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Cost of Producing Apples in Berrien County, Michigan 1935

Michigan State University Agricultural Experiment Station

Special Bulletin

K.T. Wright , W. R. O'Brien, Farm Management

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APPLES
In Berrien County, Michigan
1935**

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AGRICULTURAL EXPERIMENT STATION

MICHIGAN STATE COLLEGE
Of Agriculture and Applied Science

SECTION OF FARM MANAGEMENT

East Lansing

CONTENTS

	PAGE
Introduction	
Number of Apple Trees in Michigan	3
Production of Apples	3
Michigan's Apple Crop	4
Apple Prices in Michigan	5
Review of Available Data on Apple Costs	6
Costs and Returns of Producing Apples in Berrien County in 1935	
Objectives of Study	7
Methods and Source of Data	8
Description of Berrien County	8
Description of the Farms	9
Variety of Apples	9
Average Apple Costs and Returns Per Acre	9
Costs and Returns Per Bushel Apples	11
Comparison of Most and Least Profitable Orchards	13
Apple Costs and Returns by Age of Trees	15
Factors Affecting Apple Costs and Returns	
Yield	19
Soil Type	21
Number of Trees Per Acre	22
Age of Trees	22
Amount of Spray	22
Size of Orchard	24
Labor and Machinery Costs	
Labor Cost	25
Labor Distribution	25
Sprayer Costs of Operation	26
Spraying Costs	27
Discussion	27
Summary	28
Appendix	31

Cost of Producing Apples in Berrien County, Michigan in 1935

K. T. WRIGHT AND W. R. O'BRIEN¹

Number of Apple Trees in Michigan—According to the United States Census of 1890 there were 8.5 million bearing apple trees in Michigan. Ten years later the number of trees was reported as being nearly 11 million. Since 1900, however, the number of apple trees in this state has been decreasing, and in 1930 there were only 5.2 million trees of bearing age. Thus the number of bearing apple trees in Michigan decreased slightly more than 50 per cent in the 30 years. During this same period, the total number of apple trees of bearing age in the United States decreased 55 per cent. (See Table 18.)

During the 40 years, 1890 to 1930, there was a decided shifting of the location of the apple producing area in Michigan. Some counties that had two to three hundred thousand trees in 1890 had less than 50,000 in 1930, while others had a considerably larger number of trees at the latter date than in 1890. There were large decreases in the number of bearing apple trees in the counties of the central and southeastern portions of the state, and moderate increases in counties along Lake Michigan from Oceana north to Emmet. The number of bearing apple trees in Berrien County declined from 466,000 in 1890 to 273,000 in 1910, but increased to 435,000 by 1930, the increase being rapid between 1920 and 1930.

Production of Apples—The total production of apples in the United States fluctuates widely from year to year, even though the number of producing units from one year to the next is approximately the same. Table 1, showing average yearly production of apples by five-year periods beginning with 1890, indicates that the long-time trend in United States apple production was upward to the 1900-'04 period, dropping sharply for the next five years, but in 1910-'14 closely approaching the former peak, and since then gradually declining to an

¹Mr. Wright, research assistant in Farm Management, designed the record blanks, made suggestions regarding collection of the data, supervised the summarization of the records and analysis of the data, and wrote the bulletin.

Mr. O'Brien, representing the Horticulture Department as fieldman, selected the cooperators, visited each approximately every two weeks and made sure the records were complete in every respect. He also did a major portion of the actual summarizing of the records, and contributed suggestions on this bulletin.

ACKNOWLEDGMENTS—Sincere appreciation is expressed to the many farmers for their cooperation on this study. Acknowledgments are also due Director V. R. Gardner of the Horticulture Section for his many valuable suggestions in the writing of this bulletin; to C. E. Atwater of the Federal Land Bank for his help and suggestions in analyzing the data; and to many others on the staff at Michigan State College.

Table 1. Trend in total apple production for U. S. and Michigan and net* supply per capita.

Five-year Period	Average Yearly U. S. Production in 1,000 Bu.	Average Yearly Michigan Production in 1,000 Bu.	Average Yearly U. S. Net Supply Per Capita (Pounds)
1890-1894.....	129,801	8,803	94
1895-1899.....	181,877	10,582	118
1900-1904.....	196,614	14,598	114
1905-1909.....	153,370	10,234	80
1910-1914.....	194,298	11,247	93
1915-1919.....	180,215	8,006	81
1920-1924.....	166,717	9,221	73
1925-1929.....	160,892	6,443	63
1930-1934.....	152,033	7,327	55

Data on United States production and consumption from 1927 and 1934 U. S. D. A. Yearbooks. Michigan production from unpublished data from Michigan Division of Crop and Livestock Estimates, Department of Agriculture.

*Imports and exports taken into account.

average of 152 million bushels for the 1930-'34 period. This is a decline of 22 per cent from the 1900-'04 average production. From the number of bearing and non-bearing trees, it appears likely that this downward trend in apple production will continue for a few years at least, although at a slower rate.

Michigan's average yearly production has shown the same general long-time trend during this period, although the 1930-'34 average production was practically 50 per cent less than the peak in 1900-'04 or more than twice the rate of decline of the country as a whole. The average annual net supply of apples per capita in the United States has declined from well over 100 pounds around 1900 to an average of 55 pounds for the five years 1930-'34.

Michigan's Apple Crop—Michigan ranked sixth among the states in average yearly apple production for the 10 years 1926-'35. Michigan's apple crop has been averaging around seven million bushels annually during recent years. The average value of the apple crop during the 10 years 1926-'35 was slightly in excess of six million dollars annually. Apples usually ranked sixth or seventh among the crops of the state in value, and are by far the most important of the fruit crops grown in this state.

Regarding the relationship between Michigan's production of apples and the amount consumed in the state, another study² shows that slightly more apples are produced than are consumed in most years. As an average for the years 1922-'33 Michigan's total yearly production of apples was 7,358,000 bushels with 4,561,000 bushels of commercial³ production. Of this commercial production 1,835,000 bushels was shipped to other states. Receipts of apples in Michigan from other states averaged 1,168,000 bushels annually during this period, so there was a net surplus of 667,000 bushels, or less than 10 per cent of the total production. The principal states to which Michigan apples were

²G. N. Motts "The Production-Consumption Balance of Agricultural Products in Michigan" Part 1, Fruits and Vegetables, Mich. Special Bul. No. 263 (Oct. 1935) p. 9.

³Commercial production is the amount produced primarily for sale and in sufficient quantity to be considered one of the cash income enterprises on the farm.

sent were Illinois, Wisconsin, Indiana, and Ohio. The states of Washington and New York supplied a large share of the apples shipped into this state.

Apple Prices in Michigan—Ninety per cent of Michigan’s apple crop is usually sold by farmers in the four months, August through November, and apple prices are generally considerably lower during these months than during the rest of the year. In Fig. 1 the average farm price of apples during those four months for the years 1910-’14 was considered as 100, and the average price for each year graphed for the years 1914 to 1935. The average price index for the fall months of the 22 years was 121, or 95 cents per bushel. The index of apple prices at the farm for the same months in 1935 was 80. The average index of “all-farm costs” for the 22 years was 151, and for 1935 the index was 118. Thus, “all-farm costs” had an average index 30 points higher than the apple price index the four months of August through November during the 22 years, and 38 points higher in 1935.

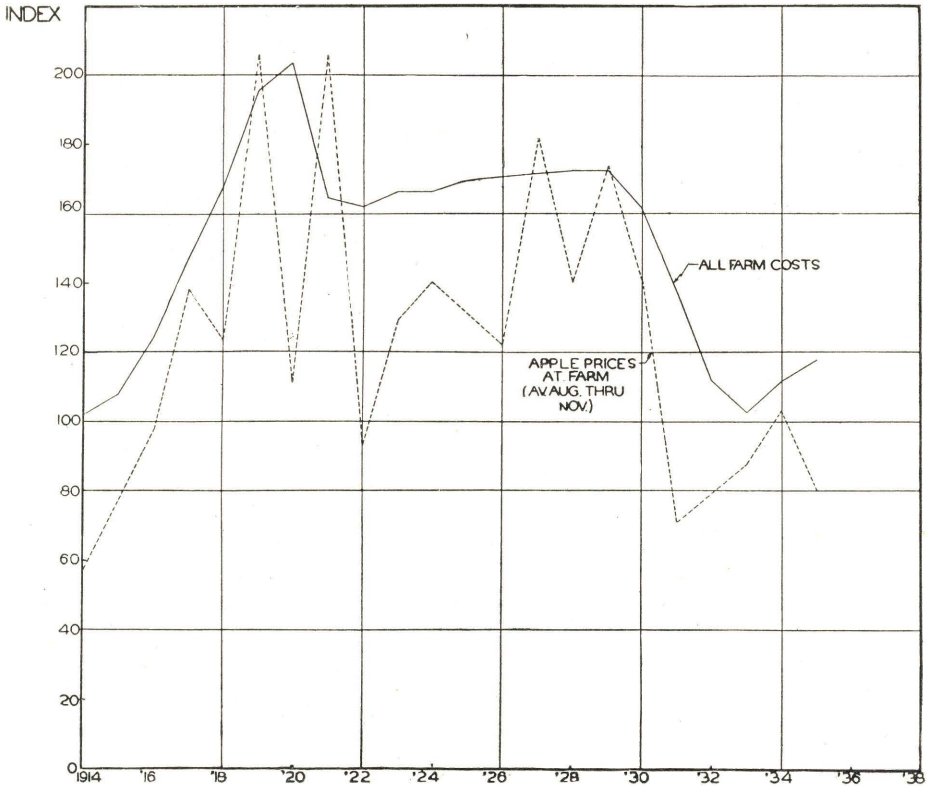


Fig. 1. Index of apple prices and all-farm costs in Michigan, 1914-'35 (1910-'14 = 100).

“All-farm costs” determined from weighted index of prices paid by farmers for commodities used in living and production, farm taxes, farm wages and interest payments. Data for this graph are from Mich. Tech. Bul. 139 (June 1934) “Michigan Farm Prices and Costs” by O. Ulrey, and from unpublished data since publication of the bulletin.

Review of Available Data on Apple Costs—An attempt has been made to bring together comparable data on apple production costs in leading apple-producing states (See Table 2). Comparable information on other important apple-producing states could not be found. Production cost per acre in Washington was high compared with other states because of the far greater amount of labor spent on each acre, irrigation expenses, interest on high land valuation, high taxes and high equipment expenses. Harvesting costs per acre also were high due partly to the high yield. Apple yields per acre in Washington were very high, but even then the cost per unit of product was higher than in most states. Apple costs per acre were low in New York, but the average yield per acre also was low. Costs per acre in New Jersey were somewhat higher than New York but so were the yields on the farms where records were kept. Though data for Michigan for a comparable period are not available, it appears from the 1935 study that Berrien county producers can grow apples as cheaply as producers in other states.

Table 2. Apple costs in specified states.

Items	Washington *		New York **	New Jersey ***	Ohio ****
	Wenatchee	Yakima	Newfane- Olcott	Monmouth	
Years of study	1926-28	1926-28	1926-28	1929-31	1924-28
Production cost per acre	\$333	\$244	\$73	\$95	
Harvesting cost per acre	295	264	31	57	
Total cost per acre	\$628	\$508	\$104	\$152	\$97
Yield of apples (bu.) per acre	450	406	105	208	139
Cost per bu. apples	\$1.40	\$1.25	\$0.99	\$0.73	\$0.70

*Niel W. Johnson.

"Economic Aspects of Apple Production in Washington"—Washington Bulletin No. 239 (April, 1930).

