INFLUENCE OF DEGREE OF SPECIALIZATION OF SOUTHERN MICHIGAN DAIRY FARMERS ON EFFICIENCY AND EARNINGS, 1940 TO 1949

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INFLUENCE OF DEGREE OF SPECIALIZATION OF SOUTHERN MICHIGAN DAIRY FARMERS ON EFFICIENCY AND EARNINGS, 1940 TO 1949

By

Ray O. Yeutter

AN ABSTRACT

Submitted to the School of Graduate Studies of Michigan
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During the period 1940-1949 there was a trend toward greater specialization in dairying by Michigan farmers. This study was undertaken to determine if specialized dairy farmers have higher incomes or are more efficient than diversified dairy farmers.

A sample of farms from the Michigan Farm Account Study was chosen for analysis. The farms included in this study were [1] located in southern and southeastern Michigan, [2] farm account cooperators throughout the period 1940-49, and [3] classed as either specialized dairy farms, diversified dairy farms or dairy-hog farms on the basis of their 1949 organization. This breakdown of farms was based on the per cent of the productive man work units spent on the various enterprises. The specialized dairy farms were further separated into large and small farms depending on the average number of cows kept.

Data from the farm account records of these farms were studied by tabular analysis to find how the four groups compared in farm income and efficiency.

Data from the years 1940, 1947 and 1949 were also studied by correlation analysis to find the relationship between degree of specialization and efficiency and between size of enterprise and efficiency.

Degree of specialization in the dairy enterprise was but one of many factors that affected a dairy farmer's income.

Labor income was influenced more by volume of business and relative price levels than degree of specialization.

Rate of return on investment was mainly the result of relative price levels.

The correlation between labor income and gross income was highest on the specialized dairy farms. Because of this a specialized dairy farmer is more likely to see his gains in gross income evenly reflected in labor income.

Stability of labor income was related to size and kind of business as well as degree of specialization. The specialized dairy farms, however, had a more stable labor income than diversified farms with the same volume of business. This means when planning his organization a dairy farmer should think of expense, income and efficiency and not consider diversification solely for the purpose of spreading risk.

Specialization in dairying had a small, but significant, positive effect on dairy sales per cow. This small relationship is important for it means with careful planning a farmer who increases his dairy herd may also increase his income per cow.

There was no significant difference among the four groups of farms in efficiency in the use of buildings, machinery and equipment. In labor efficiency the only significant difference was that the small specialized dairy farms

were less efficient than the other three groups. This means if there were efficiencies connected with specialization in dairy during the period 1940-1949 the specialized dairy farmersin this study did not take advantage of them.

This study has shown the importance of volume of business on a farm. Regardless of degree of specialization in dairying or the efficiency with which a farm is operated, a large volume of business is necessary for a satisfactory income.

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The author also wishes to thank the farmers who faithfully cooperated in the Farm Account Study throughout the period covered by this thesis.

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Any omissions or errors in this manuscript are to be credited to the author.

TABLE OF CONTENTS

TABLE OF CONTENTS [continued]

TABLE OF CONTENTS [continued]

LIST OF TABLES

LIST OF TABLES [continued]

LIST OF FIGURES

INTRODUCTION

One of the questions often asked a person who has undertaken or completed a research study is, "Why did you select this particular topic?" In the author's case, the following bit of history is offered in answer to that question.

At the 1940 Lenawee County Farm Management banquet, Mr. Clyde May, then Extension Specialist in Farm Management, asked his audience, "What are the prospects for the dairy industry becoming more specialized?"[1] This question which, incidentally, Mr. May made no attempt to answer, started a good-natured discussion between the large producers of milk and the men with smaller herds.

One of the dairymen with a large herd said, "The man with four or five cows doesn't make any money, but he does help to produce the surplus which depresses the market."

Another dairyman declared, "The big producers are squeezing out the little man who can't afford to meet inspection requirements. The dairy doesn't want to buy his milk because there is just as much bookkeeping work in

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[1]Annual Report of Lenawee County Agricultural Agent (1940), p. 157.

his case as with the large accounts and the hauler doesn't want to bother with a small amount of milk."

A hog raiser, who also had a few cows, observed, "Then the dairyman must quit raising a few hogs because he depresses the market for the large producers of hogs."

The author attended this particular banquet and, as a boy of fourteen, was impressed with the observations quoted above. Then, and later, he often wondered whether they were true. His interest in the subject continued and when, eleven years later as a beginning graduate student in Agricultural Economics, it came time to pick a topic for thesis research he was fortunate in having his advisor agree to the undertaking reported in the following pages.

REVIEW OF PERTINENT LITERATURE

The effect of specialization on efficiency and earnings has either been ignored or treated sketchily by most writers of farm management texts. A few have discussed the subject and a digest of their views follows.

In Elements of Farm Management, John A. Hopkins, bases his analysis on the principle of comparative advantage.

As advantages of specialization Hopkins lists growing on land the crops it is best suited for, allowing the operator to become more efficient in the operations required for the enterprise, making for more efficient use of capital and making farm management easier.

As advantages to diversification he lists reducing risk and taking advantage of complementary and supplementary relationships.

Hopkins states, "The greatest comparative advantage usually results from a combination of enterprises rather than any single one." He adds the whole group of enterprises should yield the highest net return from a farmers resources. Enterprises should be added and increased as long, and only as long, as such action promises to increase net income.

In Production Economics, John D. Black emphasizes that specialization is a matter of degree. A highly diversified

farm is slightly specialized in a number of enterprises while a highly specialized farm is highly specialized in one enterprise.

Dr. Black points out the difficulty a farm manager has in forecasting in advance the effect adding another enterprise will have on farm income. This is the result of enterprises which are supplementary or complementary in certain areas being competitive in other areas. The net result of this effect is often impossible to estimate.

Dr. Black adds that cost accounting is of little value in determining the enterprises to be combined in a farm business. This is because the act of combining the enterprises changes the conditions the data were based on.

He gives an example of a single enterprise business which added a supplementary enterprise. At the end of the first year the records were compared to see if the supplementary enterprise should be continued. From this analysis three decisions could have been made. They are: [1] the supplementary enterprise doesn't pay and it should be discontinued, [2] the supplementary enterprise adds to net income and should be continued, or [3] more time is needed to see if the supplementary enterprise adds or lowers the net income. Dr. Black says that if adding the enterprise doesn't prove successful in the long run it is probably an expensive experiment.

In Forward Prices for Agriculture, D. Gale Johnson lists four reasons farmers diversify. They are: to spread risk, to attain a more even seasonal distribution of receipts, to include a product with a high degree of price stability and to make fuller use of resources. He states the first three reasons are the result of the capital market while the fourth is the result of the technical conditions of production. He adds that, "Diversification is probably carried beyond the point that would be required by cost considerations alone, and farmers thus sacrifice income because of safety preference."

Glenn L. Johnson and Lawrence A. Bradford in their book Farm Management Analysis take a more statistical approach to the problem. They show how by the use of iso-cost, iso-revenue, and marginal value product curves a farm business can be planned so the marginal value of the inputs are equal in all enterprises.

TERMINOLOGY USED

Since it has seemed advisable to present precise concepts of certain terms used in this paper, as well as to avoid an undue number of explanatory footnotes, all terms which the author feels merit explanation are defined below.

Animal Unit -- The amount of livestock equivalent to a mature cow; based primarily on the amount of feed consumed.

Budgeting or Substitution -- A method of analysis in which model budgets are set up to determine the effect of various combinations of factors upon an enterprise or firm. This method attempts to determine in advance what substituting one condition or practice for another will have on output. This method requires enough factual information on inputs and outputs to give sound basis for the calculation.

Butterfat Feed Ratio -- The pounds of feed-ration equal in value to one pound of butterfat.

Case Studies -- A method of analysis in which a large amount of information from a few cases (or one case) is collected and analyzed in detail.

Competitive Enterprises -- Those which compete for the use of one or more of the farmer's productive resources, and thus tend to crowd each other out of the farming system.

Complementary Enterprises -- Those enterprises which are mutually contributive, one to the other, and thus contribute jointly to the farm income.

Corn-Hog Ratio -- The number of bushels of corn that the price of 100 pounds of hog will buy.

Crop Yield Index -- The percentage the combined crop yields on an individual farm are of the average yields of the same crops on all farms considered.

