigned per acre of each fruit category, such that 100 points represented per annum sales of $40,000. For each name obtained, the acreage in each fruit category was estimated and a total point value calculated. From the list, after confirming the information with county agents, the 100 growers with the highest point totals were selected for interview.

Allocation of the 200 other interviews was made by means of the area frame. To represent non-farm resident fruit growers, the Non Open Country (NOC) stratum was used. In the twenty fruit counties, 841 NOC segments were located, including 126 in Kent County which had previously been classified as "fruit segments". Sample allocation to the NOC stratum of the 20 counties in the June Enumerative Survey (JES) had consisted of five segments. For this survey, four segments were allocated, two to Kent County's fruit NOC segments, and two to the remaining 715 NOC segments.

Since experience with JES has indicated an incidence of 1.2 farm operators per half segment, and since fruit farms comprise about half of all farms in this area, it was expected that about 1.2 fruit farm operators would be found per segment. To allow for the separate sampling of the largest growers and to provide a safety margin, 188 segments were allocated to open country segments. This would yield the desired number of interviews if 1.06 fruit farm operator interviews per segment were obtained.

The open country stratum had previously been classified as cultivated (intensive) or other (extensive). Within the cultivated stratum, each count unit in which commercial orchards were spotted from aerial photo prints were classified as "fruit", and all segments therein called fruit segments. Within the 20 counties, the 12,815 open country segments consisted of 2,568 fruit segments, 9,589 cultivated (other than tree fruit) segments, and 658 "other" segments.

With the help of 1959 Census data, the Minor Civil Divisions (MCD's) within the 20 county area had been classified as having 20 or more fruit farms (designated 20+ MCD's) or having 19 or less fruit farms (designated 19 - MCD's). Breakdown of the segments within the classifications were as follows:

Classification	20 + MCD's	19 - MCD's	Total
Fruit segments	2,369	199	2,568
Cultivated	2,150	7,439	9,589
Other	105	553	658
Total	4,624	8,191	12,815

This classification had been done by ERS and would have been the principal method of stratification, had it not been for classification of count units by SRS. With the identification of fruit segments, however, the above classification was used in separate sample allocation only in the cultivated stratum. For other strata, the classification was used in systematic sampling.

The least likely segments to contain fruit farm operators were "other" segments. Nevertheless, these, like the NOC segments, needed representation in the sample. Three segments were allocated, using a systematic sample allocation among the 658 segments. For this and other sample draws, the counties were ordered in a serpentive fashion from north to south in the following order:

1. Cheboygan
2. Antrim
3. Grand Traverse
4. Leelanau
5. Benzie
6. Manistee
7. Mason
8. Oceana
9. Muskegon
10. Newaygo
11. Mecosta
12. Montcalm
13. Ionia
14. Kent
15. Ottawa
16. Allegan
17. Kalamazoo
18. Van Buren
19. Berrien
20. Cass

In ordering the segments in the above county order, the 20+ MCD segments were listed first and then the 19 - MCD segments for each county.

The remaining 185 segments were allocated between cultivated (non-tree fruit) and tree fruit. From the 1959 Census data, the number of acres in fruit trees and vines was listed for each of the twenty counties. These acreages were divided by 2.5 to convert to equivalent acres of strawberries necessary to produce the same gross sales per year. Blueberry and raspberry acreages were expanded by a factor of 1.75 to convert to strawberry equivalent (SE) acres, and this added to the acres in strawberries to arrive at a total berry acreage (SE). The totals for all twenty counties showed 72 percent of the fruit acres (SE) as fruit trees and vines and 28 percent as berries. Since fruit segments would be expected to contain some berry acreage, it was felt that a larger percentage of sample segments should be allocated to fruit segments. The decision was made to adopt an 84-16 percent split which gave 155 segments to fruit and 30 segments to the cultivated segments other than tree fruit.