**T. A. La Mont.

"Costs and Returns in Producing Apples"—Cornell University Bulletin No. 565 (June, 1933).

***John W. Carncross.

"Costs of Producing Apples in Monmouth County, 1929-1931"—Mimeograph report of Dept. of Agr'l Economics, New Jersey Agricultural Experiment Station (February, 1933).

****S. H. Ballou.

"What Does It Cost to Grow a Bushel of Apples?"—Ohio Bulletin No. 435 (May, 1929).

The valuations placed on the apple orchards studied in the different states varied considerably, but there appears to be a relationship between the acre values and the yields. On the Washington orchards that were studied, the yields averaged 428 bushels per acre, and the average value placed on the orchards at that time was \$1,120 an acre, or 2.6 times the bushels per acre. In New York the average value was \$355 an acre, or 3.4 times the bushels per acre. On the New Jersey farms studied, the value was figured at \$520 an acre, or 2.5 times the yield. The calculated value of the Michigan orchards studied in 1935 was \$440 an acre, or 2.6 times the three-year average bushels per acre.

COSTS AND RETURNS OF PRODUCING APPLES IN BERRIEN COUNTY IN 1935

Objectives of Study—The objects of this cost of production study on apples were: (1) to determine the costs of producing, harvesting, marketing and overhead items in a Michigan county where apple production is of considerable importance; (2) to determine the amounts of labor and materials used in production, so that current prices could be applied to these amounts to obtain average costs at any later date; (3) to make a farm management study of some economic phases of apple production; and (4) to study the relationship between conditions

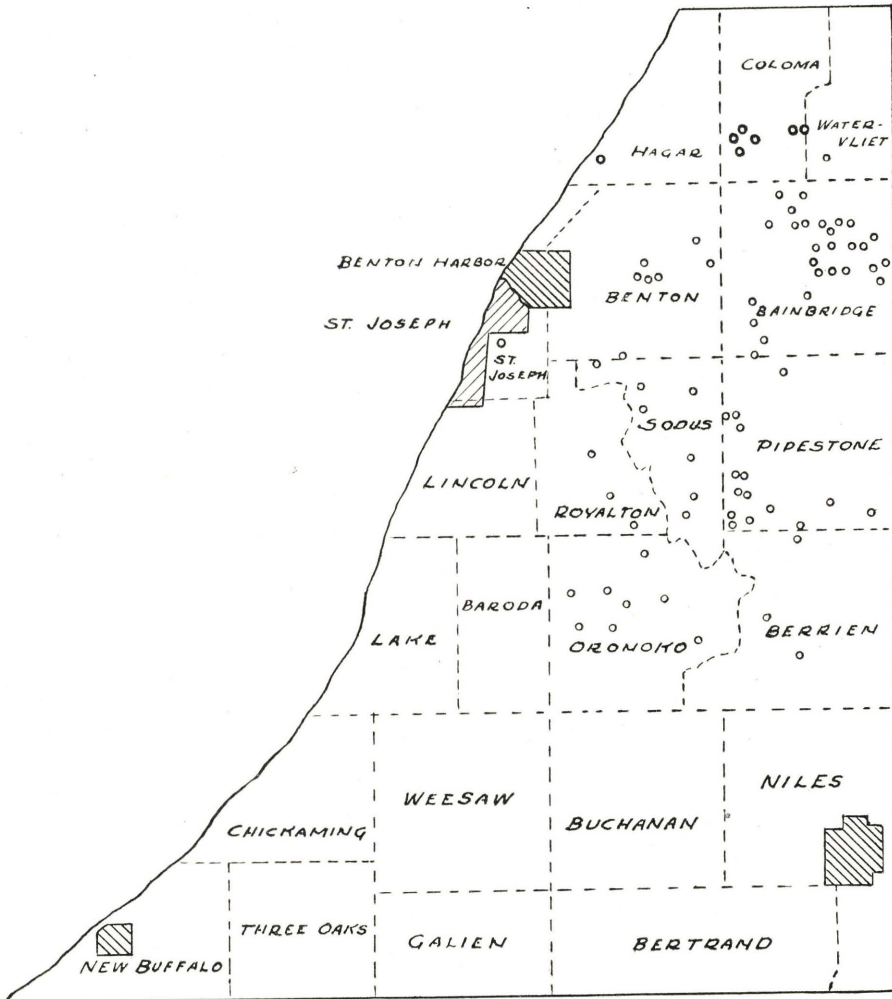


Fig. 2. Location of apple orchards in Berrien County where records were kept in 1935. (Dots indicate location of orchards on which records were kept.)

or management practices, and the efficiency of apple production and net returns.

Methods and Source of Data—Berrien County farmers cooperating in this study were provided with a record book, in which an account was kept of all the hours of labor spent on the apple orchard, the amount and cost of all materials used, the investment in special equipment, the number of trees bearing and non-bearing, the bushels of apples produced and their value, and a description of conditions and practices followed in the orchard. These farmers were called upon about every two weeks through the 1935 season and given assistance with their records to insure completeness. In the fall after most of the apples were sold, the carefully checked records were collected from 80 farmers in Berrien County. The accompanying map shows the location of the 80 farms.

Description of Berrien County—This county is in the southwest corner of the state, fronting on Lake Michigan and bounded by Indiana on the south. The climate of the county, particularly the western and northern portions, is greatly influenced by Lake Michigan, which moderates climatic conditions, and is one of the important factors making possible profitable fruit growing in Berrien County. There are several soil types in the county, some of which are favorable and some unfavorable for fruit growing. The topography of the county is such that some sections have excellent air drainage, while other parts have areas subject to frost damage. Several economic factors favor fruit production in the county—including a large nearby industrial and urban population, excellent highways and transportation facilities, a well-developed local market, and heavy tourist traffic on the trunk line highways—all of which improve market outlets.

The accompanying table, based upon census data, gives a good idea of the kinds of fruit grown in Berrien County, and the trend in the

Table 3. Number of fruit trees, grapevines and acreage of small fruits in Berrien County as reported by the United States Census.

Kind of Fruit	1900	1910	1920	1930
Apples... { Bearing.....	425,033	273,409	287,883	434,803
*Non-bearing.....	—	—	220,403	250,143
Cherries... { Bearing.....	14,368	51,523	69,398	89,628
*Non-bearing.....	—	—	25,910	80,490
Peaches... { Bearing.....	923,288	267,800	772,721	763,852
*Non-bearing.....	—	—	295,315	444,565
Pears..... { Bearing.....	240,094	351,825	388,937	331,550
*Non-bearing.....	—	—	103,891	38,822
Plums.... { Bearing.....	51,378	17,362	26,954	41,237
*Non-bearing.....	—	—	15,563	20,891
Grapevines { Bearing.....	744,478	2,192,008	4,319,218	7,557,244
*Non-bearing.....	—	—	259,587	301,339
Blackberries and dewberries..... (acres)	3,150	—	—	1,134
Raspberries..... (acres)	3,500	2,850	4,206	4,574
Strawberries..... (acres)	3,510	2,041	2,683	1,930

*Not reported prior to 1920 by counties.

number of trees and other fruit producing plants by census periods since 1900. The last census indicates a well-diversified fruit production in the county, with more than 750,000 bearing peach trees, 430,000 bearing apple trees, 330,000 bearing pear trees, and a large acreage of grapes. There was also a large number of young non-bearing trees to replace old trees and keep the orchards in a high state of productivity. In 1930 Berrien county had more than 50 per cent more bearing apple trees than any other county in Michigan, and approximately 8 per cent of the total number of bearing trees in the state. More than 35 per cent of all the bearing peach trees in the state were in Berrien county, 40 per cent of the pear trees, and nearly 45 per cent of all the grapevines. Total area in orchard fruits and vineyards in this county in 1930 was 47,214 acres or about 21 per cent of the tillable land. Approximately one-sixth of the entire acreage in the state devoted to fruit growing is in Berrien County.

Description of the Farms—The 80 farms in Berrien County on which complete cost records on apples were obtained averaged 66 acres in size with 16 acres in apples. The size of the farms in this group ranged from 10 to 300 acres, and the acreage of apples from 2 to 50. Regarding other fruit on the farms, there were an average of 5.9 acres of peaches, 2.1 acres of cherries, 1.6 acres of pears and 0.2 acre of plums, or a total of 25.9 acres of tree fruits. There were also 4.8 acres of grapes, 1.7 acres of raspberries and dewberries, and 3.4 acres of strawberries, melons and tomatoes. Thus, 35.8 acres of the farms were in fruits and vegetables as an average, leaving 30.2 acres for other crops, woods, idle land, farmstead and roads. Complete data on the amount of livestock on those farms were not obtained, but livestock enterprises were generally small and unimportant. Regarding the machinery and equipment more than 50 per cent of the farms had tractors, about 90 per cent had trucks, and all had sprayers.

Gross income from fruits and vegetables in 1935 averaged slightly in excess of \$3,000 per farm. Apple sales made up 41 per cent of the total, peaches 24 per cent, cherries 11 per cent, grapes about 7 per cent, and other fruits and vegetables 17 per cent. In addition to the foregoing, there was a small amount of livestock income.

Variety of Apples—Jonathan was the predominating variety of apple trees on those 80 farms, since 31 per cent of all the trees were of this variety (Table 4). Delicious was the next most common variety, followed by Wealthy, Duchess, Grimes, McIntosh, Baldwin, and Northern Spy. There were many other varieties of apples as some individual farms had as many as 30 or 40 different varieties. Table 4 also shows that a major portion of the young trees were of the following varieties: Jonathan, Delicious, Wealthy, Grimes and McIntosh, Northern Spy, Duchess, Baldwin. Miscellaneous varieties, however, had been planted earlier and were mostly in the older age groups. More than one-half of the trees of those eight varieties were from 10-19 years old, and one-fourth from 20-29 years of age. The average age of all bearing trees was approximately 22 years.

Average Apple Costs and Returns Per Acre—The 80 fruit growers keeping a cost account on their apples had an average of 16.1 acres of apples per farm, but records were kept on only 12.5 acres. The num-

Table 4. Variety and age of apple trees on 80 Berrien County farms, 1935.

Variety	Per Cent of All Trees	Per Cent of Trees by Varieties, by Ages			
		Less Than 10 Yrs.	10-19 Yrs.	20-29 Yrs.	30 Yrs. and More
Jonathan.....	31	30	52	17	4
Delicious.....	11	21	16	7	4
Wealthy.....	10	13	8	2	2
Duchess.....	6	11	10	10	2
Grimes.....	5	4	9	2	1
McIntosh.....	5	4	2	2	4
Baldwin.....	2	1	1	1	12
Northern Spy.....	2	—	2	5	31
Others.....	28	16	0	54	40
Total.....	100	100	100	100	100
Per cent of all trees.....	100	9	56	27	8

ber of trees per acre averaged 37 bearing and 3 non-bearing. The tree-run yield of apples in 1935 on those farms averaged 184 bushels per acre or 5 bushels per bearing tree. Data were available on the production of apples the two preceding years on practically 80 per cent of the farms. The average yield in 1933 was 166 bushels per acre, in 1934 it was 160 bushels, and in 1935 the yield was 184 bushels. Thus the 1935 production per acre was approximately 10 per cent above the average of the two preceding years. The average for the three years was 170 bushels per acre. During 1935 the growers spent 102 hours of man labor, 24 hours of horse labor, used a tractor 6 hours, and drove the truck 29 miles for every acre in apples. An average of 1,634 gallons of spray was applied per acre of apples.