Diversification -- Dividing the available inputs among several items of production.

Expenses and Net Decreases -- The sum of cash expenses and net inventory decreases.

Experience-Observation Studies -- Information from a large number of cases is assembled and classified according to various factors. The effect of these factors is measured statistically.

Farm Expenses -- The sum of the following items: [1] cash expenses, [2] net inventory decreases and [3] a charge for operators and unpaid family labor. (Interest on investment is not included.)

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Gross Income (or Receipts and Net Increases) -- The sum of cash receipts from the sale of farm products, miscellaneous items and payment for labor off the farm and the net increases in any of the enterprises and feed crops and supplies.

Labor Income -- The return to the operator for his labor and management. In computing labor income "Expenses and Net Decreases" is subtracted from "Receipts and Net Increases" to give "Return for Family Labor". From this the value of the unpaid family labor other than the operator is subtracted to give "Net Farm Income". A charge for interest (usually 5 per cent) is subtracted from "Net Farm Income" to give "Labor Income".

Milk Feed Ratio -- The pounds of feed-ration equal in value to one pound of milk.

Parity Ratio -- Index of prices received by farmers in Michigan divided by the index of prices paid by farmers in the United States. (The latter includes prices paid, interest, taxes, and wage rates.)

Productive Man Work Unit (PMWU) -- The average amount of productive work that can be done by a man working at average labor efficiency in a ten hour day. Productive work implies work on crops, livestock and other income activities such as labor off the farm.

Rate Earned on Investment -- The return for the capital invested expressed in per cent. It is found by deducting a charge for operators labor from "Net Farm Income" to get "Net Income from Capital Investment." This is divided by the total investment (beginning inventory) and the result multiplied by 100 to give "Rate Earned on Investment."

Specialization -- Concentrating the available inputs upon one main enterprise or item of production.

MATERIALS AND METHODS

The choice of an approach to this subject presented a number of problems and a number of alternatives. The alternatives were: [a] budgeting, [b] case studies, and [c] experience - observation studies. The problems involved the feasibility of the several alternatives, as well as the availability of data to be used for each. Although the budgeting technique allows all factors but one to be held constant, it presents a major problem: The obtaining of accurate input-output data. In 1951, when this study was being planned, most input-output data contained gaps that would have limited their use in a study of this kind. Case Studies, in addition to requiring a great amount of time, are quite expensive. Experience - observation studies are relatively inexpensive, if all the needed data are available, and the amount of time required to complete a project is not unduly great. The major disadvantage of experience-observation studies is the fact that the data upon which they are based are generally collected for some other purpose and do not always fit completely into the limits of a given problem.

After weighing the advantages and disadvantages of the three possible types of approach, the experience -

observation method was decided upon. Data for this study were taken from the summary sheets of the Michigan farm account cooperators. These summary sheets contain the most important information taken from the farm account books kept by farmers in cooperation with the Extension Service of Michigan State College. Summary sheets for every year since 1929 are now on file in the Department of Agricultural Economics, and some digests of these summaries have been published.

The years 1940 to 1949 were selected for this study because during this ten year period a large number of farmers were cooperating with the Extension Service and, also, this was a period when the parity ratio ranged from 85 to 121.

Type-of-Farming areas one, two, five, six, seven, and eight in southern and southeastern Michigan were selected as the area to be studied. (Fig. 1.) This area was selected because it is a commercial dairy section containing both specialized and non-specialized dairy farms.

For another study the Department of Agricultural Economics separated the 1949 records into groups based on the percentage of productive man work units spent on the various enterprises. Productive man work units were used instead of income because they do not change when prices change as much as income does. The groups of cooperators and the number in each group who had cooperated throughout the period 1940 to 1949 were as follows:

Group 1 -- Specialized dairy [41 farms]

Group 2 -- Diversified dairy [27 farms]

Group 3 -- Dairy - poultry [14 farms]

Group 4 -- Dairy - hogs [24 farms]

Group 5 -- Cash crops-dairy, and/or general livestock [14 farms]

Group 6 -- Farming and supplemental income

Group 7 -- Crops only, or primarily crops

Group 8 -- General livestock [26 farms]

Three of the above groups (1, 2, and 4) were selected for this study since they show varying degrees of specialization in dairying and contained enough farms in each group to be statistically significant. The organization of the farms in the three groups is shown in Table I.

The specialized dairy farms (41 in number) were further subdivided into large specialized dairy farms (20 in number) and small specialized dairy farms (21 in number). All of the 92 farms were located in the 27 counties of southeastern Michigan which fall within Type-of-Farming areas one, two, five, six, seven, and eight (see Map, Fig. 1). Large specialized dairy farms were concentrated in areas five, six, and seven; dairy-hog farms were primarily within areas one, two, and five; and the other two types of farms were more or less equally scattered through the area of study. All of the farms had been represented for ten years or more, as of 1949, in the farm account study.

TABLE I

ORGANIZATION OF THE FARMS IN THE THREE GROUPS USED IN THIS STUDY

	Per cent of the productive man work units spent on the various enterprises		
Enterprise	Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
Dairy	60% or more	25% or more	10 % or more
Hogs	less than 1%	less than 5%	5% or more
Beef	less than 5%	less than 5%	less than 5%
Sheep	less than 1%	less than 5%	less than 1%
Poultry	less than 10%	less than 25%	less than 25%
Crops	less than 40.5%	less than 40.5%	- - - - -
Off Farm	less than 10%	less than 25%	- - - - -

The 92 farms utilized in this study were probably better than average for the areas in which they are located, for at least two reasons. First the better farmers would tend to cooperate in the study and second the information gained from studying past years records would aid a farmer in doing a better job.

Fig. 1. TYPE-OF-FARMING AREAS IN MICHIGAN

(Areas on a natural-line basis)

The farms in this study were from areas 1, 2, 5, 6, 7 and 8 (outlined in red)

1. General Livestock and Corn
2. Dairy, Livestock and Corn
3. Southwestern Fruit, Dairy and Truck
4. Dairy, Poultry and Truck
5. Dairy and General Farming
6. Dairy, Part-Time and Truck
7. Dairy and Cash Crops
8. Cash Crops and Dairy
9. General Livestock and Part-Time
10. Dairy, Potatoes and Truck
11. Northwestern Fruit and Dairy
12. Dairy, Part-Time and Potatoes
13. Forestry, Part-Time and Cattle
14. Cattle, Potatoes and Part-Time
15. Cattle, Hay and Part-Time
16. Dairy and Potatoes
17. Dairy, Potatoes, Part-Time Forestry

The 83 counties in Michigan are here grouped into 17 type-of-farming areas as indicated in this map. The "natural" boundaries of these areas do not, however, follow county boundaries, but lines representing the influences of soil, climate and markets.

TABLE II

DESCRIPTIVE SUMMARY FOR AVERAGES OF CERTAIN CHARACTERISTICS OVER THE PERIOD 1940-1949 FOR EACH OF THE FOUR GROUPS AND THE RANGE OF YEARLY AVERAGES DURING THE PERIOD

Characteristic	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
Tillable Acres:				
Range	191-206	111-136	116-148	134-160
Average	198	125	127	149
Number of Cows:				
Range	21.1-28.9	11.1-17.7	9.5-15.5	10.2-12.4
Average	25.5	14.5	12.2	11.5
Litters of Pigs:				
Range	3.2-0	1.8-.1	1.9-5.7	6.1-12.0
Average	.9	.9	3.9	8.3
Crop Yield Index:				
Range	94-111	96-106	93-106	94-106
Average	102	101	98	102
Number of Men:				
Range	2.39-2.73	1.43-1.74	1.47-1.71	1.57-1.78
Average	2.56	1.55	1.57	1.67
Per Cent of PMWU from Dairy:				
Range	53.1-66.2	51.4-67.2	40.1-51.3	41.7-37.7
Average	59.1	59.0	45.4	39.8
Per Cent of PMWU from Hogs:				
Range	2.0-.01	1.3-.1	8.0-2.0	7.1-10.9
Average	.7	1.0	4.9	9.0

The following "average" descriptions of the four groups within the present study indicate that these farms differ in other ways than just degree of specialization.

The twenty large specialized dairy farms used in this study averaged 198 tillable acres during the period. The average number of cows ranged from 21.1 to 28.9 with an average of 25.5 for the period. These farms averaged 0.89 litters of pigs per year during the period. The majority of the large specialized dairy farms provided work for two or more men, the average number for the period being 2.6. The crop yield index for the period averaged 102.