Allocation of the 155 fruit segments to individual counties was calculated based upon 1959 Census data of tree fruit and vines and number of fruit farms in each county. This provided two separate sample allocations. A compromise was made between the two allocations. The indicated sample allocation was used for each of the six largest counties. For the remaining 14 counties, a systematic sample selection was used in which 19 - MCD segments were listed following 20 + MCD segments for each county. Originally, 150 samples were allocated to the 20 + MCD's, but with the small number of 19 - MCD fruit segments involved, the latter segments were placed at the end of the 20 + lists for each of the six counties and the same sampling interval and order used. The 19 - MCD segments provided the extra five sample segments.

Allocation of the 30 cultivated segment samples between 20 + MCD's and 19 - MCD's was divided evenly, 15 samples to each. In each case, the counties were ordered in the serpentive fashion with a random start.

APPENDIX B

FRUIT PRICE DATA

Appendix Table B-1. Prices of Michigan Fruit Crops Received by Growers in 1966.

Commodity	Average Price for the Season			
	Unit	Fresh Price	Processed Price	Blend Price
			(Dollars)	
Apples	ton	---	---	64.57
Tart cherries	ton	---	---	280.00
Sweet cherries	ton	---	---	270.00
Peaches	ton	138.80	86.00	126.60
Plums	ton	---	---	92.00
Pears	ton	92.00	58.80	71.60
Grapes	ton	160.00	83.00	88.00
Strawberries	pound	.212	.154	.188
Blueberries	pound	---	---	.24
Raspberries	pound	---	---	.17
Apricots	ton	---	---	198.00

Source: <u>Michigan Agriculture Statistics</u>, Michigan Department of Agriculture.

APPENDIX C

DATA ON FAMILY AND HIRED LABOR

Appendix Table C-1. Family Labor: Hours per Month by Type Worker.

Item	No. of Obser-vations	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual Average
Area Sample														
Operator														
Hrs./individual	103	112	115	152	198	227	245	262	251	242	220	147	122	2,295
Hrs./farm	87	132	137	181	235	270	290	310	297	287	261	174	145	2,717
Wife														
Hrs./individual	65	31	25	42	71	74	97	120	108	120	78	33	28	829
Hrs./farm	60	34	27	45	77	80	105	130	117	130	85	36	31	898
Other family														
Hrs./individual	64	21	21	31	52	70	109	115	108	81	57	31	28	735
Hrs./farm	41	33	33	48	80	108	169	178	166	126	88	48	43	1,147
All family														
Hrs./farm	87	170	170	232	323	373	439	480	453	432	357	219	185	3,878
Large Farm Sample														
Operator														
Hrs./individual	216	155	154	183	221	239	249	268	264	264	254	186	163	2,599
Hrs./farm	170	197	196	233	281	303	317	340	336	335	322	336	208	3,503
Wife														
Hrs./individual	118	37	31	38	57	58	75	98	90	94	90	45	45	759
Hrs./farm	111	39	33	40	60	62	79	104	96	100	96	48	48	805
Other family														
Hrs./individual	179	42	38	43	72	74	125	145	141	94	83	49	52	958
Hrs./farm	79	97	86	98	166	169	286	333	324	216	190	111	119	2,170
All family														
Hrs./farm	**170**	**267**	**257**	**304**	**396**	**422**	**500**	**561**	**547**	**499**	**472**	**319**	**294**	**4,840**

Appendix Table C-2. Type of Work and Number of Days Worked by Multiple Jobholders.

Type Work	Number of Days Worked						
	1-24	25-74	75-149	150-249	250 and over	Un-known	Total
Area Sample							
Non-farm self employment	-	1	-	1	2	1	5
Farm related self employment	-	-	-	-	1	-	1
Non-farm employee	1	2	4	4	13	1	25
Farm employee	-	1	1	1	2	-	5
Unknown or other	1	1	-	-	1	1	4
Total	2	5	5	6	19	3	40
Large Farm Sample							
Non-farm self employment	2	1	1	-	2	-	6
Farm related self employment	-	2	5	-	2	1	10
Non-farm employee	1	5	6	6	3	1	22
Farm employee	-	5	3	-	1	1	10
Unknown or other	1	2	1	-	-	3	7
Total	4	15	16	6	8	6	55

Appendix Table C-3. Calculation of Chi-Square for a 3 x 3 Table.