The relative importance of the various items of cost is shown in Fig. 3. The charge for man labor, horse labor, tractor, truck and machinery use was the major item of cost, constituting more than 32 per cent of the total. The group of cost items next in importance included the packages, washing and other charges of preparing the apples for market. These expenses totaled \$22.74 per acre on these farms, where the yield averaged 184 bushels of apples per acre, and made up nearly 22 per cent of the total cost. In determining the total cost of production, interest was figured at 5 per cent on the estimated investment in trees and land; that amounted to \$21.96 an acre, or 21

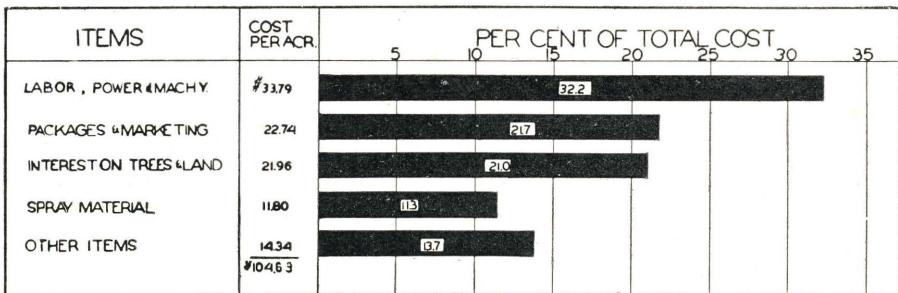


Fig. 3. Major items of cost in producing apples in Berrien County, 1935.

per cent of the total. The cost of spray materials used in making the 1,634 gallons used per acre constituted over 11 per cent of the total, while other items⁴ accounted for the remaining 14 per cent of the total cost.

In Table 5 the costs on those orchards have been grouped into three classifications: (1) production costs, (2) harvesting and marketing costs, and (3) overhead costs. Production costs included spray material, fertilizer, manure, and all man labor, horse labor, tractor and machinery used up to picking time. These cost items averaged \$36.13 an acre, or 35 per cent of the total cost. Harvesting and marketing costs included all man labor, horse labor and truck used in picking and marketing the apples. Any expenses that a grower had for packages, washing, or cooperative association charges for handling the apples were included in this group of costs. These costs totaled \$37.37 an acre, as average. Overhead costs included some non-cash as well as cash items that have to be taken into account in a complete cost of production statement. Interest on the estimated value of \$440 an acre for land and trees was the largest item of this group, although the orchard's share of the general farm expenses and taxes were fairly large items. Those overhead costs averaged \$31.13 an acre or nearly 30 per cent of the entire cost. Total cost per acre, including the \$22 interest but not including any management charge for the operator, amounted to \$104.63 an acre. If all the work done by the operator had been charged at 50 cents an hour, \$9 would have been added to the cost per acre.

Income from the 184 bushels of apples averaged \$93.05 an acre in 1935. Appreciation in the value of the young apple trees was considered as income, adding \$13.14 an acre. Thus, the total income was \$106.19 or \$1.56 more than the total cost on these orchards in 1935. This could be considered as return for the operator's management and would make his labor return about 25 cents an hour. If interest on the estimated value of the orchard is omitted from costs, and tree appreciation not added to the income, the income from apples was approximately \$10 an acre more than costs.

The index of "all-farm costs" for 1935 was 118, using 1910-'14 as 100. The average index for the 10 preceding years was about 150. If apple production costs were in the same relationship to "all-farm costs" as in 1935, the 10-year average cost of apple production on farms comparable to those 80 farms probably was approximately \$135 an acre. Production information was available on most of those farms for the last three years, and the average yield was 170 bushels. If the 10-year average was the same, the calculated average cost per bushel for the years 1925-'34 would have been nearly 80 cents a bushel. The index of apple prices in 1935 for August through November was 80 compared with 120 for the 10 years preceding. Thus, the 10-year average income from apples on farms comparable with this group would have been about \$140 an acre. If there was the same appreciation of \$13 an acre in value of the trees, there would have been \$18 net return per acre on farms having costs comparable with those 80 and a yield of 5 bushels for each bearing tree.

Costs and Returns per Bushel Apples—The average costs of apple production per acre shown in Table 5 have been divided by the aver-

⁴Share of general farm expenses, taxes, fertilizer, manure and miscellaneous items.

age yield of 184 bushels (tree-run) to obtain the costs on a bushel basis. Table 6 shows that the total cost per bushel of tree-run apples produced on those farms averaged practically 57 cents. If the operator's labor had been charged at 50 cents an hour, the total cost per bushel would have been 5 cents higher. Production costs amounted to

Table 5. Apple costs and returns per acre in Berrien County, Michigan, 1935.

Item	Average of 80 Farms	Labor Hours per Acre:		
		Man Hours	Horse Hours	Tractor Hours
Acres of apples in orchard.....	12.5			
Number of trees per farm { *Bearing.....	463			
Non-bearing.....	39			
Number of trees per acre { Bearing.....	37			
Non-bearing.....	3			
Apple production { Total..... (bu.)	2,288			
Per acre..... (bu.)	184			
Per tree..... (bu.)	5			
Spray used { Per acre..... (gals.)	1,634			
Per tree..... (gals.)	44			
PRODUCTION COSTS: (per acre)				
Pruning (labor and power).....	\$2.66	15.2	3.4	
Fertilizer (labor and power).....	1.07	3.1	1.9	2.5
Cultivating (labor and power).....	2.53	4.4	3.2	2.0
Spraying (labor and power).....	5.41	14.5	14.9	1.5
Thinning (labor and power).....	1.09	5.4		
Fertilizer and manure.....	3.84			
Spray material.....	11.80			
Equipment use.....	7.23			
Miscellaneous.....	.50			
Total.....	\$36.13	42.6	23.4	6.0
HARVESTING AND MARKETING COSTS: (per acre)				
Picking (labor and power).....	11.37	54.4	.3	
Marketing (labor and truck use).....	2.43	5.4	.1	
Packages.....	13.77			
Other marketing expense.....	8.97			
Packing house use.....	.93			
Total.....	\$37.37	59.8	.4	
OVERHEAD COSTS: (per acre)				
Share of general farm expense.....	4.95			
Taxes on orchard.....	3.80			
Interest on trees.....	19.46			
Interest on land.....	2.50			
Depreciation of trees.....	.42			
Total.....	\$31.13			
TOTAL COST PER ACRE.....	104.63			
INCOME: (per acre)				
Apples.....	93.05			
Appreciation of trees.....	13.14			
Total income.....	\$106.19			
PROFIT (per acre).....	1.56			

*Ten years old or more.

In determining costs of production, all purchased items were charged at actual cost, and those things not purchased were figured at the usual market price or estimated average cost. Man labor was charged at 15 cents an hour for pruning and 20 cents an hour for all other work. Horse labor was figured at 10 cents per horse hour. Light two-plow tractors were charged at the rate of 60 cents an hour, and medium weight at 75 cents an hour. Truck use was estimated at 5 to 8 cents a mile depending on size of truck and usage. Charges for the use of other machinery and equipment was determined from an actual record of repairs, supplies, depreciation and interest. (See appendix for detailed explanation of all items).

Table 6. Apple costs and returns per bushel in Berrien County, Michigan, 1935.

Item	Average of 80 Farms (cents)
PRODUCTION COSTS: (per bushel)	
Labor, power and machinery	10.8
Spray material	6.4
Fertilizer, manure and miscellaneous	2.4
Total	19.6
HARVESTING AND MARKETING COSTS: (per bushel)	
Labor, power and truck use	7.5
Packages	7.5
Other marketing expenses	5.3
Total	20.3
OVERHEAD COSTS: (per bushel)	
Interest on trees and land	12.0
Taxes and general farm expense	4.8
Depreciation of trees .....	.2
Total	17.0
TOTAL COST PER BUSHEL	56.9
INCOME: (per bushel)	
Apples	50.6
Appreciation of trees	7.1
Total	57.7
PROFIT (per bushel) .....	.8

19.6 cents per bushel, marketing costs 20.3 cents, and overhead costs 17.0 cents per bushel. The charge for labor, power, and machinery used in producing the apple crop until picking averaged 10.8 cents per bushel of apples harvested, while spray material cost amounted to 6.4 cents per bushel apples, and fertilizer, manure, and miscellaneous items were 2.4 cents.

In picking and marketing the apples, the labor and power cost was again a large item, although the cost of packages, washing, and cooperative association handling charges was greater than the labor and power cost. Of the overhead items, interest on investment in trees and land was the most important, amounting to 12 cents per bushel apples produced. Income from the sale of apples, approximately one-half of which graded number one, averaged 50.6 cents per bushel. Thus, there was a loss of 6 cents a bushel unless appreciation of trees was taken into account.

Comparison of Most and Least Profitable Orchards—Net return per acre, after taking into account all items of cost and income, except appreciation of trees, ranged from a profit of \$66 to a loss of \$88 per acre. Some of this extreme variation may have been the result of unusual conditions, so the figures on the 15 most profitable apple orchards have been averaged for comparison with the average of the 15 least profitable (Table 7). The average net return was \$43.32 profit per acre on the most profitable group, and \$36.83 loss per acre on the least profitable.

The average yield of apples was 290 bushels on the most profitable

Table 7. Comparison of the most and least profitable apple orchards, 1935.

Item	Average 15 High-profit Farms*	Average 15 Low-profit Farms*
Acres of apples per farm.....	13.8	13.8
Number of trees per acre of bearing age.....	40	42
Apple production per acre	290	107
Total..... (bu.)	290	107
No. 1..... (bu.)	174	48
No. 2..... (bu.)	18	18
Others..... (bu.)	98	41
Spray used per acre..... (gal.)	2,192	1,324
COSTS PER ACRE:		
Production.....	\$44.14	\$35.69
Harvesting and marketing.....	56.70	22.17
Overhead.....	35.02	32.67
Total.....	\$135.86	\$90.63
INCOME PER ACRE:		
Apples.....	167.66	46.07
Appreciation of trees.....	11.52	7.63
Total.....	\$179.18	\$53.70
PROFIT OR LOSS PER ACRE.....	43.32	-36.83
Total cost per bushel.....	.47	.84
Total income per bushel.....	.62	.50
Variety of apples produced: (per cent)		
Jonathan.....	25	31
Wealthy.....	17	11
McIntosh.....	9	1
Delicious.....	8	5
Northern Spy.....	5	0
Grimes.....	4	11
Others.....	32	41

*Selected on the basis of profit per acre, excluding tree appreciation.

group and 107 bushels on the unprofitable. The average yield in 1934 was 197 and 156 bushels, respectively, and in 1933 it was 254 and 107 bushels, respectively. Thus, it is evident that the higher yields were the result of orchard management and conditions, rather than some unusual situation occurring in 1935.

Some of the major factors causing the difference in returns were general orchard management, type of soil, extent of pruning, amount of spraying, and grade and variety of apples. The high-profit orchards were usually on the more desirable soil types,⁵ while the low-profit orchards were on soils less adapted to profitable apple production. The high-return group did less pruning, as more than one-half indicated that they pruned lightly. In the case of the low-return group only 20 per cent practised light pruning, and the remainder, medium to heavy pruning. The farmers in the high-profit group applied nearly 2,200 gallons of spray per acre of apples, compared with slightly more than 1,300 gallons in the low-profit group. Disease control was much better on the first group, and the size of the apples averaged larger, so that 60 per cent of the 290 bushels production per acre graded number one in contrast with 45 per cent of the 107 bushels production of the low-profit group. Regarding variety of apples, there were more Jonathans, Wealthy, McIntosh, and Delicious in the high-profit or-

⁵See appendix for description of soil types.

chards, while the leading varieties in the low-profit group were Jonathans, Wealthy, Grimes, and Duchess. The difference in varieties on these two groups of orchards, however, was negligible and could in no sense account for the differences in returns.