The twenty-one small specialized dairy farm studied averaged 125 tillable acres during the period. The average number of cows ranged from 11.1 to 17.7 with the average for the period being 14.5. An average of 0.87 litters of pigs per year were farrowed during the period. These farms were one and two man units. The average number of men ranged from 1.4 to 1.7, with an average of 1.55 for the period. The crop yield index on these farms averaged 101 for the period.

The twenty-seven diversified dairy farms averaged 127 tillable acres during the ten year period. The average number of cows ranged from 9.5 to 15.5, with an average for the period of 12.2. An average of 3.9 litters of pigs were farrowed each year during the period. The majority of the

farms were one and two man units although some were larger. The average number of men ranged from 1.47 to 1.71 and the average for the period was 1.57. The crop yield index on these farms averaged 98 for the period.

The twenty-four dairy-hog farms studied had an average of 149 tillable acres during the period. The average number of cows ranged from 10.2 to 12.4, and the average number was 11.5. An average of 6.4 litters of pigs were farrowed each year during the period. The average number of men ranged from 1.57 to 1.78, and the average for the period was 1.67. The crop yield index on these farms averaged 102 for the period.

The differences expressed in the above "average" descriptions are presented in tabular form in Table II. Such differences, of course, will affect the results of any study based upon these groups. To offset such differences, a unit basis (that is, returns per cow, returns per $1,000 invested in machinery, etc.), as well as total income, will be used in analysis.

A limitation on the results of this study is the relatively small number of farms in each of the four groups. A larger sample would be desirable since Michigan farms are quite variable, both in soil and topography, and many factors other than organization affect their efficiency. Correlation analysis will partially overcome this limitation and will

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give a check on the tabular analysis phase of the study as well as explain some of the cause and effect relationships observed.

As intimated in the preceding paragraph, two methods of analysis were used for the available data: [1] tabular analysis to determine the effect of the various types of organization on farm efficiency and income, and [2] correlation analysis to determine the possible relationship between the degree of specialization and certain measures of efficiency. Trends toward specialization over the ten year period were also studied.

HISTORICAL BACKGROUND

Trends during the Ten-Year Period, 1940-1949

The ten-year period from 1940 through 1949 was one of many economic changes. These changes must be considered before an analysis of data from the period can be made.

The period opened just as the war in Europe was beginning and the depression in the United States was ending. Farm prices were low. The parity ratio was 85. The war soon became world wide. Although the war brought full employment to the United States, it also brought the draft, inflation, price control, rationing, increased taxes, increased emphasis on nutrition, and raw material shortages. These factors all had an effect upon farming in Michigan.

The end of the war released men and materials for civilian production, and it also released a pent-up demand for civilian goods. As a result the inflation continued. The end of the war unfortunately did not bring peace. As soon as the shooting-war with Japan ended, the cold-war with Russia began. The uncertainty that the cold-war forced upon our economy continued through the rest of the period.

The business of farming changed tremendously during the ten year period 1940-49. The average size of all farms

TABLE III

AVERAGES OF CERTAIN CHARACTERISTICS FOR ALL FARMS IN THE MICHIGAN FARM ACCOUNT STUDY AND THE PARITY RATIO FOR MICHIGAN, 1940-49[1]

Year	Parity Ratio	Tillable Acres	PMWU's Per Man	Number of Men	Dairy Sales Per Cow	Gross Income	Labor Income
1940	85	112	242	1.9	$102	$3,110	$ 787
1941	98	117	254	1.9	125	4,370	1,675
1942	107	117	262	1.8	146	5,526	2,303
1943	119	122	269	1.8	176	6,017	1,990
1944	109	129	286	1.8	209	6,875	2,406
1945	112	131	286	1.7	226	7,055	2,483
1946	117	133	284	1.8	267	8,718	3,374
1947	122	134	286	1.7	282	9,432	3,486
1948	118	136	281	1.7	297	9,172	2,735
1949	104	136	292	1.6	266	8,269	1,815
Average	109	127	274	1.8	210	6,864	2,305

[1] K. T. Wright and J. C. Doneth, "The Business Side of Michigan Farming, 1940-49", Michigan Agricultural Experiment Station Quarterly Bulletin, Vo. 33, No. 2 (November 1950) pp. 73 - 95.

in the Michigan farm account study increased from 112 to 136 tillable acres. The gross incomes on these farms tripled between 1940 and 1947. Farm expenses increased continuously throughout the period. The average number of men on the farms in the farm account study decreased from 1.9 to 1.6 men per farm while the productive man work units per farm rose from 452 in 1940 to 506 in 1944, and then dropped to 477 in 1949.

GENERAL DISCUSSION

The farms in the four groups used for this study tended to follow the same trends as all of the farms in the Michigan farm account study. The average number of tillable acres per farm in each group increased slightly during the period. The average productive man work units per farm and the productive man work units per man also increased. The average number of men per farm in only one of the groups in this study followed the same pattern as all the farms in the Michigan farm account study. The average number of men per farm on the Dairy-Hog Farms dropped during the period. The average number of men per farm on the large specialized dairy farms increased during the period but dropped at the end of the period. The average number of men per farm in the other two groups increased throughout the period. The increased number of men on the farms in these three groups may be due to the average number of cows on these farms being increased faster than farm efficiency. This theory is upheld by the increase in productive man work units per man which took place in all the groups.

There was a definite trend toward specialization during the period. The average number of cows per farm increased from 21 to 29 on the large specialized dairy farms. The percentage of the productive man work units from the dairy enterprise increased from 53 to 60 per cent. The number of

litters of pigs farrowed on the large specialized dairy farms fell from 3.2 to zero and the per cent of productive man work units from hogs fell from 2 per cent to 0.01 per cent.

On the small specialized dairy farms the average number of cows increased from eleven to eighteen. The percentage of the productive man work units spent on the dairy enterprises increased from 52 to 67 per cent. The number of litters of pigs farrowed on the small specialized dairy farms dropped from 0.7 litters to 0.1 litters and the per cent of productive man work units spent on the swine enterprise dropped from 1.3 to 0.1 per cent.

The average number of cows per farm on the diversified dairy farms increased from ten to sixteen during the period. The per cent of the productive man work units spent on the dairy enterprise increased from 40 to 49 per cent. The number of litters of pigs farrowed dropped from 5.4 to 3.6 litters per farm. The percentage of the productive man work units from hogs dropped from 8.0 to 2.8 per cent.

On the dairy-hog farms there were an average of 10.2 cows per farm in 1940. This number increased to 12.4 in 1947, and dropped to 10.4 in 1949. The percentage of productive man work units spent on the dairy enterprise was 40.1 in 1940; this rose to 41.7 in 1947 and dropped to 37.7 in 1949. There was an average of 6.1 litters of pigs farrowed on the dairy-hog farms during 1940. The number of

litters farrowed varied slightly until 1949 when an average of twelve litters of pigs per farm were farrowed. The percentage of the productive man work units from hogs on these farms rose from 7.1 to 10.9 per cent during the period.

The trend toward greater specialization in dairy by the large and small specialized dairy farms and the diversified dairy farms was quite marked. The trend toward greater specialization in hogs by the dairy-hog farms was less marked.

BASIC HYPOTHESES

As a basis for analysis on the effect of various degrees of specialization upon the efficiency and earnings of dairy farmers, the following hypotheses were made after a preliminary examination of the data.

A. Hypotheses with respect to the effect of various degrees of specialization upon income were that:

1. The rate of return on investment was highest on the dairy-hog farms.
2. Labor income was highest on the large specialized dairy farms.
3. Labor income was less variable on the diversified dairy farms.
4. The correlation between labor income and gross income was highest on the small specialized dairy farms.

B. Hypotheses with respect to the effect of various degrees of specialization upon efficiency were that:

1. The expense per $100 of income was lowest on the large specialized dairy farms.
2. Labor efficiency was highest on the large specialized dairy farms.

3. Dairy sales per cow were highest on the large specialized dairy farms.
4. The number of pigs weaned per litter was largest on the dairy-hog farms.
5. The income per $1,000 invested in power and machinery was highest on the dairy-hog farms.
6. The income per $1,000 invested in improvements was highest on the diversified dairy farms.