Type of Work		Number of Days Worked 1-74	75-149	Over 150	Totals
Self employed	observed	6	6	8	20
	expected	5.32	5.06	9.62	20
	deviation	.68	.94	-1.62	0
	chi-square	.092	.175	.273	
Non-farm employee	observed	9	10	26	45
	expected	11.96	11.39	21.65	45
	deviation	-2.96	-1.39	4.35	0
	chi-square	.732	.170	.874	
Farm employee	observed	6	4	4	14
	expected	3.72	3.54	6.73	14
	deviation	2.28	.46	-2.73	0
	chi-square	1.397	.060	1.107	
Totals	observed	21	20	38	79
	expected	21	20	38	79
	deviation	0	0	0	0

Chi-square = 4.88 with 4 df, ns

Appendix Table C-4. Frequency Distribution of Age of Operator.

Age of Operator	Percent of Farms	
	Area Sample	Large Farm Sample
20-24	0	1.19
25-29	4.60	3.57
30-34	9.20	7.14
35-39	9.20	11.31
40-44	10.34	23.81
45-49	11.49	17.86
50-54	22.99	12.50
55-59	11.49	8.93
60-64	2.30	8.93
65 and over	18.39	4.76
Mean	50.52	46.58
Median	51.00	45.00

Appendix Table C-5. Number of Farms Employing Regular Hired Workers by Number of Workers.

Number of Regular Workers	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Area Sample												
0	65	66	64	61	61	61	60	60	62	60	65	68
1	14	13	15	17	16	15	17	18	16	17	14	13
2- 5	6	6	6	7	8	10	8	8	8	8	7	5
6-10	2	2	2	2	2	1	2	1	1	1	1	1
Large Farm Sample												
0	84	83	77	75	75	76	72	74	73	75	83	88
1	45	46	47	46	47	48	50	49	49	50	47	43
2- 5	33	33	38	41	40	38	40	39	40	37	32	31
6-10	7	7	7	7	7	6	6	6	6	6	7	7
11 and over	0	0	0	0	0	1	1	1	1	1	0	0

Appendix Table C-6. Number of Farms Employing Seasonal Hired Workers by Number of Workers.

Number of Seasonal Workers	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Area Sample												
1- 5	11	13	18	22	17	20	21	18	13	15	7	6
6-10	0	0	0	2	1	2	4	2	0	0	0	0
11 and over	0	0	1	2	2	3	1	1	1	0	0	0
Large Farm Sample												
1- 5	24	26	38	52	50	53	60	44	39	27	26	20
6-10	3	2	2	7	7	14	8	15	8	6	2	1
11 and over	1	0	1	7	10	6	4	3	2	1	2	2

Note: The number of farms in this table may total to less than the number shown employing seasonal hired workers in Table III.3, since the number of workers employed was not known on certain farms.

Appendix Table C-7. Number of Farms Employing Harvest Workers by Number of Workers.

Number of Harvest Workers	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Area Sample												
1-10	0	0	0	0	1	4	13	15	36	27	4	2
11-25	0	0	0	0	1	5	19	15	15	5	2	0
26-50	0	0	0	0	0	1	15	8	4	1	0	0
Over 50	0	0	0	0	1	2	8	4	1	0	0	0
Large Farm Sample												
1-10	0	0	0	0	3	6	17	19	40	48	12	0
11-25	0	0	0	0	1	3	37	27	48	46	3	0
26-50	0	0	0	0	1	5	34	31	28	21	3	0
Over 50	0	0	0	0	1	10	26	17	7	5	0	0

Appendix Table C-8. Number of Farms Employing Hired Workers by Number of Workers.