The number of trees per acre was about the same in both groups, but the average age of the bearing trees in the high-profit orchards was about 20 years compared with approximately 23 years in the low-profit orchards.

Production costs totaled \$44.14 an acre on the high-profit group and \$35.69 on the low-profit, or 15 cents and 33 cents a bushel respectively. Harvesting costs per acre were also higher on the high-profit group, but on a per bushel basis each approximated 20 cents. Overhead costs were \$35.02 an acre on the first group and \$32.67 on the latter group, or 12 cents and 30 cents a bushel, respectively. All costs totaled slightly more than \$135 an acre on the high-profit farms, as an average, compared with \$90 on the low-profit farms. Total cost per bushel of apples harvested, however, was 47 cents on the high-profit group and 84 cents on the low-profit. Income per acre from the apples was almost four times as high on the profitable group as on the unprofitable farms, because there were nearly three times as many apples and the sale price was 15 cents a bushel higher, because of the higher percentage of number one apples. Net return per acre as pay for the grower's management was \$80 greater on the high-profit farms than on the low-profit, which means that the growers in the first group had \$600 profit on their apple orchards and the low-profit men lost \$500 on apple orchards of the same size.

The most profitable individual apple orchard of the entire group in 1935 was one of 11.5 acres with an average of 47 bearing and 6 non-bearing trees per acre. One-third of the trees were Jonathans, one-fourth Northern Spies, and there were some McIntosh, Grimes, Wealthy, and Delicious. Most of the bearing trees were 18 years old. Those trees were on Bellefontaine soil and had made good growth. The trees were pruned lightly. Ten tons of manure were applied to the orchard in 1934 and 20 tons in 1935, along with 1,800 pounds of nitrogenous fertilizer. Clean cultivation was practised. There were six swarms of bees in the orchard. Spray applications during the season amounted to 2,072 gallons per acre. The yield of apples on this orchard averaged over 11 bushels per tree, or 534 bushels per acre, 58 per cent of which were number one apples. The 1934 crop was less than 1935, but the 1933 production was considerably larger than 1935, so the three-year average was 465 bushels per acre. The 1935 apple crop was sold at the farm and brought \$234 an acre or an average of 44 cents a bushel. Production costs were slightly over \$47 an acre, or 8.8 cents per bushel, while harvesting costs were \$83 an acre, or 15.6 cents a bushel, and overhead costs \$38 an acre or 7.1 cents a bushel. Total cost per acre was \$168 and per bushel apples 31.5 cents. Net return per acre was nearly \$66 besides the \$28 an acre appreciation in value of the trees.

Apple Costs and Returns by Age of Trees—The average age of the bearing apple trees in these orchards was approximately 23 years; in 13 orchards the bearing trees were less than 15 years old, in 19 orchards from 15 to 19 years old, in 36 from 20 to 29 years and in 12 the trees were 30 years old or older (see Table 8). The orchards were grouped

according to the age of the bearing trees to study the relationship between tree age, costs and returns.

Production cost, or cost up to picking time, averaged slightly over \$26 an acre on orchards 14 years old or less, and from \$37 to \$39 on orchards in the three older age-groups. The lower production cost on the young orchards was due principally to less spraying and pruning.

Table 8. Apple costs per acre by age of bearing trees on 80 Berrien County farms, 1935.

Item	Age of Bearing Trees			
	14 Years and Less	15-19 Years	20-29 Years	30 Years and Up
Number of farms.....	13	19	36	12
Acres of apples per farm.....	13.1	12.2	13.2	10.2
Number of trees per acre { Bearing.....	36	44	36	32
{ Non-bearing.....	1	3	3	7
Sprays used { Per acre..... (gal.)	1,060	1,910	1,453	1,986
{ Per tree..... (gal.)	29	41	40	62
Apple production { Per acre..... (bu.)	113	227	180	212
{ Per tree..... (bu.)	3.1	5.2	5.0	6.6
PRODUCTION COSTS: (per acre)				
Pruning (labor and power).....	\$2.12	\$3.02	\$2.28	\$4.10
Fertilizing (labor and power).....	.70	1.19	1.20	.81
Cultivating (labor and power).....	2.12	2.78	2.85	1.47
Spraying (labor and power).....	4.01	5.64	5.88	5.17
Thinning (labor and power).....	.16	1.25	1.48	.61
Fertilizer and manure.....	3.57	3.91	3.71	4.59
Spray material.....	7.37	12.64	12.35	14.21
Equipment use.....	6.47	7.81	7.04	7.94
Miscellaneous.....	.14	.34	.78	.22
Total.....	\$26.66	\$38.58	\$37.57	\$39.12
HARVESTING AND MARKETING COSTS: (per acre)				
Picking (labor and power).....	8.93	14.98	10.50	11.19
Marketing (labor and truck use).....	1.35	3.01	2.50	2.63
Packages.....	8.01	20.53	13.25	11.01
Other marketing expense.....	2.39	13.80	9.86	5.68
Buildings use.....	.49	.47	1.03	1.24
Total.....	\$21.17	\$52.79	\$37.14	\$31.76
OVERHEAD COSTS: (per acre)				
Share of general farm expense.....	3.53	5.88	5.09	4.69
Taxes on orchard.....	3.41	3.23	4.09	4.30
Interest on trees.....	16.47	20.22	20.76	17.29
Interest on land.....	2.74	2.43	2.39	2.75
Depreciation of trees.....	0	0	.50	1.50
Total.....	\$26.15	\$31.76	\$32.83	\$30.53
TOTAL COST (per acre).....	73.98	123.13	107.54	101.41
INCOME: (per acre)				
Apples.....	62.55	123.83	92.31	80.33
Appreciation of trees.....	24.16	21.13	7.31	4.98
Total.....	\$86.71	\$144.96	\$99.62	\$85.31
NET RETURN (per acre).....	12.73	21.73	-7.92	-16.10
PRODUCTION HISTORY:				
Bushels per acre, 1933*.....	85	229	156	226
Bushels per acre, 1934*.....	105	161	173	190
Bushels per acre, 1935*.....	113	234	179	223
Bushels per acre, Average*.....	101	208	169	213

*Production histories were available on 12 orchards of the youngest group, 13 of the second, 28 of the third and 10 of the oldest.

Harvesting and marketing costs per acre varied considerably on the various age-groups, but were approximately in proportion to the yield, although marketing method had some effect on those costs. Harvesting and marketing costs averaged slightly more than \$21 an acre on the youngest orchards having a 113-bushel yield per acre, and nearly \$53 an acre on orchards 15 to 19 years yielding 227 bushels per acre in 1935. Overhead costs varied less than the two preceding groups of costs, being approximately \$26 an acre on the youngest orchards and slightly over \$30 to \$32 on orchards in the three older age-groups. Total cost per acre averaged about \$74 on the youngest orchards, \$123 on those 15 to 19 years, about \$108 on those 20 to 29 years, and over \$101 on those 30 years old or older.

More bearing trees per acre were in the orchards 15 to 19 years old than average, and less than average in the oldest group. Total yield of tree-run apples in 1935 was lowest on the youngest group of orchards, highest in the group 15 to 19 years, about average on the group 20 to 29 years old, and relatively high on those 30 years old or more. Average yield per acre for the three years 1933-'35 showed about the same yield difference by age of trees as for 1935, although the oldest trees had slightly the highest average. Income per acre from apples in 1935 varied in about the same degree as the yield per acre, although the income was proportionally lower on the oldest orchards in this study because of lower quality of apples. Net return per acre above total cost, disregarding appreciation in value of the trees, was highest-

Table 9. Apple costs and returns per bushel on 80 Berrien County farms, 1935.

Item	Age of Bearing Trees			
	14 Years and Less	15-19 Years	20-29 Years	30 Years and Up
PRODUCTION COSTS: (per bushel)	(cents)	(cents)	(cents)	(cents)
Labor, power and machinery.....	13.8	9.5	11.5	9.4
Spray material.....	6.5	6.9	6.8	6.6
Fertilizer, manure and miscellaneous.....	3.3	1.9	2.5	2.3
Total.....	26.6	18.3	20.8	18.3
HARVESTING AND MARKETING COSTS: (per bushel)				
Labor, power and truck use.....	9.0	7.9	7.1	6.5
Packages.....	7.1	9.0	7.4	5.2
Other marketing expenses.....	2.5	6.3	6.1	3.3
Total.....	18.6	23.2	20.6	15.0
OVERHEAD COSTS: (per bushel)				
Interest on trees and land.....	17.0	10.0	12.8	9.5
Taxes and general farm expense.....	6.1	4.0	5.1	4.2
Depreciation of trees.....			.3	.7
Total.....	23.1	14.0	18.2	14.4
TOTAL COST PER BUSHEL.....	65.3	55.5	59.6	47.7
INCOME: (per bushel)				
Apples.....	55.4	54.6	51.1	38.0
Appreciation of trees.....	21.4	9.3	4.0	2.3
Total income.....	76.8	63.9	55.1	40.3
NET RETURN (per bushel).....	11.5	8.4	-4.5	-7.6

for the orchards 15 to 19 years old, and lowest for the orchards 30 years old and more.

Average apple production per tree for the three years was 2.8 bushels for the orchards 14 years old or less, 4.7 bushels per tree for both those 15-19 years and from 20-29 years, and 6.6 bushels for the orchards 30 years old or more. Those yields are essentially the same as those reported by Gardner in Michigan Agricultural Experiment Station Special Bulletin 161 for a larger and more widely distributed group of Michigan orchards.

Table 8 presents a detailed statement of the costs and returns per acre according to the age of the trees, while Table 9 contains a brief statement of the costs and returns per bushel of apples. These figures were obtained by dividing the cost and returns per acre by the total bushels of apples produced per acre in 1935. Cost up to picking time, calculated on a per bushel basis, was higher on the youngest orchards and those 20-29 years old, principally because of lower yield per acre. Harvesting and marketing cost per bushel was higher on orchards 15 to 29 years than on the youngest or oldest orchards, due largely to method of marketing. Overhead costs per bushel showed a very close correlation with the yield of apples per acre, being lowest on the two age-groups with the highest yields. The average price received for the apples was higher for the younger trees, and was decidedly lower for the orchards 30 years old or older. Appreciation in value of the trees was greater on the younger orchards, so that the total income, calculated on the basis of a bushel of apples produced, was considerably higher on the young orchards.

FACTORS AFFECTING APPLE COSTS AND RETURNS

Many factors influence the yield of apples obtained per acre and the costs of production. One of the most important is the personal element of management. There is no way that this factor can be correlated with yield and costs, except as it can be measured by the methods followed by the fruit grower which lend themselves to statistical tabulation. Methods or conditions reflecting management, such as the site and soil type of the orchard, the variety and spacing of the trees, the method of pruning, amount and kind of manure and fertilizer applied, soil management, thoroughness of spraying, kind of equipment used, extent of apple thinning, and method of marketing are all more or less dependent upon the manager.

Of course, after the farmer has taken into consideration the soil type and selected the site for the orchard, selected the varieties and decided upon the spacing of the trees, nothing much can be done about it thereafter, which means that these things should be done with infinite care. There are other conditions over which the fruit grower has little or no control, such as damage by hail, low temperatures or frost, rainfall, prevalence of diseases, of insects, and the demand and supply of apples. The grower can reduce, however, the likelihood of frost damage by selection of site, partly overcome lack of rain by soil practices, and prevent insect damage by thorough spraying. This section is devoted to a consideration of the effects of the factors under

the control of the individual grower upon costs, yield per acre and net returns.