C. Hypotheses with respect to the relationship between degree of specialization in dairy and certain efficiency factors were that:

1. The dairy sales per cow were positively correlated with the per cent of productive man work units spent on the dairy enterprise.
2. The number of productive man work units per man were positively correlated with the per cent of productive man work units spent on the dairy enterprise.
3. The more specialized dairy farms, as measured by the per cent of total productive man work units spent on dairy cattle, have a lower improvement investment per animal unit.

D. Hypotheses with respect to relationships between the size and the efficiency of the dairy and hog enterprises were that:

1. There was a direct correlation between the number of litters of pigs raised and the number of pigs weaned per litter.
2. There was a direct correlation between the average number of cows in the herd and dairy sales per cow.

TESTING OF HYPOTHESES

The observations and correlative discussion with respect to the series of hypotheses just presented will be considered on the basis of the four major hypothesis groups:

A. Hypotheses with respect to the effect of various degrees of specialization upon income;

B. Hypotheses with respect to the effect of various degrees of specialization upon efficiency;

C. Hypotheses with respect to the relationship between degree of specialization in dairy and certain efficiency factors; and

D. Hypotheses with respect to relationships between the size and the efficiency of the dairy and hog enterprise.

Each individual hypothesis presented in the preceding section will be tested to see if the data upon which it is based upheld the primary premise that specialization increased farm efficiency and income.

Hypotheses with Respect to Income

In this first group of hypotheses the data were studied by tabular analysis to determine the effect of various degrees of specialization upon income. Each of the four hypotheses in this group will be considered separately.

Hypotheses No. 1 -- The rate of return on investment was highest on the dairy-hog farms. A high return on investment was expected on the dairy-hog farms because of a favorable corn-hog ratio that existed during most of the period, [See Table VII]. The dairy-hog farmers were able to expand their swine herds rapidly to take advantage of the favorable prices. In many cases the expansion of the swine herd required little additional investment. As the income increased, with relatively little increase in investment, a large increase in return on investment could be expected.

Prices of milk products also were favorable during the period, and this raised the income from dairy herds. Expansion of dairy herds, however, takes several years and requires an increased investment.

The data in Table IV disprove this hypothesis; these data are presented graphically in Figure 2. The large specialized dairy farms had an average return on investment of 14.7 per cent during the period which was the highest

of the four groups. The small specialized dairy farms were next highest with an average return of 13.6 per cent for the period. The dairy-hog farms had an average of 13.5 per cent for the ten year period and the diversified dairy farms had an average of 13.2 per cent, which was the smallest for the period. As Table IV shows, the year to year variations were great. The differences between the large specialized dairy farms and the diversified dairy farms were not significant at the five per cent level.

TABLE IV

AVERAGE RATE EARNED ON INVESTMENT, 1940-49

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
	Per Cent	Per Cent	Per Cent	Per Cent
1940	8.8	8.9	7.2	6.6
1941	16.1	13.5	14.5	13.1
1942	15.8	15.4	15.8	18.5
1943	13.6	12.1	12.5	11.2
1944	16.6	12.4	9.6	12.1
1945	15.8	16.2	17.2	14.9
1946	17.2	16.2	16.9	17.8
1947	14.9	18.5	16.3	20.8
1948	14.9	13.2	12.7	12.0
1949	13.1	9.7	8.8	7.9
Average	14.7	13.6	13.2	13.5

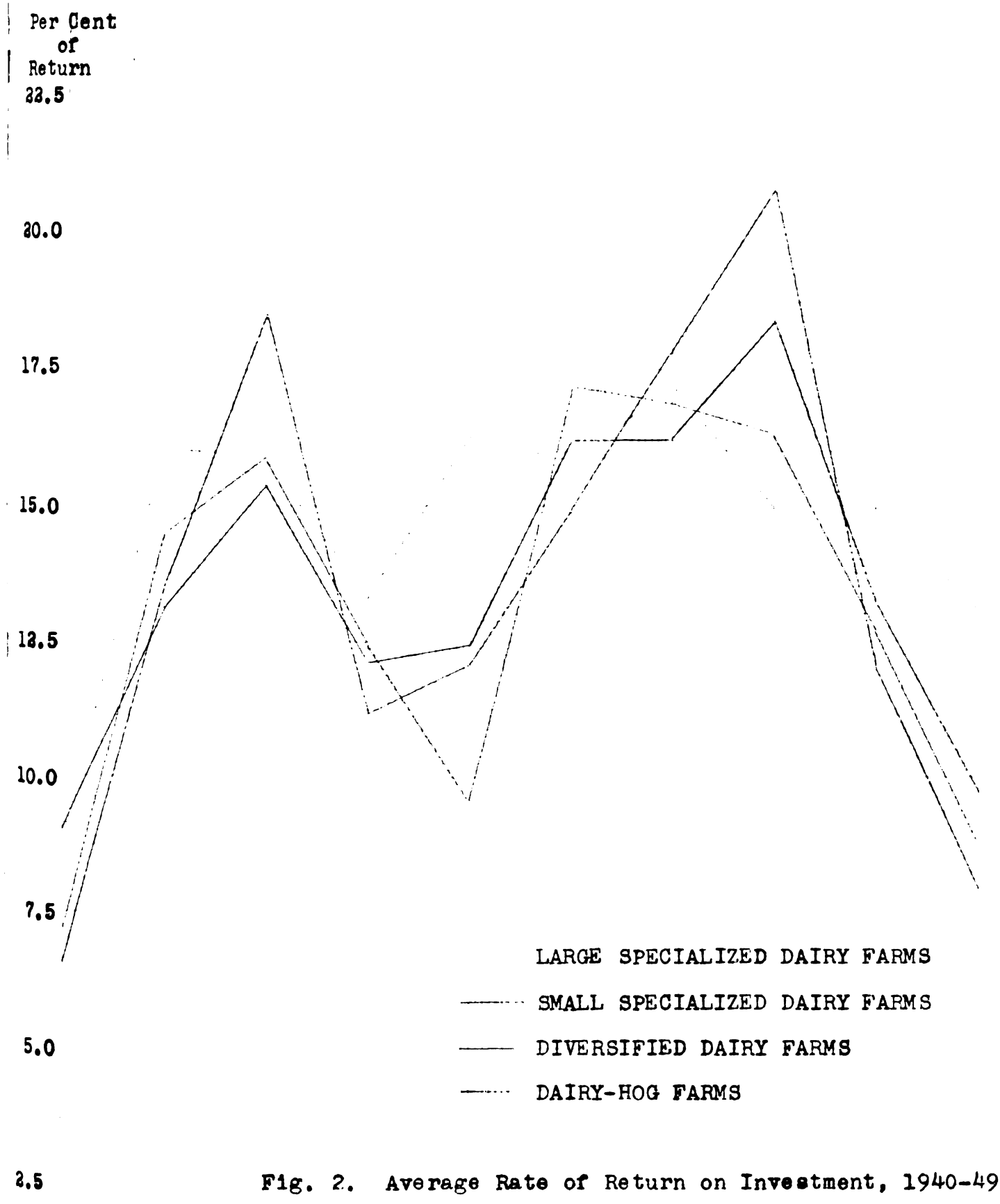


Fig. 2. Average Rate of Return on Investment, 1940-49

The year to year variation in return on investment is quite interesting. The large specialized dairy farms had the highest rate of return for five years during the period and the lowest only one year. The small specialized dairy farms had the highest return two years and the lowest one year. The diversified dairy farms had the highest return one year and the lowest one year. The dairy-hog farms had the highest return on investment three years during the period and the lowest six years. This means that there was only one year during the period when the dairy-hog farms did not have either the highest or the lowest return on investment.

These variations show that degree of specialization did not influence the rate of return on investment. Other factors, such as relative price levels, were more important.

Hypotheses No. 2 -- Labor income was highest on the large specialized dairy farms. The highest labor income was expected on the large specialized dairy farms because [a] they were large farms with a large volume of business, [b] the operators of the large specialized dairy farms could be expected to be better managers than the operators of the smaller farms, and [c] a higher production per cow was expected on the large specialized dairy farms.

The data in Table V support this hypothesis; these data are presented graphically in Figure 3. The large

specialized dairy farms had the highest labor income nine out of the ten years and averaged $4,125 for the period. The dairy-hog farms were next highest with an average annual labor income of $2,961. The diversified dairy farms had an average annual labor income of $2,651 and the small specialized dairy farms $2,600.