Item	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Area Sample												
Number of Workers												
1- 5	27	25	31	38	32	33	11	21	16	28	28	24
6- 10	3	4	3	5	3	3	11	10	24	17	2	2
11- 25	0	0	0	1	2	7	18	16	16	5	2	0
26- 50	0	0	1	1	1	2	16	8	6	1	0	0
51-100	0	0	0	0	1	2	8	5	1	0	0	0
Over 100	0	0	0	0	0	1	0	1	0	0	0	0
Number of Farms	30	29	35	45	39	48	64	61	63	51	32	26
Percent of Farms	34.5	33.3	40.2	51.7	44.8	55.2	73.6	70.1	72.4	58.6	36.8	29.9
Large Farm Sample												
Number of Workers												
1- 5	88	86	104	99	94	90	35	47	28	32	84	80
6- 10	9	13	11	16	16	12	13	16	28	32	12	10
11- 25	3	1	2	9	13	10	38	24	54	49	8	2
26- 50	0	0	0	1	2	5	35	35	28	23	3	0
51-100	0	0	0	0	1	8	23	17	10	8	0	0
Over 100	0	0	0	0	1	5	8	5	1	1	0	0
Number of Farms	100	100	117	125	127	130	152	144	149	145	107	92
Percent of Farms	58.8	58.8	68.8	73.5	74.7	76.5	89.4	84.7	87.6	85.3	62.9	54.1

Appendix Table C-9. Number of Workers Employed, by Type, by Month.

Item	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Area Sample												
Total, All types	71	72	108	150	233	821	1,743	1,103	817	355	107	55
Regular hired	46	45	48	51	52	53	54	52	50	50	45	38
Seasonal hired	25	27	60	99	90	110	98	86	56	30	16	13
Harvest	0	0	0	0	91	658	1,591	965	711	275	46	4
Large Farm Sample												
Total, All types	280	264	328	498	759	2,919	5,634	3,635	2,989	2,543	479	249
Regular hired	185	186	201	211	210	210	218	226	226	221	188	181
Seasonal hired	95	78	127	287	418	443	317	256	179	107	86	68
Harvest	0	0	0	0	131	2,266	5,099	3,153	2,584	2,215	205	0

Appendix Table C-10. Hired Labor: Average Number of Hours Worked per Worker and per Farm by Type Worker.

Type Worker	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Area Sample												
Regular, per worker	137	141	150	164	179	191	204	200	197	188	142	130
per farm	288	303	314	323	360	389	410	385	394	362	292	262
Seasonal, per worker	80	93	105	96	109	98	116	126	126	114	74	108
per farm	183	194	333	366	491	432	440	519	506	230	170	234
Harvest, per worker	0	0	0	0	26	49	107	75	68	137	71	110
per farm	0	0	0	0	960	1,282	2,615	1,381	689	941	119	220
Large Farm Sample												
Regular, per worker	168	171	172	187	189	193	197	190	185	182	179	176
per farm	366	371	376	421	424	438	444	454	436	430	393	390
Seasonal, per worker	102	124	85	99	78	93	108	128	131	126	126	120
per farm	354	351	267	429	488	569	479	529	480	399	363	355
Harvest, per worker	0	0	0	0	117	98	105	84	89	149	109	0
per farm	0	0	0	0	3,250	10,196	4,957	2,794	1,815	2,668	1,010	0

Appendix Table C-11. Number and Percent of Farms Employing Workers on a Method of Payment Basis.