Influence of Yield on Costs and Returns—The total production of apples in this state sometimes varies as much as 100 per cent from one year to another, due to climatic conditions, insects and diseases. The average yield of apples per tree of bearing age in Michigan is about 1.2 bushels, while the average yield on these 80 farms in 1935 was 5.0 bushels per bearing tree. Apple yield per acre on these farms ranged from 17 to 534 bushels. Two growers averaged more than 500 bushels per acre or in excess of 11 bushels per tree, and three others had more than 400 bushels of apples per acre. Table 10 shows the number of growers having yields ranging from less than 100 to 350 and more, by intervals of 50 bushels per acre. The group having the lowest yield averaged only 64 bushels of apples per acre, or 1.8 bushels per bearing tree. The eight growers with the highest yields averaged 436 bushels per acre, or 10.3 bushels per bearing tree. Average yields the two preceding years indicate that the high-yield growers were consistently better. Thus it is evident that where environmental conditions were favorable for high yields and good management methods employed, an increase of approximately 100 per cent in production and overhead costs was responsible for an increase in yield of approximately 600 per cent as compared with indifferent orchards under less efficient management.

Total cost per acre in 1935 for production, harvesting and overhead costs varied from \$61.59 for the group with the lowest yield to \$167.42 for the growers having the highest yield. Approximately \$11 of the difference was in overhead costs, \$34 in production costs, and \$60 in harvesting and marketing. Figure 4 shows this difference graphically. Total income per acre in 1935 varied even more than costs, being only

Table 10. Influence of apple yield on costs per acre and per bushel, 1935.

Item	Apple Yield per Acre (in bushels)						
	99 and Less	100-149	150-199	200-249	250-299	300-349	350 and Up
Number of farms.....	16	13	16	10	11	6	8
PER ACRE:							
Yield, 1935 (bu.).....	64	121	169	222	267	312	436
Average yield, 1933-'34 (bu.)....	81	126	117	222	226	262	306
Production cost (1935).....	\$21.15	\$37.80	\$32.89	\$42.06	\$49.55	\$44.03	\$55.56
Harvest cost (1935).....	13.71	28.23	31.57	39.87	52.64	77.50	74.19
Overhead cost (1935).....	26.73	31.36	29.43	33.10	33.28	36.32	37.67
Total cost (1935).....	\$61.59	\$97.39	\$93.89	\$115.03	\$135.47	\$157.85	\$167.42
Total income (1935).....	46.11	75.62	89.64	134.79	141.56	190.02	212.39
Net return (1935).....	-15.48	-21.77	-4.25	19.76	6.09	32.17	44.97
PER BUSHEL:							
	(cents)	(cents)	(cents)	(cents)	(cents)	(cents)	(cents)
Production cost (1935).....	33.1	31.2	19.5	19.0	18.6	14.1	12.7
Harvest cost (1935).....	21.5	23.3	18.7	18.0	19.7	24.8	17.0
Overhead cost (1935).....	41.8	25.9	17.4	14.9	12.5	11.7	8.6
Total.....	96.4	80.4	55.6	51.9	50.8	50.6	38.3

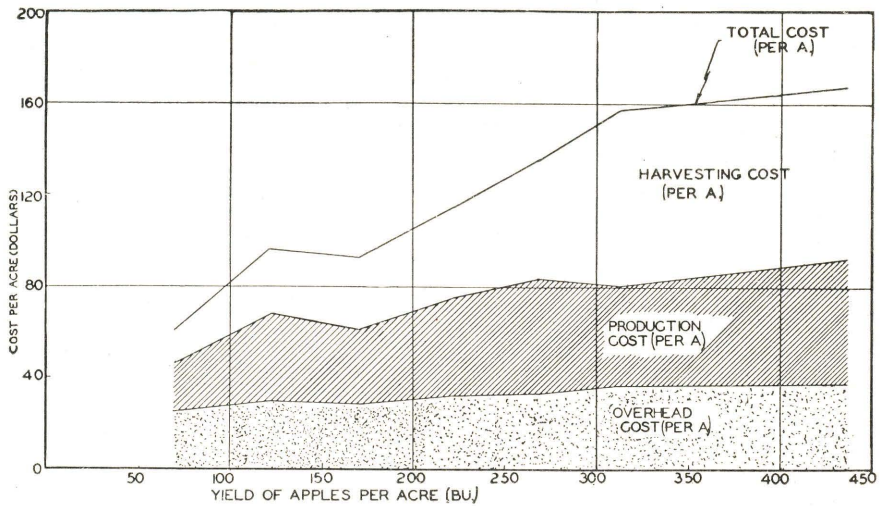


Fig. 4. Relation of yield to apple costs per acre, 1935.

\$46.11 on the low-yield group and \$212.39 on the high-yield group. Net return per acre to the grower for his management after allowing all costs of production varied from losses of \$15.48 and \$21.77 on the two low-yield groups to an average net return of \$44.97 per acre on orchards with the highest yields. Thus, the net return was more than \$60 an acre higher on the high-yield group than on the two low-yield groups, and if apple prices had been high this difference would have been still greater.

Costs per bushel of apples produced varied greatly on the low- and high-producing orchards. Total cost per bushel of tree-run apples aver-

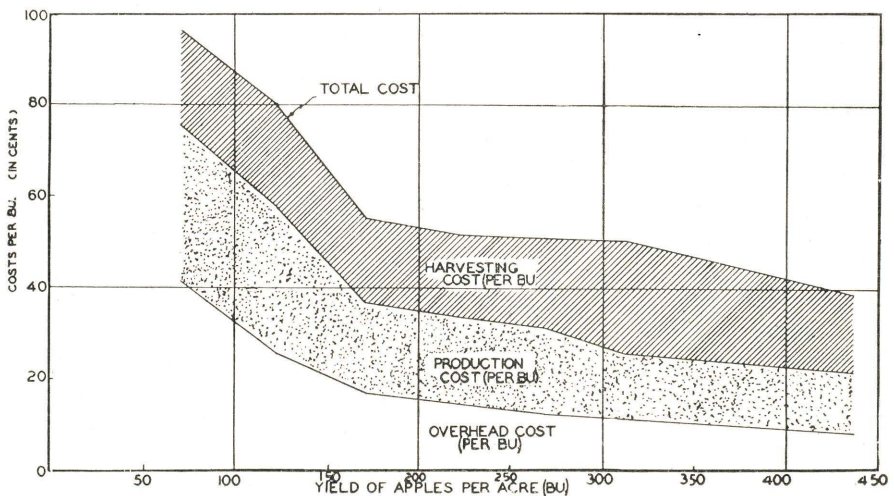


Fig. 5. Relation of yield to costs per bushel apples, 1935.

aged 96 cents on orchards averaging 64 bushels per acre in 1935, compared to 38 cents on orchards producing 436 bushels of apples (Fig. 5). Of this difference of 58 cents in the total cost per bushel of apples, 33 cents were in overhead costs, 20 cents in production cost, and 5 cents in harvesting and marketing costs. Overhead cost per bushel alone was more on the low-yield group than total cost on the high-yield. A yield of more than 200 bushels per acre was needed to pay costs of production in 1935 when the apples sold for an average of 50.7 cents a bushel, if appreciation of trees was not considered as part of the income. Forty-four per cent of the 80 orchards in this group produced 200 bushels or more per acre in 1935.

Effect of Soil Type on Costs and Returns—The farms were grouped into eight general soil types, based upon the predominating soil type of the apple orchard. In comparing the average results on each soil type it should be kept in mind that the site, the amount of erosion, the number of trees per acre, and the general level of the managing ability of the growers may have been unequal. It is thought that the number of orchards in most groups was sufficient to even out these variables, although there seems to be some discrepancy in the case of the Miami soil type results. It is generally thought that this is one of the better soil types for apple production, and the author is of the opinion that the small number of trees per acre, and possibly other factors lowered the average yield and raised the cost per bushel on this group of orchards.

The three-year average yields on this group of apple orchards indicate the desirability of Napanee, Hillsdale, and Bellefontaine soil types for apple production. The estimated cost per bushel on the basis of three-year average yields shows that apples can be produced at a lower cost on those soils. It should be pointed out that the orchards on Bellefontaine soils had an exceptionally large number of trees per acre and as those orchards get older, crowding will probably reduce the

Table 11. Influence of soil type on apple costs and returns in Berrien County, 1935.

Item	Soil Type							
	Bellefontaine	Napanee	Hillsdale	Allendale	Fox	Miami	Plainfield	Coloma
Number of farms	10	10	11	7	9	15	3	14
Acres of apples per farm	10.5	9.3	10.0	17.1	21.4	11.3	12.6	11.7
Trees per acre { Bearing	54	41	33	35	38	28	47	35
Non-bearing	2	5	4	5	1	6	2	1
Average age of trees (years)	21	21	22	19	21	25	25	19
Yield per acre in 1935 (bu.)	224	187	212	136	213	181	133	153
Yield per acre (1933-35) (bu.)	218	217	178	175	167	138	139	125
Total cost per acre in 1935	\$110	\$98	\$113	\$101	\$117	\$97	\$109	\$94
Total cost per bushel, 1935 (cents)	.49	.53	.53	.74	.55	.54	.82	.62
Total cost per bushel (1933-35)*	.50	.48	.60	.62	.66	.64	.80	.71

*Using three-year average yields, and 1935 production and overhead costs per acre, and harvesting cost per bushel.

yield. Average yields and costs also show the Plainfield and Coloma soil types to be generally undesirable for profitable apple production.

It is possible that superior management by a grower may result in a high net return on one of the less desirable soil types, or that a poor site may make a plat of one of the better soil types unprofitable for apple production. Other variable factors may also have an influence on profits, but when all other factors equal except soil type, it seems that growers locating apple orchards on Napanee, Hillsdale, Bellefontaine, and Miami soil types have the best opportunities for profitable apple production.

Relation of Number of Trees Per Acre and Costs and Returns—The records on those orchards were sorted according to the number of bearing trees per acre in order to study whatever relation there was with costs and returns. Table 12 shows that the farms with the fewest trees had the lowest yield per acre and the lowest net return. The highest yield per acre and the highest net return were obtained from apple orchards having 35 to 40 bearing trees per acre. Orchards having an average of 51 bearing trees per acre did not yield as well as the preceding group and showed a loss in 1935.

Table 12. Relation of number of bearing apple trees to cost and returns, 1935.

Item	Number of Trees per Acre:			
	Under 30	30-34.9	35.0-39.9	40 and Up
Number of farms.....	21	19	16	24
Number of trees per acre { Bearing.....	24.6	32.4	35.7	51.3
{ Non-bearing.....	4.9	3.6	2.4	2.0
Apple production per acre (bu.).....	131	187	229	187
Total cost per acre.....	\$75.31	\$105.98	\$127.42	\$108.67
Net return per acre.....	-8.50	5.29	15.62	-3.93

Age of Trees and Costs and Returns—According to Table 8 orchards having bearing trees of 14 years or less had a three-year average yield of 101 bushels, compared with 208 bushels for those 15-19 years old, 169 bushels for orchards 20-29 years old, and 213 bushels for those 30 years old or older. There were no really old orchards for comparison beyond the 30-year group.

Influence of Amount of Spray on Costs and Returns—More or less extreme variations in the costs of pruning, cultivation and of fertilizers applied were expected for there are wide differences of opinion and in recommendations as to what constitute good practice in these operations. Spraying, on the other hand, is universally accepted as a necessary procedure and for the most part there is an effort to follow a more or less standard set of recommendations (those contained in the spraying calendar⁶ of the Michigan Agricultural Extension Division). Nevertheless the records show that there were as great differences in spraying performance as in these other practices.