TABLE V

AVERAGE LABOR INCOME PER FARM, 1940-49

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	$1,545	$1,045	$ 894	$ 838
1941	3,490	1,595	2,003	1,922
1942	3,970	2,330	2,661	3,445
1943	3,723	2,226	2,525	2,515
1944	4,598	2,305	2,075	2,648
1945	4,348	2,999	3,403	3,252
1946	5,016	3,133	3,374	4,069
1947	4,829	4,011	3,726	5,280
1948	5,180	3,282	3,226	3,413
1949	4,549	3,070	2,622	2,224
Average	$4,125	$2,600	$2,651	$2,961

The difference between the labor income of the large specialized dairy farms and the other three groups is significant. The differences in the labor incomes of the other three groups are not significant.

These results are apparently due to the volume of business on the farms in the various groups. The large

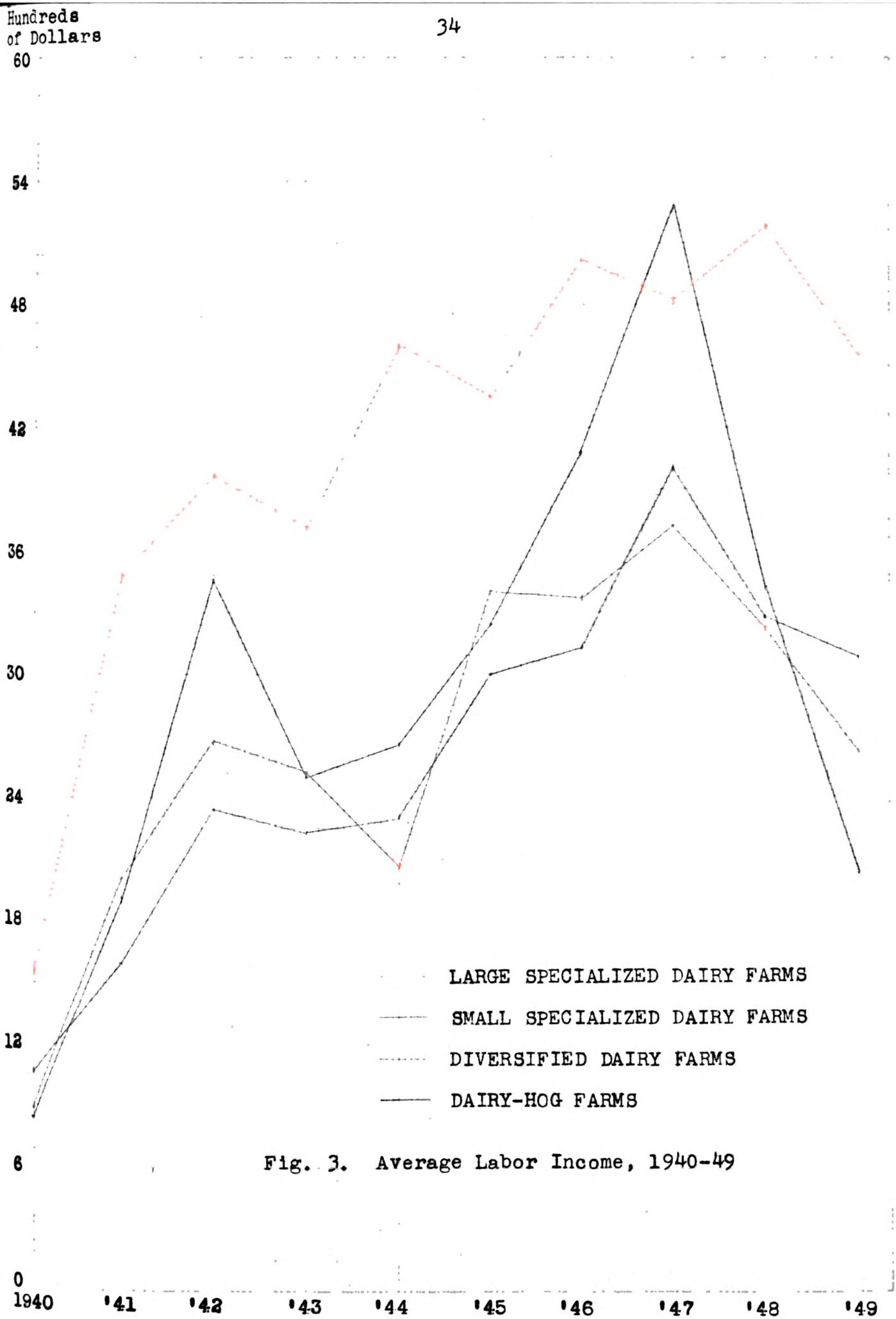


Fig. 3. Average Labor Income, 1940-49

specialized dairy farms had the largest volume of business, while there was no great difference in the average volume of business in the remaining three groups.

The data in Table V do not support the idea that specialization in dairy will increase labor income for, while the large specialized dairy farms had the highest labor income, the labor income on the small specialized dairy farms was no higher than on other farms with the same size of business. This gives emphasis to the principle that an adequate volume of business is of prime importance if a farmer is to enjoy an adequate labor income.

Hypotheses No. 3 -- Labor income is less variable on the diversified dairy farms. The labor income on diversified dairy farms was expected to be least variable because they were small farms with a small volume of business. These farms were not in a position to expand production greatly when prices were high; therefore, their income was more stable than on farms that could greatly expand production when prices rose.

The data in Table VI fail to support this hypothesis. It is true that the standard deviation of the labor income on the diversified dairy farms was lower than the other three groups but it was only three per cent lower than the small specialized dairy farms. This small difference over

a ten year period cannot be considered significant. The variation in labor income on both the diversified dairy farms and the small specialized dairy farms was much lower than the variation on the dairy-hog farms and the large specialized dairy farms.

TABLE VI

VARIATION IN LABOR INCOME OVER THE TEN YEAR PERIOD, 1940-49

Group	Average Labor Income	Standard Deviation of Labor Income	Co-efficient of Variation
Large Specialized Dairy Farms	$4,125	$1,059	25.7%
Small Specialized Dairy Farms	2,600	872	33.5%
Diversified Dairy Farms	2,651	845	31.9%
Dairy-Hog Farms	2,961	1,227	41.4%

These results were probably due to the differences in the size of the farms and the size of the business rather than due to the differences in degree of specialization. This statement is supported by the fact that, while the diversified dairy farms had the lowest variation in income, the variation on the small specialized dairy farms was nearly as low.

The high variation in labor income on the dairy-hog farms was due to the wide variation in hog prices that occured during the period. As Table VII shows yearly hog prices ranged from $5.60 per hundred pounds to $24.20 per hundred pounds. The average for the period was $15.28 per hundred pounds. The standard deviation of yearly hog prices was $5.99 or 39.2 per cent of the mean. Milk prices were less variable. The average yearly price for the period was $3.26 per hundred pounds of milk. The standard deviation in milk prices was $.93 or 28.5 per cent of the mean. The average corn hog ratio for the period was 12.6 to 1. The standard deviation of the corn hog ratio was 1.26 or 10.0 per cent of the mean. The average milk feed ratio for the period was 4.13 to 1. The standard deviation of the milk feed ratio was .314 or only 7.6 per cent of the mean.

Hypotheses No. 4 -- The correlation between labor income and gross income was highest on the small specialized dairy farms. It was expected that this correlation would be highest on the small specialized dairy farms because milk prices did not fluctuate as widely as other farm prices. With a favorable market throughout the period, specialized dairy farmers would see their gains in gross income more evenly reflected in labor income. The correlation between

TABLE VII

PRICES RECEIVED BY FARMERS
AND LIVESTOCK-FEED RATIOS IN MICHIGAN, 1940-49

Year	Prices Received			Livestock-Feed Price Ratios		
	Fluid Milk	Butter-fat	Hogs	Butterfat Feed	Milk Feed	Corn Hog
	Per cwt.	Per lb.	Per cwt.			
1940	$1.75	$.30	$ 5.60	71.5	4.36	9.3
1941	2.15	.36	9.10	76.1	4.57	12.8
1942	2.50	.41	13.10	67.2	4.10	15.5
1943	3.15	.52	13.80	72.3	4.46	13.3
1944	3.25	.53	13.10	61.7	3.83	11.2
1945	3.20	.53	14.20	60.8	3.71	12.3
1946	3.86	.68	18.10	71.6	4.01	11.9
1947	4.21	.76	24.20	65.2	3.71	12.3
1948	4.81	.83	23.20	71.2	4.11	11.7
1949	3.76	.65	18.40	72.2	4.41	15.6
Average 1940-49	3.26	.56	15.28	69.0	4.13	12.6
Average 1935-39				62.8	3.85	13.1

labor and gross income was expected to be closest on the small specialized dairy farms because being small farms their labor incomes were less affected by changes in wage rate and other items of expense.