Type Worker by Method of Payment	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Area Sample												
Monthly, Number	1	3	0	2	1	4	6	2	1	2	1	1
Percent	1.13	3.40	0.00	2.27	1.13	4.54	6.81	2.27	1.13	2.27	1.13	1.13
Weekly, Number	2	2	3	3	2	3	6	5	3	3	3	2
Percent	2.27	2.27	3.40	3.40	2.27	3.40	6.81	5.68	3.40	3.40	3.40	2.27
Daily, Number	0	0	1	1	1	1	5	1	0	1	0	0
Percent	0.00	0.00	1.13	1.13	1.13	1.13	5.68	1.13	0.00	1.13	0.00	0.00
Hourly, Number	22	23	29	40	38	42	41	35	35	33	25	20
Percent	25.00	26.13	32.95	45.45	43.18	47.72	46.59	39.77	39.77	37.50	28.40	22.72
Piece Rate, Number	4	5	5	8	7	16	55	40	52	34	9	3
Percent	4.54	5.68	5.68	9.09	7.95	18.18	62.50	45.45	59.09	38.63	10.22	3.40
Large Farm Sample												
Monthly, Number	23	23	23	23	23	24	24	24	23	22	23	23
Percent	13.52	13.52	13.52	13.52	13.52	14.11	14.11	14.11	13.52	12.94	13.52	13.52
Weekly, Number	21	20	18	23	24	27	28	26	25	23	18	18
Percent	12.35	11.76	10.58	13.52	14.11	15.88	16.47	15.29	14.70	13.52	10.58	10.58
Daily, Number	1	1	3	2	1	2	9	4	7	4	3	0
Percent	.58	.58	1.76	1.17	.58	1.17	5.29	2.34	4.11	2.35	1.76	0.00
Hourly, Number	73	76	92	114	108	113	122	114	117	103	81	70
Percent	42.94	44.70	54.11	67.05	63.52	66.47	71.76	67.05	68.82	60.58	47.64	41.17
Piece Rate, Number	4	5	1	9	16	27	109	86	112	108	14	2
Percent	2.35	2.94	4.11	5.29	9.41	15.88	64.11	50.58	65.88	63.52	8.23	1.17

Appendix Table C-12. Regular Hired Workers: Average Grower Costs per Worker and per Farm.

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Weighted Annual Average
						(Dollars)							
						Area Sample							
Wages													
Per worker	219	221	236	252	260	271	296	290	285	273	228	233	3,084
Per farm	458	473	493	494	520	553	591	559	570	524	467	465	6,216
Perquisites													
Per worker	42	40	43	42	42	43	42	44	45	43	45	44	516
Per farm	88	85	90	83	84	87	84	84	90	83	92	89	1,032
Wages and Perquisites													
Per worker	261	260	279	294	302	314	337	334	330	316	273	277	3,600
Per farm	546	558	583	578	605	640	675	643	660	607	559	554	7,248
						Large Farm Sample							
Wages													
Per worker	275	280	277	292	290	296	300	291	285	282	293	289	3,456
Per farm	598	605	605	657	649	668	673	693	670	663	640	639	7,776
Perquisites													
Per worker	37	36	34	38	36	37	35	33	33	33	35	36	420
Per farm	79	78	75	85	80	83	78	80	77	77	78	81	948
Wages and Perquisites													
Per worker	311	316	311	330	326	333	334	325	317	315	328	324	3,876
Per farm	678	684	680	741	728	751	752	773	747	740	717	716	8,724

Appendix Table C-13. Seasonal Hired Workers: Average Grower Costs per Worker and per Farm.

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Weighted Annual Average
						(Dollars)							
						Area Sample							
Wages													
Per worker	101	118	138	120	138	142	151	211	165	147	100	151	1,752
Per farm	229	245	435	457	620	626	568	863	658	293	229	327	6,144
Perquisites													
Per worker	5	4	6	4	7	3	5	7	5	2	2	5	60
Per farm	11	8	18	16	31	14	19	27	21	4	4	10	204
Wages and Perquisites													
Per worker	105	122	144	124	145	146	156	217	170	149	102	155	1,812
Per farm	240	253	453	473	651	640	587	890	680	297	234	337	6,348
						Large Farm Sample							
Wages													
Per worker	138	172	118	123	98	118	145	166	170	172	167	160	1,620
Per farm	477	524	382	538	614	717	639	685	620	542	479	472	7,008
Perquisites													
Per worker	6	10	7	11	15	15	7	10	12	9	7	5	132
Per farm	19	27	20	45	92	84	23	38	40	24	18	14	528
Wages and Perquisites													
Per worker	144	183	124	134	111	133	152	173	180	180	174	170	1,728
Per farm	496	551	402	582	705	800	662	723	659	565	496	485	7,524

Appendix Table C-14. Harvest Workers: Average Grower Costs per Worker and per Farm.