As few as four applications were made in some of the orchards and as many as 14 in others. Probably more important than number of

⁶Ext. Bul. 154.

applications was thoroughness of coverage measurable in part by the amount of spray material applied. The number of gallons of spray used per acre in the course of the season on these 80 orchards ranged from 225 to 4,890 and averaged 1,634. The 225 gallons were applied in 4 applications to an orchard containing 26 trees to the acre, making slightly more than 2 gallons per tree per application, an amount obviously inadequate for thorough coverage. The 4,890 gallons was applied in 14 applications to 57 trees to the acre, making approximately 6 gallons per tree per application. Assuming the same concentration of active ingredients in the spray material, here was a difference of 10 to one in the film of protection to foliage and fruit.

That the more heavily sprayed orchards should bear larger and better crops of fruit was to be expected, although part of the additional spraying may have been due to the heavier crop on the trees. The records show that the average production of the 21 orchards receiving less than 1,000 gallons of spray per acre was 75 bushels, while that of the 10 "most sprayed" orchards was 278 bushels (Table 13). Doubtless part of this difference in yield was due to the other differences between the two groups of orchards, as it would be expected that growers who do the most thorough spraying would likewise do a relatively better job of maintaining their soils. Nevertheless, there is every evidence that a considerable part of this difference in yield was due to spraying practices, though possibly some of the orchards were getting more spray material than they actually required. It was observed that most growers applying 2,000 gallons per acre on mature trees usually obtained good control of both scab and worms.

The figures on percentages of No. 1 grade fruit from these several groups of orchards receiving different amounts of spray material are less striking than those for yields. Though the fruit from those orchards receiving the least spray material graded out the poorest, there is the suggestion in the data that most of the culling of the fruit from all of the orchards was due to factors other than blemishes occasioned by insect and fungous injury, and that the further reduction of low grades must be sought through practices other than spraying.

Spray material cost per acre on individual orchards ranged from \$2.18 to \$29.66 and averaged \$11.80 an acre. The charge for labor and power used in spraying varied from \$1.01 to \$11.46 and averaged \$5.41 an acre. Annual sprayer cost ranged from \$1.92 to \$12.49 an acre, and averaged \$4.95. Total spraying cost per acre varied from \$6.19 to \$48.34 and averaged \$22.16 an acre. On a per tree basis the lowest cost was 25 cents, the highest \$1.51, and the average 55 cents. These differences are explainable partly on the basis of the greater efficiency of some of the operators and partly because of the fact that, though when the sprayer has once pulled up beside a tree it takes twice as long to put on 6 or 8 gallons as it does 3 or 4, no extra time is required for the trip to and from the supply station.

Total spraying costs on orchards receiving about 700 gallons of spray per acre (Table 13), averaged \$12.73 an acre, \$1.83 per 100 gallons, or 37 cents per bearing tree. Spraying costs on orchards sprayed the most (3,221 gallons per acre), averaged \$35.19 an acre, \$1.09 per 100 gallons, or 78 cents per tree. When the total costs of spraying were reduced to cost per bushel it was found that the spraying cost per bushel

Table 13. Influence of gallons of spray per acre on apple costs and returns, 1935.

Item	Gallons of Spray per Acre				
	999 and Less	1,000- 1,499	1,500- 1,999	2,000- 2,499	2,500 and More
Number of farms.....	21	25	11	13	10
Acres of apples per farm.....	11.5	11.2	12.4	16.8	12.1
Number of bearing trees per acre.....	34	36	38	37	45
Apple production per acre (bu.).....	75	171	202	256	278
Apple production per acre, No. 1 (bu.)....	35	90	125	160	168
Approximate number of sprays (average) .	9	10	11	14	14
Sprays used per acre (gal.).....	694	1,205	1,792	2,235	3,221
Spray material cost per acre.....	\$5.15	\$8.73	\$14.02	\$16.44	\$21.50
Sprayer cost per acre.....	4.17	3.39	4.88	4.62	5.98
Spraying cost per acre.....	3.41	5.31	5.44	6.26	7.71
Total spraying cost.....	\$12.73	\$17.43	\$24.34	\$27.32	\$35.19
Total cost per acre.....	66.14 ¹	93.26 ¹	99.86	142.03	145.27
Net return per acre.....	-17.50	.50	14.21	13.14	7.35

of apples harvested was 17 cents for the group using the least spray, 10 cents for the second group, 12 cents for the third, 11 cents for the fourth and 13 cents for the group using the most spray. Total cost per bushel of tree-run apples was 88 cents for the group using the least spray, and 52 cents for those applying the most.

Effect of Size of Orchard on Costs and Returns—The apple orchards forming the basis of this study ranged in size from two to slightly more than 50 acres. There were 13 apple orchards less than 5 acres in size, 28 from 5 to 10 acres, 25 from 10 to 20 acres and 14 over 20 acres (Table 14). Production and overhead costs totaled approximately 7 per cent less on apple orchards averaging 29 acres than on those averaging 6 acres. Yield per acre averaged 13 per cent less, so the cost per bushel of apples was higher on the large orchards. Most efficient production was accomplished on apple orchards ranging from 10 to 20 acres in size, averaging 13 acres, with 9 acres of other tree fruit. On those

Table 14. Effect of size of orchard on apple costs and returns, 1935.

Item	Acres of Apples per Farm:		
	Under 10	10 to 19.9	20 or More
Number of farms.....	41	25	14
Acres of apples per farm.....	6.1	13.4	29.2
Acres, all tree fruit per farm.....	17.0	22.3	59.0
Number of apple trees per acre.....	39	42	39
Apple production per acre, 1935 (bu.).....	190	201	165
Average age of bearing trees (years).....	23	21	22
Gallons of spray per acre.....	1,558	1,600	1,704
Production cost per acre.....	\$38.30	\$37.38	\$33.88
Overhead cost per acre.....	32.07	29.76	31.71
Production cost per bushel.....	.20	.19	.21
Overhead cost per bushel.....	.17	.15	.19
Harvesting cost per bushel.....	.20	.20	.21
Total cost per bushel.....	\$0.57	\$0.54	\$0.61

orchards, production and overhead costs were relatively low, and the yield per acre averaged higher than that of either of the other size groups.

LABOR AND MACHINERY COSTS

Labor Cost—Those fruit growers spent an average of 102 hours of man labor per acre of apples. Table 15 shows that the operators of those farms spent 29 hours per acre themselves, their family approximately 8 hours, and nearly 65 hours were hired. In other words, the operator and his family did approximately one-third the work, and two-thirds was hired. The major portion of this hired help was employed in picking the apples. Man labor was charged at 20 cents an hour in all cases, except for pruning, which was figured at 15 cents an hour. Those rates approximate the average hired help rate. No charge was made for management by the operator. At the above rates, the man labor cost averaged \$19.72 per acre, or nearly 20 per cent of the total cost. Horses were used about 24 hours, tractors 6 hours, and trucks driven about 29 miles for every acre in apples. The charge for the use of the horse, tractor, and truck averaged \$6.84 an acre, so the labor and power charge for all work on apples totaled \$26.56 an acre. This does not include the machinery and equipment expenses of \$7.23 an acre, which makes the total expense of all operations, counting man labor, horse labor, and tractor, truck and all machinery use \$33.79 an acre, or about one-third the total cost.

Table 15. Labor requirements per acre by operations in producing apples, 1935.

Operation	Man Labor per Acre:				Power per Acre:				Total Labor and Power Cost
	Operator's Hours	Family Hours	Hired Hours	Cost	Horse Hours	Tractor Hours	Truck Miles	Cost	
Pruning.....	6.3	1.1	7.9	\$2.28	3.4	.....	.....	\$0.38	\$2.66
Fertilizing....	1.4	.3	1.4	.62	1.9	2.5	.....	.45	1.07
Cultivating....	1.8	.4	2.1	.87	3.2	2.0	.....	1.66	2.53
Spraying.....	7.3	1.0	6.2	2.90	14.9	1.5	.....	2.51	5.41
Thinning.....	.4	.4	4.6	1.09	.....	.....	.....	.....	1.09
Picking.....	8.4	4.4	41.6	10.88	.3	.....	6.6	.49	11.37
Marketing.....	3.6	.9	1.0	1.08	.1	.....	22.0	1.35	2.43
Total....	29.2	8.5	64.8	\$19.72	23.8	6.0	28.6	\$6.84	\$26.56

Picking the apples was the operation requiring the most time. Those growers with a yield of 184 bushels spent 54 hours per acre in picking the apples. Pruning the trees took an average of slightly more than 15 hours per acre, and spraying nearly 15 hours per acre. The other 18 hours were spent spreading fertilizer, disking or dragging, thinning, and marketing. The labor and power cost for picking was \$11.37 per acre, spraying \$5.41, pruning \$2.66, and cultivating \$2.53. Other work cost \$4.59, making a total of \$26.56 per acre.

Labor Distribution—Figure 6 shows the monthly distribution of the work performed on the apple orchards. Hours of man labor per acre

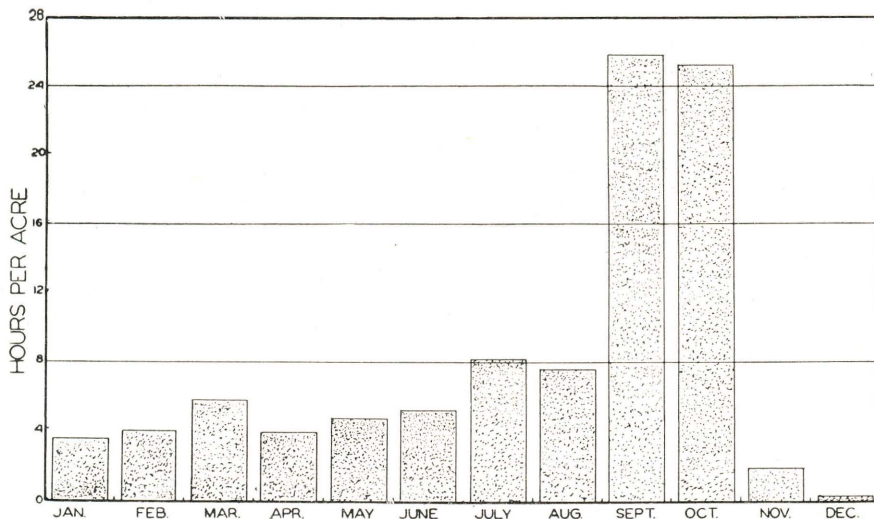


Fig. 6. Monthly distribution of man labor on apple orchards, 1935.

each month ranged from slightly under four to a little over eight hours during the months of January through August, and exceeded 25 hours per acre during both the months of September and October. Approximately one-half the season's work was picking the apples, and nearly all of this came in the latter months.

Sprayer Costs of Operation—All of the men keeping records had sprayers, and two growers had two sprayers each. Some of the sprayers were new while some were old, and the average value placed on them by the farmers was \$343. The average depreciation for the year's use was \$42.89 (Table 16), at which rate the sprayer investment would be completely depreciated in eight years from January 1935. The total expense per sprayer was \$93.51 as an average. Depreciation accounted for 46 per cent of the total, repairs 17½ per cent, interest 16½ per cent, gasoline and oil 12 per cent, and shelter 8 per cent. Of this amount \$60.10 was allocated to the apple orchard, making an average charge of \$4.95 per acre of apples for the use of the sprayer. The use of all other machinery and equipment, exclusive of tractor and truck, amounted to \$2.28 an acre, making a total of \$7.23 charge for the use of general and special equipment.

Table 16. Cost of operating sprayers, 1935.