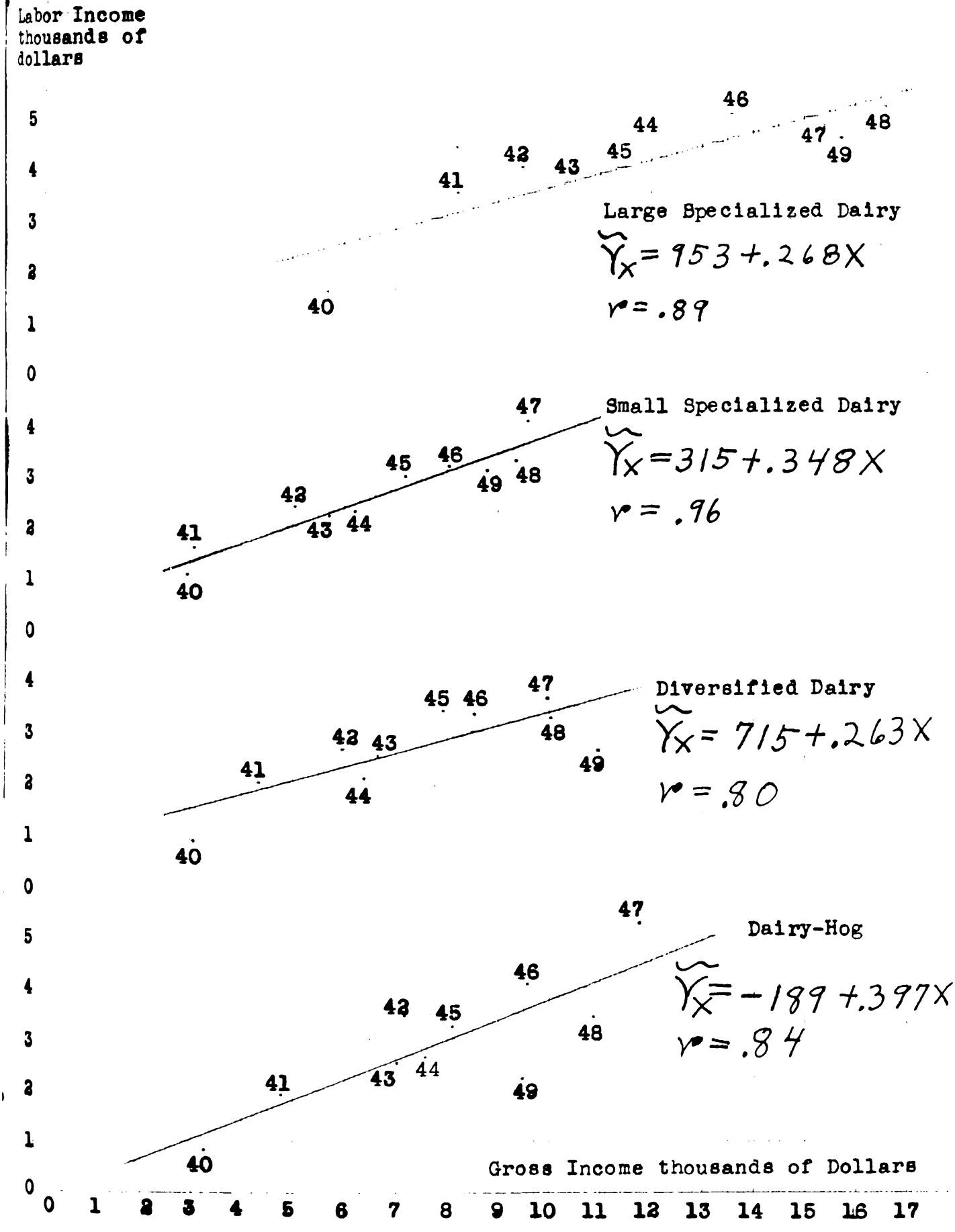
The data graphed in Figure 4 support this hypothesis. The coefficient of correlation between receipts and net increase and labor income was 0.96 on the small specialized dairy farms. The large specialized dairy farms had a coefficient of correlation of 0.89 was next highest. On the

dairy-hog farms and diversified dairy farms the coefficients were 0.84 and 0.80, respectively.

The results appear to be due to the price relationships explained above. The drop in labor income in 1949 was smallest on the specialized dairy farms, while the dairy-hog farms also had a sharp drop in 1948. Due to continuing costs, declines, in labor income were much sharper than declines in gross income. For this reason, 1948 and 1949 were below the trend line for each group of farms.

The close correlation in all groups is important because it shows how important a large volume of business is to a farmer. The slopes of the trend lines are also interesting. The steep slope of the trend line for the dairy-hog farms is due to favorable prices of hogs during 1946 and 1947 as compared to 1940 and 1941. The steep slope of the trend line for the small specialized dairy farms is probably due to their being small farms and, therefore, less affected by the increases in costs that developed during this period.

Fig. 4. Relationship between gross income and labor income, 1940-49



Hypotheses with Respect to Efficiency

In this second group of hypotheses, which deal with the effect of various degrees of specialization upon the efficiency of farm operation, the tabular analysis method of analysis was also used. Each of the six hypotheses in this group will be considered separately.

Hypotheses No. 1 -- The expense per $100 of income was the lowest on the large specialized dairy farms. Expense per $100 of income is a commonly used measure of the efficiency of a farm business. A low expense per $100 of income is, of course, quite desirable. The large specialized dairy farms were expected to have the lowest expense per $100 of income primarily because they were larger units. Being larger units, they were more likely to have more efficient operators who could do a better job of managing the farm enterprises. The larger units were also in a position to better utilize their power and machinery, thus reducing the expense per unit.

The data in Table VIII uphold this hypothesis. The large specialized dairy farms had the lowest expense per $100 income seven years during the ten year period and the next to the lowest two years during the period. The average expense per $100 income of the large specialized dairy farms was $60.48. This was 4.2 per cent lower than

the dairy hog farms which were next to the lowest. The data from Table VIII are presented graphically in Figure 5.

TABLE VIII

AVERAGE EXPENSE PER $100 INCOME 1940-49

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	$60.32	$63.75	$67.29	$68.23
1941	48.53	65.70	53.08	54.66
1942	53.50	57.70	57.06	52.09
1943	64.05	67.42	66.97	67.62
1944	59.20	68.23	72.43	66.28
1945	60.30	62.09	60.50	59.13
1946	56.48	63.36	62.14	57.16
1947	67.26	63.16	66.81	57.60
1948	66.88	69.97	70.95	70.60
1949	68.30	75.48	77.10	78.23
Average	60.48	65.69	65.43	63.16

The dairy-hog farms had the lowest expense per $100. income the other three years. It is interesting to note that the dairy-hog farms, which had the next to the lowest average for the period, were lowest for three years and highest for three years. This was due to the fluctuations in the prices of hogs and dairy products. In years when hogs were high compared to dairy it cost less to produce $100 worth of pork. When milk was relatively higher it cost less to produce $100 worth of milk.