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Weighted Annual Average
						(Dollars)							
						Area Sample							
Wages													
Per worker	0	0	0	0	47	390	106	73	111	193	104	166	1,029
Per farm	0	0	0	0	1,414	19,716	3,076	1,687	1,408	1,552	798	331	24,176
Perquisites													
Per worker	0	0	0	0	18	8	16	11	8	11	25	70	84
Per farm	0	0	0	0	542	415	451	242	95	86	193	139	1,944
Wages and Perquisites													
Per worker	0	0	0	0	64	398	122	84	119	204	129	235	1,113
Per farm	0	0	0	0	1,956	20,130	3,527	1,928	1,504	1,640	992	470	26,136
						Large Farm Sample							
Wages													
Per worker	0	0	0	0	110	76	111	104	147	256	185	0	924
Per farm	0	0	0	0	2,408	6,585	4,834	3,468	3,072	4,728	2,104	0	28,588
Perquisites													
Per worker	0	0	0	0	15	11	15	17	13	18	8	0	105
Per farm	0	0	0	0	337	993	643	591	265	332	96	0	3,234
Wages and Perquisites													
Per worker	0	0	0	0	126	87	125	121	160	274	195	0	1,029
Per farm	0	0	0	0	2,744	7,578	5,471	4,051	3,333	5,056	2,194	0	31,794

APPENDIX D

REGRESSION RESULTS AND CORRELATION MATRICES

APPENDIX TABLE D-1. Elasticities and Related Statistics for Regression Analysis, Models I-IX

Model	Value of Constant	Acres of Bearing Fruit	Machinery & Equipment Investment	Family Labor	Regular Hired Labor	Seasonal Hired Labor	Harvest Hired Labor	All Hired Labor	Sum of Elasticities	Coefficient of Multiple Determination	Standard Error of Estimate	Number of Observations
Model I-A Area sample	1.413	xxx .700 (.145)	.124 (.244)	-.012 (.114)	-.008 (.030)	.009 (.033)	xxx .342 (.069)		1.15	.869	.259	48
Large farm sample	1.538	xxx .285 (.075)	xx .172 (.069)	-.018 (.036)	xx .023 (.010)	-.006 (.012)	xxx .474 (.049)		.930	.815	.149	95
Model I-B Area sample	1.785	xxx .639 (.134)	-.038 (.211)	-.030 (.106)				xxx .446 (.076)	1.02	.882	.240	48
Large farm sample	1.405	xxx .256 (.082)	xxx .183 (.072)	-.017 (.038)				xxx .500 (.060)	.922	.787	.158	95
Model II-A Area sample	1.229	xxx .592 (.169)	.174 (.223)	-.049 (.087)	-.009 (.024)	.019 (.026)	xxx .419 (.096)		1.15	.804	.184	39
Large farm sample	1.582	xxx .286 (.075)	xxx .176 (.068)	-.016 (.036)	xx .023 (.010)	-.005 (.012)	xxx .450 (.049)		.91	.816	.148	95
Model II-B Area sample	1.676	xxx .564 (.157)	-.006 (.182)	-.070 (.080)				xxx .511 (.101)	.99	.822	.171	39
Large farm sample	1.426	xxx .263 (.082)	xxx .184 (.072)	-.012 (.038)				xxx .480 (.059)	.92	.786	.158	95
Model II-C	1.300	.354 xxx (.072)	.175 xxx (.067)	-.028 (.035)				.487 xxx (.051)	.99	.827	.163	134
Model III-A Area sample cherry farms	.038	x .447 (.253)	x .593 (.342)	.058 (.090)				xx .290 (.123)	1.39 1/	.846	.154	21
Large farm cherry farms	.837	.212 (.210)	x .301 (.189)	.008 (.108)				xxx .515 (.130)	1.04	.764	.199	33
All cherry farms	.929	xx .326 (.156)	xx .301 (.152)	.019 (.071)				xxx .432 (.089)	1.08	.812	.180	54
Model III-B Large farm apple farms	1.481	-.022 (.068)	.046 (.055)	.028 (.022)				xxx .717 (.051)	.77 2/	.943	.071	38
All apple farms	1.31	x .137 (.091)	.091 (.080)	-.018 (.033)				xxx .665 (.070)	.88 3/	.878	.116	46
Model IV A	2.049	xxx .451 (.103)	.109 (.092)	x -.140 (.089)				xxx .405 (.094)	.825	.658	.174	68
B	1.946	xxx .301 (.104)	xxx .270 (.106)	-.006 (.036)				xxx .258 (.092)	.823	.580	.147	66
Model V A	1.026	xxx .414 (.139)	x .252 (.171)	-.030 (.051)				xxx .459 (.099)	1.10	.691	.191	53
B	1.315	x .333 (.124)	.119 (.300)	.034 (.073)				xxx .495 (.084)	.981	.654	.161	48
C	2.020	xxx .350 (.118)	.080 (.214)	xx -.192 (.099)				xxx .555 (.088)	.793	.843	.127	33
Model VI A	1.030	xxx .592 (.163)	xxx .265 (.106)	-.038 (.095)				xxx .373 (.077)	1.19	.766	.152	36
B	1.168	.420 (.292)	-.052 (.172)	.011 (.052)				xxx .697 (.113)	1.08	.577	.191	44
C	1.219	xxx .436 (.168)	xxx .314 (.104)	-.084 (.066)				xxx .368 (.078)	1.03	.690	.146	54
Model VII A	2.182	xxx .620 (.165)	-.005 (.160)	x -.010 (.082)				xxx .319 (.104)	.924	.826	.150	30
B	1.110	xxx .288 (.080)	xx .134 (.084)	-.023 (.038)				xxx .552 (.061)	1.00	.829	.164	104
Model VIII A	2.278	xx .261 (.123)	x .170 (.102)	x -.143 (.093)				.343 (.101)	.631	.554	.156	42
B	3.259	x .114 (.076)	xx .123 (.068)	-.009 (.027)				x .144 (.055)	.372	.356	.096	46
C	2.610	.076 (.090)	xx .148 (.085)	.005 (.043)				xxx .341 (.067)	.570	.692	.089	46
Model IX A	1.123	xxx .469 (.134)	.178 (.171)	-.005 (.084)				xxx .463 (.104)	1.100	.874	.163	30
B	1.326	xxx .304 (.088)	xx .183 (.075)	-.031 (.040)				xxx .500 (.061) xxx	.956	.798	.166	104