Item	Total Cost	Share to Apples	Costs per 100 gals.
Depreciation in year.....	\$42.89	\$27.56	\$0.14
Repairs.....	16.50	10.61	.05
Interest on value.....	15.59	10.02	.05
Gas and oil.....	11.03	7.09	.04
Shelter.....	7.50	4.82	.02
Total.....	\$93.51	\$60.10	\$0.30

Spraying Costs—Those 80 fruit growers sprayed their apple orchards approximately 11 times, on the average, and used 1,634 gallons of spray material per acre or 44 gallons per bearing tree. The material for this spray cost \$11.80 an acre; the man labor, and horse labor or tractor use in preparing and applying the spray had a value of \$5.41 an acre; and the use of the sprayer was worth \$4.95, making a total cost of \$22.16 per acre for spraying those orchards (Table 17). This was about 22 per cent of the total cost. The total cost per 100 gallons of spray applied averaged \$1.37 on those orchards, and ranged from \$1.89 on orchards where 700 gallons of spray were applied per acre to \$1.09 where a total of 3,200 gallons were used. Figuring the cost of spraying on a per tree basis shows that the season's spraying cost 55 cents per tree as an average for all orchards. Apple orchards less than 15 years old had a total spraying cost of 44 cents a tree compared to 62 cents a tree on orchards 30 years old or more. Total cost of spraying per bushel of apples harvested averaged 12 cents a bushel on these orchards in Berrien County in 1935 where the average yield was 184 bushels per acre.

Table 17. Spraying costs on 80 apple orchards in Berrien County, 1935.

Item	Costs per Acre:		Costs per 100 Gals.	
	Amounts	Values	Amounts	Values
Spray material.....	1,634 gals.	\$11.80	100 gals.	\$0.73
Sprayer use.....	6.7 hrs.	4.95	.4 hrs.	.30
Man labor.....	14.5 hrs.	2.90	.9 hrs.	.18
Horse labor.....	14.9 hrs.	1.49	.9 hrs.	.09
Tractor use.....	1.5 hrs.	1.02	.1 hrs.	.07
Total.....		\$22.16		\$1.37

DISCUSSION

It is impracticable, if not impossible, to set any figure as an irreducible minimum for the cost of any single orchard operation any one year—unless, indeed, that minimum be zero, for obviously no pruning may be given, no fertilizer may be applied, no cultivation afforded or no thinning may be done, and yet the trees will bear more or less of a crop. Spraying alone is to be regarded as indispensable and even that may be drastically reduced some one season under special conditions, and reasonably good returns may be obtained. Experience demonstrates, however, that all of those practices and operations have their place in orchard management and that it is poor economy to try to reduce expenditures for them too far. Furthermore, the overhead costs not only cannot be done away with, but little can be done to reduce them, once the orchard is established.

In this group of 80 orchards the absolute minimum costs per acre in 1935 were: pruning \$0.25, cultivating \$0.35, spraying \$1.01, spray material \$2.18, fertilizer 0, and thinning 0. These make a small amount, but the lowest total cost on any orchard was \$47.60 an acre when over-

head, harvesting, and all items were included. The yield on this 17-year old orchard was only 24 bushels per acre, so the apples cost \$2 a bushel.

The average total cost on all orchards was \$104.63 an acre. The lowest cost per acre for any orchard in the group that showed a profit was \$48.90 on a 32-year old orchard that produced 126 bushels per acre. The average cost for the 34 orchards showing a profit on the season's operations was \$113.85 an acre. Those men had an average yield of 236 bushels per acre and made a profit of \$28.67 an acre in 1935.

It, therefore, seems reasonable to figure that if an apple orchard in Berrien County is to be so operated that it is likely to pay expenses, and net the owner something in the way of a profit, it will call for a "production" expenditure of approximately \$40 an acre, a harvesting and marketing cost of around \$40, plus an overhead cost of \$33 an acre. This means that if the crop grades out about as it does on the average and is sold at the average prices that have prevailed during the last decade, a yield of approximately 190 bushels per acre must be obtained. Unless the site, soil, and management methods are such that this can be done, the apple orchard is likely to be a financial failure.

On the other side of the picture, this study indicates that if site, soil, and management methods are such that a total expenditure of \$95 per acre will barely place the orchard on a paying basis, the expenditure of an additional \$20 an acre for fertilizer, better cultivation, spraying, thinning or other good practices, will be likely to increase the gross returns \$40 per acre, or twice the expenditure involved. Thus, the net return would be increased to approximately \$20 an acre.

SUMMARY

This detailed study of 80 orchards in Berrien County in 1935 provides data on the amount of labor and materials necessary in producing apples, the costs of all items used, and the relationship between conditions or management practices and the efficiency of apple production.

Those fruit growers kept records on an average of 12.5 acres of apple trees per farm. There was 37 bearing and 3 non-bearing trees per acre as an average. A total of 102 hours of man labor per acre was spent during the season. Spray material applications averaged 1,634 gallons per acre. The yield of apples on these farms averaged 184 bushels per acre in 1935.

Costs and Returns Per Acre of Apples—The cost of spray material, fertilizer, and labor and power up to picking time (production cost) averaged \$36.13 an acre in 1935. Costs of harvesting and marketing averaged \$37.37 an acre. Overhead costs were \$31.13, making a total cost of \$104.63 per acre of apples. Income from apples averaged \$93.05 an acre and appreciation in value of trees made a total credit of \$106.19 per acre. (For a detailed statement see Table 5.)

Costs and Returns Per Bushel—Production costs on those farms in 1935 averaged 19.6 cents per bushel of apples harvested. Harvesting and marketing costs amounted to 20.3 cents a bushel, while overhead costs totaled 17.0 cents per bushel. The entire cost amounted to 56.9

cents per bushel of tree-run apples on those orchards producing 184 bushels of apples per acre. If the yield had been the 170 bushels, which was the average the two preceding years, the total cost per bushel would approximate 65 cents. Income from the sale of apples in 1935, approximately one-half of which graded No. 1, averaged 50.6 cents a bushel, and appreciation in value of trees amounted to 7.1 cents per bushel.

Comparison of Profitable and Unprofitable Orchards—The 15 most profitable orchards had an average profit of \$43.32 an acre, while the 15 least profitable had a loss of \$36.83 per acre. The high-return orchards produced nearly three times as many apples per acre of higher grade and better varieties than the unprofitable orchards. Reasons for the higher return were better soil types, better sites, and better management. The total cost per bushel apples was 47 cents on the profitable group and 84 cents on the unprofitable.

Influence of Yield Per Acre on Costs and Returns—The production of apples varied from 17 to 534 bushels per acre on those farms, and was one of the most important factors affecting the cost per bushel, and the net return per acre. Sixteen of the lowest yield orchards of the group averaged 64 bushels per acre, and the apples produced on those farms cost 96 cents a bushel. Eight high-yield growers averaged 436 bushels, and the total cost was 38 cents per bushel. A yield of approximately 200 bushels was needed to pay costs of production in 1935, if appreciation in value of trees was not added in as income.

Soil Types and Its Effect on Net Returns—The fruit growers cooperating in this study who had their orchards on Nappanee, Hillsdale or Bellefontaine soil types had higher three-year average yields than did the others. The Plainfield and Coloma soil types had the lowest three-year yields.

Relation of Number of Trees Per Acre to Returns—Generally speaking, the orchards having from 35 to 40 trees per acre gave larger net returns than those having either more or less trees per acre.

Influence of Amount of Spray Used on Costs and Returns—Growers applying an average of approximately 3,200 gallons of spray per acre had a total spraying cost of \$1.09 per 100 gallons, or 40 per cent less than those using about 700 gallons per acre. Those using the most spray harvested 278 bushels of high grade apples, produced at a cost of 52 cents per bushel, while those using the least had 75 bushels of relatively low-grade apples costing 88 cents a bushel.

Effect of Size of Orchard on Costs and Returns—Small orchards tended to have slightly higher costs per acre than large. The cost per bushel of apples averaged lowest on the apple orchards ranging from 10 to 20 acres in size.

Sprayer Costs of Operation—The total cost of operating sprayers on those farms averaged \$93.51 each. The apples share of this cost amounted to \$4.95 an acre. Depreciation accounted for 46 per cent of this cost, repairs 17½ per cent, interest on value 16½ per cent, gasoline and oil 12 per cent, and shelter 8 per cent.

Spraying Costs—The total cost of spraying was \$22.16 an acre, or \$1.37 per 100 gallons of spray as an average. The spray material constituted 53 per cent of this cost, sprayer use 22 per cent, and man labor, horse and tractor use, 25 per cent.

Labor and Machinery Costs—Of the total of 102 hours of man labor spent per acre on those farms, one-third was performed by the operator and his family, and two-thirds was hired. An average of 54 hours were spent picking the apples, 15 pruning, 15 spraying, and the balance in other operations. Regarding monthly distribution, about one-half of the entire season's work was performed in September and October. The other one-half was fairly evenly distributed from January through August. The total charge per acre for man labor was \$19.72 per acre; for horse, tractor and truck use \$6.84 per acre; and for other machinery and equipment use \$7.23 per acre. Those items made up about one-third the total cost of production.

APPENDIX

Table 18. Number of apple trees of bearing age in specified states.

State	1890	1900	1910	1920	1930
EASTERN					
New York.....	14,429,000	15,054,832	11,248,203	9,636,698	8,284,507
Virginia.....	4,253,364	8,190,025	7,004,548	7,385,277	7,889,771
Pennsylvania.....	9,007,700	11,774,211	8,000,456	6,988,594	6,244,104
West Virginia.....	2,870,535	5,441,112	4,570,948	5,554,731	5,246,817
North Carolina.....	4,249,468	6,438,871	4,910,171	3,474,821	3,116,115
CENTRAL					
Michigan.....	8,582,386	10,927,899	7,534,343	5,615,905	5,199,890
Ohio.....	10,860,613	12,952,625	8,504,886	5,970,410	4,660,680
Illinois.....	6,949,336	13,430,006	9,900,627	5,113,063	3,718,007
Missouri.....	8,150,442	20,040,399	14,359,673	5,162,859	3,047,219
WESTERN					
Washington.....	315,479	2,735,824	3,009,337	7,964,167	5,193,571
California.....	1,269,784	2,878,169	2,482,762	3,128,386	2,874,417
Oregon.....	1,268,395	2,825,898	2,029,913	3,315,093	1,641,101
Idaho.....	96,497	982,349	1,005,668	2,380,523	1,250,179
OTHER STATES.....	47,759,796	88,122,544	66,761,305	43,618,638	29,536,592
UNITED STATES.....	120,152,795	201,794,764	151,322,840	115,309,165	88,848,970

Table 19. Apple production for specified states, 1928-'35.

State	Total Production in Million Bu.				Commercial Production in Million Bu.*			
	Average 1928-'32	1933	1934	1935	Average 1928-'32	1933	1934	1935
EASTERN								
New York...	19.0	16.1	11.8	16.9	12.8	9.6	8.3	9.8
Virginia...	13.2	10.9	9.3	16.7	8.2	5.3	6.6	10.7
Pennsylvania...	9.6	7.3	8.6	11.4	3.8	2.2	3.4	4.0
West Virginia...	6.9	4.2	3.6	5.6	3.7	2.1	2.5	3.1
CENTRAL								
Michigan....	6.6	8.7	6.5	9.2	4.2	5.2	4.2	5.5
Ohio.....	6.5	4.4	4.0	8.0	1.9	1.5	1.4	2.7
Illinois.....	4.5	2.2	2.4	7.2	3.1	1.6	1.9	5.4
Missouri.....	2.4	3.1	1.5	4.4	1.2	1.6	.7	2.3
WESTERN								
Washington..	33.5	29.2	33.0	31.4	27.8	20.0	24.5	20.6
California....	10.2	9.7	6.5	10.4	5.5	4.4	3.6	5.1
Idaho.....	5.1	5.2	3.3	5.9	4.1	3.5	2.5	3.6
Oregon.....	5.1	3.5	4.8	3.9	3.4	1.8	3.1	2.1
OTHER STATES.	38.7	38.5	25.4	37.5	18.2	16.2	10.8	16.8
UNITED STATES	161.3	143.0	120.7	168.5	97.9	75.0	73.5	91.7

Above data compiled from Crops and Markets, Vol. 11, No. 12; Vol. 12, No. 7 and No. 12.