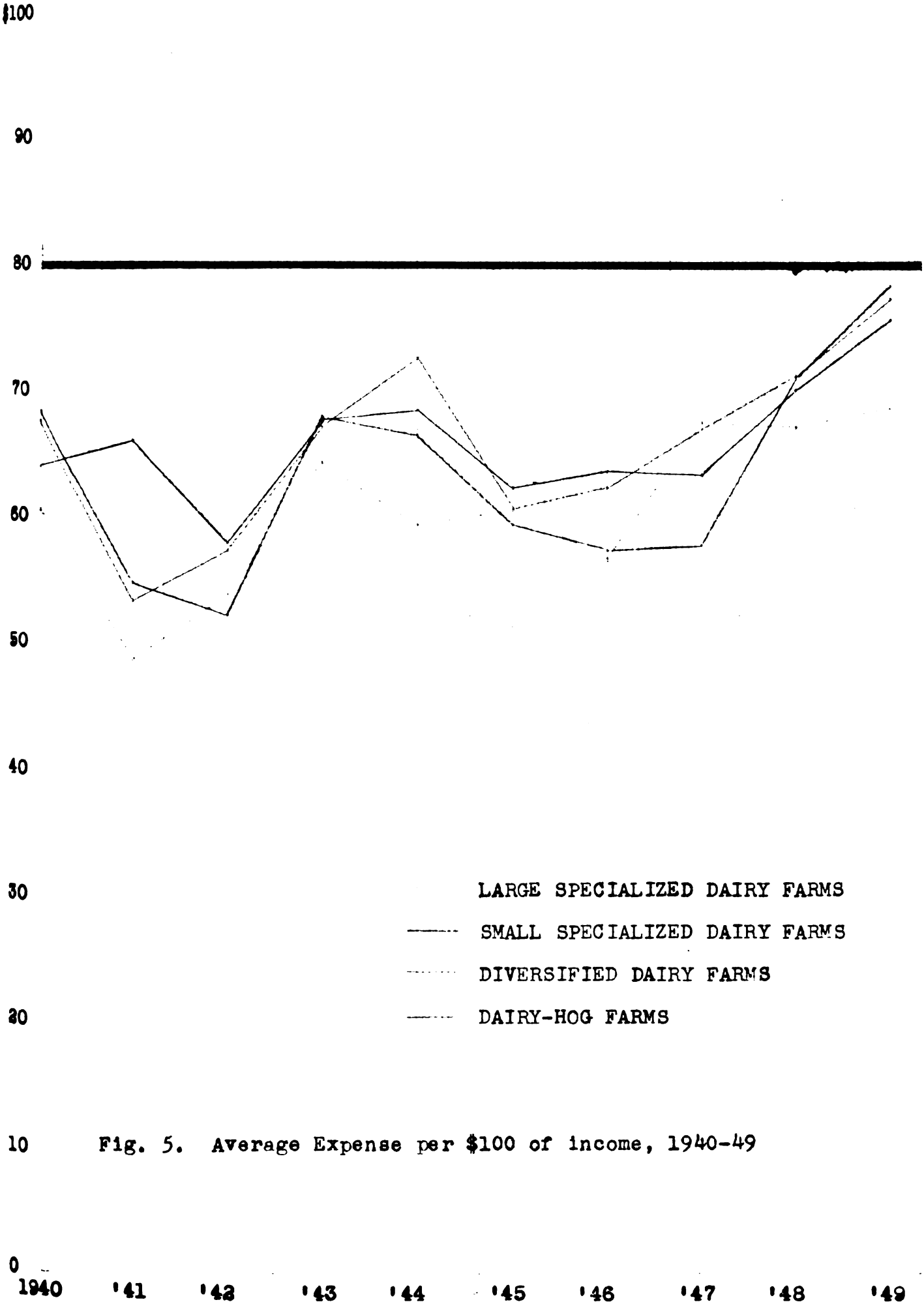


Fig. 5. Average Expense per $100 of income, 1940-49

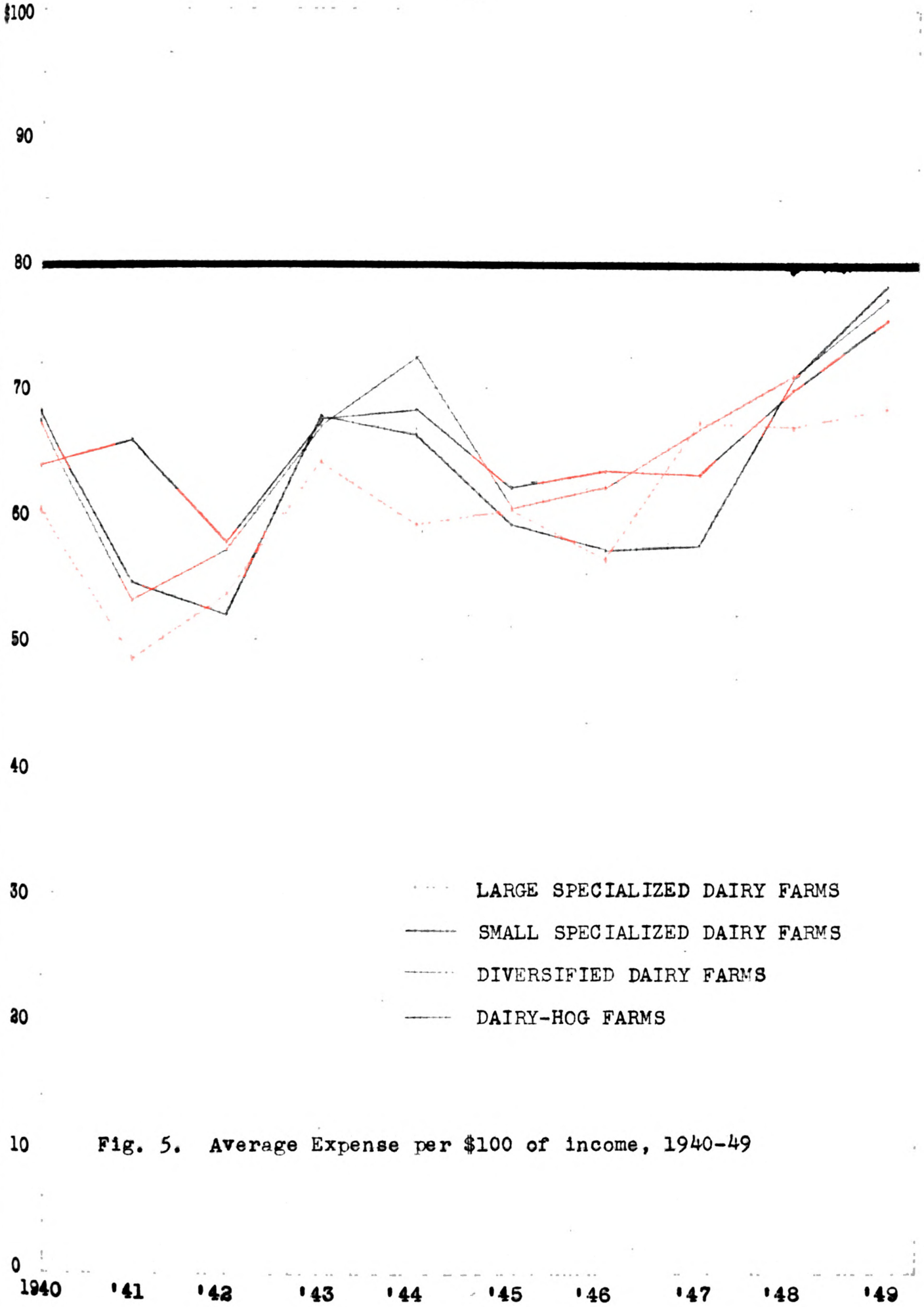


Fig. 5. Average Expense per $100 of income, 1940-49

The three years hogs had the lowest expense per $100 income hog prices had risen rapidly compared to milk prices. In 1942 hogs averaged $4 per hundredweight higher than 1941 while milk only averaged $.35 higher per hundredweight. In 1945 hogs averaged $1.10 per hundredweight higher than the year before while milk prices were unchanged. In 1947 hog prices averaged nearly $6 higher than in 1946 while milk prices increased only $.35.

The small specialized dairy farms and the diversified dairy farms had average expenses of $65.69 and $65.43, respectively, or about 3.5 per cent higher than the dairy-hog farms. While there were some year to year differences between the small specialized dairy farms and the diversified dairy farms they tended to follow the same pattern. The exception to this was in 1941 when the expenses per $100 income on the small specialized dairy farms rose slightly while the other three groups dropped sharply. This was probably due to an unusual circumstance large enough to affect the group average, on one of the small specialized dairy farms.

Specialization in dairy by itself does not seem to affect this factor. This is shown by the fact that while the large specialized dairy farms had the lowest expense per $100 income the small specialized dairy farms had the highest. It appears that the largest farms with the

highest volume of business tended to have the lowest expense per $100 income. This pattern, however, was altered by the year to year variations caused by the relationship between the prices of the various farm products.