xxx Significant at .01 level, by one tail t test
xx Significant at .05 level, by one tail t test
x Significant at .15 level, by one tail t test

1/ Significant at .10 level, by F test
2/ Significant at .01 level, by F test
3/ Significant at .10 level, by F test

Appendix Table D-2. Correlation Matrix, Models I-A and I-B.

Item	Fruit Sales	Acres	Machinery	Family Labor	Regular Worker Wages	Seasonal Worker Wages	Harvest Worker Wages
Simple Correlations, Model I-A and I-B, Area Sample							
Acres	.837						
Machinery	.828	.765					
Family labor	.263	.214	.304				
Regular worker wages	.371	.368	.511	.104			
Seasonal worker wages	.416	.432	.461	.117	-.001		
Harvest worker wages	.868	.679	.831	.300	.379	.346	
All hired worker wages	.900	.726	.867	.314	.448	.402	.990
Simple Correlations, Model I-A and I-B, Large Farm Sample							
Acres	.740						
Machinery	.658	.589					
Family labor	.146	.216	.225				
Regular worker wages	.456	.399	.412	-.031			
Seasonal worker wages	.133	.163	.064	.016	-.117		
Harvest worker wages	.841	.631	.551	.149	.294	.215	
All hired worker wages	.857	.704	.610	.138	.492	.240	.943

Appendix Table D-3. Correlation Matrix, Models II-A and II-B.

Item	Fruit Sales	Acres	Machinery	Family Labor	Regular Worker Wages	Seasonal Worker Wages	Harvest Worker Wages
Simple Correlations, Model II-A and II-B, Area Sample							
Acres	.810						
Machinery	.690	.704					
Family labor	.081	.186	.121				
Cost of regular workers	.359	.338	.526	.005			
Cost of seasonal workers	.299	.320	.390	.043	-.162		
Cost of harvest workers	.797	.636	.586	.065	.435	.093	
All hired labor cost	.961	.716	.716	.121	.576	.210	.954
Simple Correlations, Model II-A and II-B, Large Farm Sample							
Acres	.740						
Machinery	.659	.589					
Family labor	.146	.216	.225				
Regular worker wages	.452	.395	.407	-.035			
Seasonal worker wages	.132	.160	.069	.014	-.123		
Harvest worker wages	.839	.626	.544	.145	.285	.209	
All hired worker wages	.856	.698	.607	.125	.488	.233	.942

Appendix Table D-4. Correlation Matrix, Models II-C and III-A.