*That portion of the total crop sold for consumption as fresh fruit.

Table 20. Number of apple trees and apple production in Michigan, 1889-1935.

Year	Number of Trees		Apple Production		Price per Bu. Dec. 1	Total Value of Crop (000 omitted)
	Bearing	Non-bearing	Total (1,000 bu.)	Commercial (1,000 bu.)		
1889.....			13,155			
1890.....	8,582,386		7,834			
1891.....			8,236			
1892.....			8,021			
1893.....			7,074			
1894.....			12,852			
1895.....			5,383			
1896.....			22,984			
1897.....			3,787			
1898.....			11,826			
1899.....			8,932			
1900.....	10,927,899		12,085			
1901.....			5,433			
1902.....			18,544			
1903.....			16,556			
1904.....			20,374			
1905.....			6,875			
1906.....			14,754			
1907.....			10,023			
1908.....			7,185			
1909.....			12,333			
1910.....	7,534,343	2,253,072	4,196			
1911.....			12,110			
1912.....			16,332		\$0.50	\$8,166
1913.....			8,162		.85	6,938
1914.....			15,434		.55	8,489
1915.....			8,227		.74	6,088
1916.....			10,582	4,242	.87	9,206
1917.....			4,254	1,545	1.40	5,956
1918.....			11,124	4,485	1.15	12,793
1919.....			5,844	3,150	2.20	12,857
1920.....	5,615,905	2,050,229	15,097	9,000	.77	11,625
1921.....			5,094	3,200	1.95	9,933
1922.....			10,617	6,000	.88	9,343
1923.....			9,938	6,500	.85	8,447
1924.....			5,361	3,500	1.14	6,112
1925.....			8,204	5,500	1.00	8,204
1926.....			8,428*	4,600	.62	4,964
1927.....			3,899	2,500	1.50	5,848
1928.....			4,924	3,200	1.30	6,401
1929.....			6,760	4,750	1.30	8,788
1930.....	5,199,890	1,393,611	5,588	3,500	1.05	5,867
1931.....			10,132	6,000	.50	5,066
1932.....			5,800	3,500	.65	3,770
1933.....			8,651	5,148	.65	5,623
1934.....			6,464	4,224	.90	5,818
1935.....			9,177	5,520	.66	6,057
Average, 1925-'34			6,885	4,296	.95	6,033

Figures prior to 1912 from V. H. Church, Division of Crop and Livestock Estimates, U. S. D. A. Data after that date from Annual Crop Reports for Michigan, 1928, 1934 and 1935. *Includes 421,000 bushels not harvested on account of market conditions.

Table 21. Average (pool) prices* of specified apple varieties at two fruit exchanges in southwestern Michigan.

Variety	U. S. No. 1						Michigan "B"					
	1932	1933	1934	1935	1936	Av.	1932	1933	1934	1935	1936	Av.
Baldwin....	\$0.95	\$1.00	\$1.22	\$0.79	\$1.11	\$1.01	\$0.70	\$0.70	\$0.80	\$0.59	\$0.77	\$0.71
Delicious....	1.27	1.27	1.55	1.25	1.65	1.39	.90	.85	.97	.85	1.15	.94
Greening....	.90	1.06	1.20	.82	1.18	1.03	.70	.70	.85	.56	.72	.71
Grimes....	.76	.92	1.17	.65	1.10	.92	.60	.67	.90	.53	.76	.69
Jonathan....	1.15	1.12	1.35	.91	1.40	1.19	.77	.77	.95	.64	.95	.82
King....	.97	1.05	1.20	.77	1.25	1.05	.70	.70	.85	.56	.87	.74
McIntosh....	1.12	1.20	1.30	.91	1.21	1.15	.87	.82	1.02	.71	.80	.84
NorthernSpy	1.10	1.15	1.27	1.11	1.15	1.16	.72	.75	.90	.63	.84	.77
Snow....	.92	.97	1.27	.71	1.12	1.00	.62	.75	.92	.56	.77	.72
Stark....	.85	1.02	1.17	.81	1.11	.99	.65	.75	.85	.65	.76	.73
Wealthy....	.72	.91	1.17	.73	1.22	.95	.50	.66	.80	.56	.83	.67

*Prices at which packed apples sold F. O. B. shipping point. Expenses for packages, packing, grading and other handling costs average approximately 30 cents per bushel of apples shipped.

Table 22. Range and average of Jonathan apple (pool) prices* at a number of fruit exchanges in southwestern Michigan.

Year	U. S. No. 1		Michigan "B"	
	Range**	Av.***	Range**	Av.***
1932.....	\$0.90—\$1.20	\$1.05	\$0.75—\$0.80	\$0.77
1933.....	1.00—1.15	1.06	.75— .75	.75
1934.....	1.20—1.45	1.29	.90—1.00	.95
1935.....	.70— .98	.88	.63— .65	.64
1936.....	1.25—1.45	1.34	.90—1.00	.95

*Prices at which packed apples sold F. O. B. shipping point. Expenses for packages, packing, grading and other handling costs average approximately 30 cents a bushel on apples shipped.

**Range in prices is from lowest to highest at various exchanges.

***Average prices are for the five exchanges furnishing data on U. S. No. 1 prices, and for the two giving data on Michigan "B" apple prices.

EXPLANATION OF COST ITEMS

In this cost of production study the physical amounts used were obtained on all items where such was possible. In arriving at values, all purchased items were figured at actual cost on each farm. On the items that were not purchased, assumed rates were used that approached cost or market value as nearly as possible.

Man Labor—Actual records were kept on each farm of the hours spent on each operation by the operator, the family and hired labor. The prevailing wage paid approximated 15 cents an hour for pruning and 20 cents for all other work, and all labor was charged at these rates. No attempt was made to include a management charge on the operator's labor.

Horse Labor—The work performed by horses was shown in the labor record. It was figured at 10 cents per horse hour, which was the estimated total cost of horse labor.

Machinery Use—The hours of tractor use were also shown in the labor record. Light two-plow tractors were figured at 60 cents an hour, and standard two-plow tractors at 75 cents. This estimated rate included all costs, and closely approaches the actual costs on other farms. Truck use rate was estimated by each farmer and ranged from 5 to 8 cents per mile, depending upon the size of the truck. These rates do not include the driver. The charge for the use of general and special orchard machinery and equipment was based upon the actual record of the depreciation, repairs, supplies, interest on value, and housing charge. Apples were charged a proportionate share depending upon usage.

Manure and Fertilizer—Barnyard manure was figured at \$2.50 a ton applied on the field. This amount, however, was distributed over four years, 40 per cent being charged the first year following application, 30 per cent the second, 20 per cent the third, and 10 per cent the fourth. In the case of commercial fertilizer, which consisted almost entirely of available nitrogen, no charge was made for applications previous to 1935 and all of the 1935 fertilizer cost was charged against the year's crop.

Spray Material—An actual record was kept of the amount and cost of all spray material used.

Packages and Other Marketing Expenses—Some growers sold the apples in bulk and some packed them. Any money spent for packages was entered in the cash record and charged as a cost. Some of the growers sold their apples through co-operative associations and all expenses for washing, grading and packing were entered as a cost.

Land and Tree Values—The land and the trees were valued separately. The bare land value on each farm was placed by the fieldman and varied from \$35 to \$75 an acre depending upon its value for fruit production. The value placed on the trees was estimated, and was intended to approximate the cost of growing the trees to their present age. The trees were increased in value from 55 to 80 cents apiece each year until the trees were 20 years old, with the higher rates being used where there were fewer trees per acre. No attempt was made to evaluate variety of trees, variation in size, site or location. Interest on the land and tree value was figured at 5 per cent and considered as a cost.

Taxes—The farm taxes were prorated to the orchard, not on an acre basis, but in approximately the proportion of the orchard value to the total farm value.

General Farm Expenses—Five per cent was added to the total of all costs for the orchard's share of the general farm expenses. Those expenses include such items as the farm share of the auto and telephone, labor on miscellaneous jobs, interest and taxes on land in roads, lanes, farmstead, ditches and fences, upkeep of fences and all other miscellaneous expenses that cannot be allocated to some specific enterprise. Complete cost accounts indicate that the above rate is about each farm enterprise's share of these expenses.

DESCRIPTION OF SOIL TYPES*

Allendale—

Sandy and fine sandy loams. Dark gray acid soils, underlain by wet sand; clay at 18 to 36 inches. Hard pan and iron crusts in places. Medium fertility. Flat plains, swales and gentle slopes.

Bellefontaine—

Sandy loams and light loam; moderately stony. Reddish sandy and stony friable clay subsoil, and coarse pervious sub-stratum. Medium moisture; limy at shallow depths; medium fertility. Ridges and plateau-like upland; pot holes, basins, knobs and lakes common; smooth to broken and choppy topography.

Coloma—

Sands or light sandy loams, underlain by yellowish dry sand to three feet or more, thence by pervious heterogeneous sand, clay and stones. Low in organic matter, low to medium in moisture, medium to low fertility; acid to depths of three to five feet; lime in the sub-stratum. Rolling or hilly upland.

Fox—

Light brown and brown sandy and loam soils over reddish sandy and gravelly clay and a dry sub-stratum of limy sand and gravel which appears at two to four feet. Acid surface soils; low to medium in organic matter; low to medium in moisture. Level plains, terraces, and old beach ridges. Extensive gravelly plains level to pitted land gently rolling.

Hillsdale—

Sandy loams and light loams. Light brownish and yellowish surface soil underlain by yellowish friable but moderately retentive sandy loam and gritty clay. Land locally stony. Medium in elements of fertility. Acid to depths of three to four feet. Hilly to smooth rolling upland. Locally very steep slopes, associated lakes, muck swamps, and dry depressions.

Miami—

Light brownish loam and silt loam over brownish compact and retentive but granular gritty clay. Clay sub-stratum extends to depths of several feet. Moist but not excessively wet; acid surface but limy at shallow depths. In general relatively high fertility. Locally stony but not excessively so. Gently rolling upland clay plains, associated swales of wet darker colored clay land, lakes and muck swamps. Locally steep slopes.

Napanee—

Grayish and light brown silt and clay loam surface soil over very compact yellowish clay. Lighter colored surface soil and more compact and plastic clay than that under the Miami. Level and rolling upland; clay plains, and land strips adjacent to streams in association with Brookston soils. Locally steep slopes and bluffs.

Plainfield—

Light brown sands and light sandy loams. Yellowish and grayish sand or sand and gravel to depths of several feet without any retentive clay layers. Low in organic matter and other mineral elements of fertility, and low in average moisture content. Acid to depths of 3 or 4 feet. Soil subject to blowing. Level sand plains and dry sandy valleys. Locally undulating and pitted.

*From J. O. Veatch "Agricultural Land Classification and Land Types of Michigan", Mich. Agr. Exp. Sta. Special Bul. No. 231 (Apr. 1933) pages 18-23.