Item	Fruit Sales	Acres	Machinery	Family Labor
Area Sample Cherry Farms				
Acres	.803			
Machinery	.721	.683		
Family Labor	.127	.201	.198	
All Hired Labor	.876	.747	.685	.126
Large Farm Cherry Farms				
Acres	.764			
Machinery	.727	.771		
Family Labor	.035	.084	.019	
All Hired Labor	.835	.744	.051	.016
All Cherry Farms				
Acres	.824			
Machinery	.799	.831		
Family Labor	.116	.146	.091	
All Hired Labor	.851	.766	.726	-.197

Appendix Table D-5. Correlation Matrix, Models III-B and IV.

Item	Simple Correlations, Model III-B				Simple Correlations, Model IV			
	Fruit Sales	Acres	Machinery	Family Labor	Fruit Sales	Acres	Machinery	Family Labor
	Large Farm Apple Farms				Farms with less than $10,000 Hired Labor			
Acres	.717				.715			
Machinery	.593	.499			.479	.456		
Family Labor	.187	.342	.377		.039	.259	-.012	
All Hired Labor	.968	.731	.563	.123	.716	.618	.420	.114
	All Apple Farms				Farms with more than $10,000 Hired Labor			
Acres	.733				.652			
Machinery	.603	.542			.663	.645		
Family Labor	.120	.261	.279		.199	.204	.330	
All Hired Labor	.930	.718	.580	.120	.606	.488	.553	.172

Appendix Table D-6. Correlation Matrix, Model V.

Item	Simple Correlations, Farms with less than $10,000 Machinery Inventory				Simple Correlations, Farms with $10,000-$20,000 Machinery Inventory			
	Fruit Sales	Acres	Machinery	Family Labor	Fruit Sales	Acres	Machinery	Family Labor
Acres	.694				.608			
Machinery	.509	.433			.226	.414		
Family Labor	-.095	.043	.032		.007	-.027	-.163	
All Hired Labor	.779	.628	.465	-.128	.756	.478	.111	-.035

Item	Simple Correlations, Farms with more than $20,000 Machinery Inventory			
	Fruit Sales	Acres	Machinery	Family Labor
Acres	.741			
Machinery	.470	.334		
Family Labor	.352	.516	.443	
All Hired Labor	.887	.682	.556	.478

Appendix Table D-7. Correlation Matrix, Model VI.

Item	Simple Correlations, Farms with less than 50 Acres of Fruit				Simple Correlations, Farms with 50-100 Acres of Fruit			
	Fruit Sales	Acres	Machinery	Family Labor	Fruit Sales	Acres	Machinery	Family Labor
Acres	.653				.375			
Machinery	.554	.246			.318	.537		
Family Labor	-.085	.055	-.225		.012	.146	.223	
All Hired Labor	.777	.466	.418	-.025	.742	.304	.364	-.039
	Simple Correlations, Farms with over 100 Acres of Fruit							
Acres	.564							
Machinery	.680	.464						
Family Labor	.127	.238	.272					
All Hired Labor	.744	.427	.592	.191				

Appendix Table D-8. Correlation Matrix, Model VII.

Item	Simple Correlations, Farms with Special Harvest Equipment				Simple Correlations, Farms without Special Harvest Equipment			
	Fruit Sales	Acres	Machinery	Family Labor	Fruit Sales	Acres	Machinery	Family Labor
Acres	.865				.777			
Machinery	.644	.652			.727	.664		
Family Labor	.094	.109	.290		.138	.228	.206	
All Hired Labor	.850	.782	.698	.110	.888	.737	.709	.132

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