Hypotheses No. 2 -- Labor efficiency was highest on the large specialized dairy farms. The largest number of productive man work units per man was expected on the large specialized dairy farms. They were expected to have a higher degree of labor efficiency because, being larger farms, they could have more labor saving machinery. The barns on larger specialized dairy farms were more likely to be arranged so that the herd could be cared for in the shortest possible time, thus increasing labor efficiency.

The data in Table IX does not prove this hypothesis. The dairy-hog farms and the diversified dairy farms had the highest average number of productive man work units per man during the period under study. The dairy-hog farms averaged 318 units per man and the diversified dairy farms averaged 317 units per man. Each of these groups had the highest average four years during the period. Data from Table IX are presented graphically in Figure 6.

The large specialized dairy farms had an average of 308 productive man work units per man during this period; this was 2.8 per cent lower than the two leading groups.

The large specialized dairy farms had the highest average two years during the period and the lowest two years.

TABLE IX

NUMBER OF PRODUCTIVE MAN WORK UNITS PER MAN, 1940-49

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	296	257	272	282
1941	277	290	302	308
1942	291	301	315	315
1943	293	292	298	318
1944	312	307	319	334
1945	330	305	346	332
1946	318	300	352	329
1947	308	300	312	331
1948	329	309	311	305
1949	332	281	343	327
Average	308.4	294.2	317.0	318.1

The small specialized dairy farms had an average of 294 productive man work units per man during the period or 4.5 per cent less than the large specialized dairy farms. The small specialized dairy farms had the lowest average for seven years during the period and next to the lowest the other three years.

The lack of a significant difference between the figures disprove the assumptions that were made when the hypotheses was formulated. Several factors may account for the

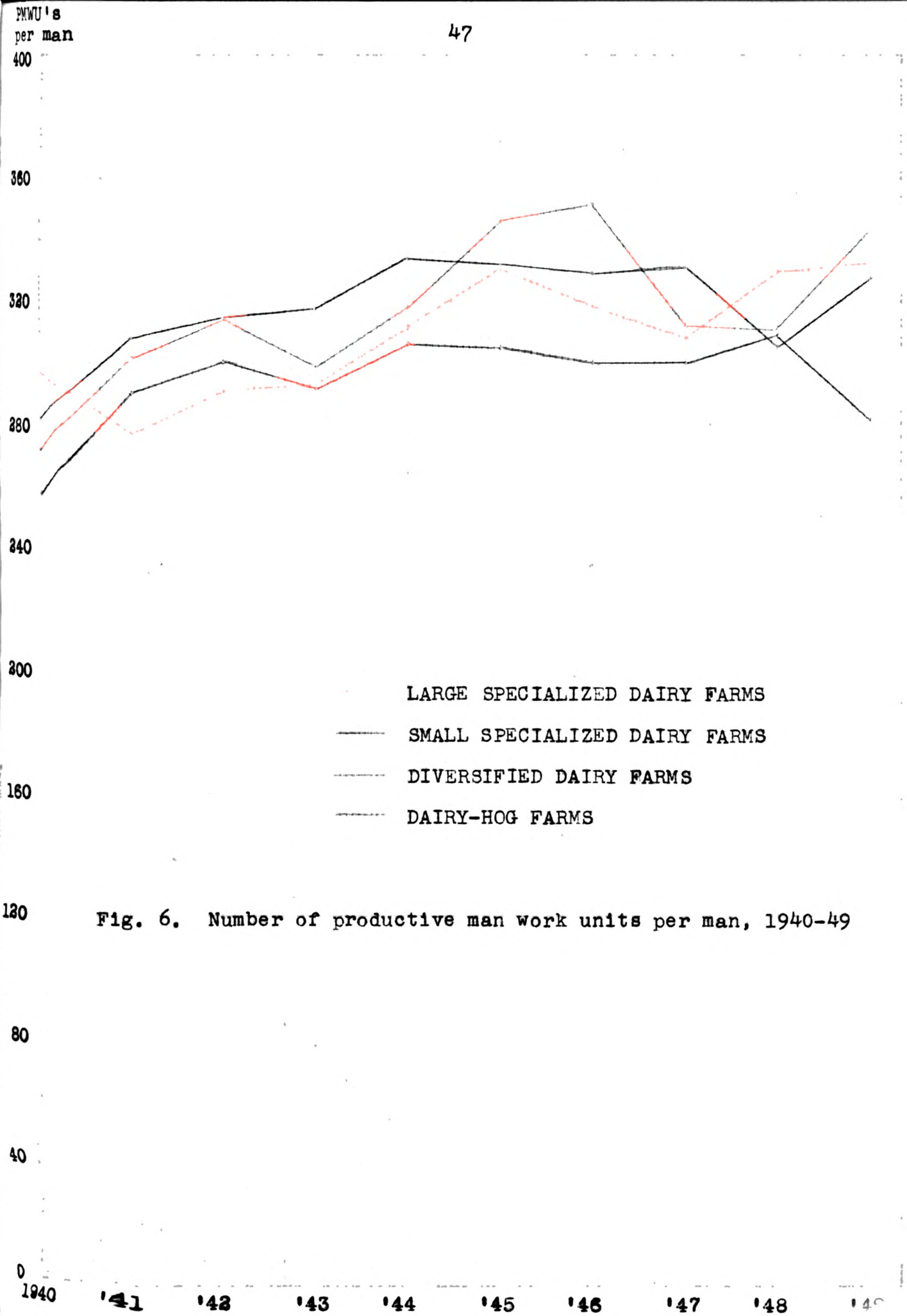


Fig. 6. Number of productive man work units per man, 1940-49

incorrectness of these assumptions. One might be the shortage of new equipment and building materials that existed during the period. This would affect dairy farmers most because they could not expand their herds with make-shift buildings and equipment in the same way that hog farmers could. The gutter cleaner, the latest development in labor saving dairy equipment, was just beginning to be popular as the period closed so it had almost no affect on the data. Another factor, which may have affected the labor efficiency on the large specialized dairy farms, is the increased emphasis on sanitation which developed during the period and the increased number of farmers selling fluid milk. The increased amount of time necessary to meet inspection requirements would lower the efficiency on the farms involved.

To further test this hypotheses, gross income per man was calculated. These data shown in Table X, follow the same pattern as productive man work units per man. The differences in gross income per man on the large specialized dairy farms, diversified dairy farms, and dairy-hog farms were not significant. The gross income per man on the small specialized dairy farms was significantly lower than on the farms in the other three groups.

TABLE X

AVERAGE GROSS INCOME PER MAN, 1940-49

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	$2,215	$1,861	$1,933	$1,845
1941	2,994	2,040	2,742	2,912
1942	3,557	3,520	3,856	4,139
1943	3,790	3,750	4,130	4,033
1944	4,463	3,956	3,967	4,444
1945	4,943	4,553	5,179	5,030
1946	5,312	5,198	5,787	5,876
1947	6,147	6,339	6,609	7,224
1948	6,741	6,046	6,330	6,376
1949	6,370	4,982	6,434	6,002
Average	4,653	4,224	4,697	4,788

Hypotheses No. 3 -- Dairy sales per cow were highest on the large specialized dairy farms. The highest dairy sales per cow were expected on the large specialized dairy farms because a farmer who specialized in dairy on a large scale would be apt to have higher producing cows. Another reason is that the operators of large specialized dairy farms were more likely to be skilled dairymen who would get the most from their cows.

The price received for milk affects this factor as well as production per cow. It can be assumed that more of the large specialized dairy farms had the equipment

necessary to sell fluid milk and, therefore, they received a higher price for their product.

The data in Table XI (see, also, Figure 7) uphold this hypothesis. The large specialized dairy farms had the highest average dairy sales per cow each year of the ten years with an average dairy sales of $278 per cow for the period.

TABLE XI

AVERAGE DAIRY SALES PER COW, 1940-49

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	$133	$119	$109	$101
1941	172	146	133	127
1942	202	183	166	154
1943	239	236	201	190
1944	293	260	235	225
1945	311	286	253	243
1946	331	328	283	289
1947	353	352	309	298
1948	397	388	356	332
1949	354	327	307	258
Average	278	263	235	222

The small specialized dairy farms were second highest each year during the period. They had an average dairy sales of $263 per cow which was 5.8 per cent lower than the large specialized dairy farms.

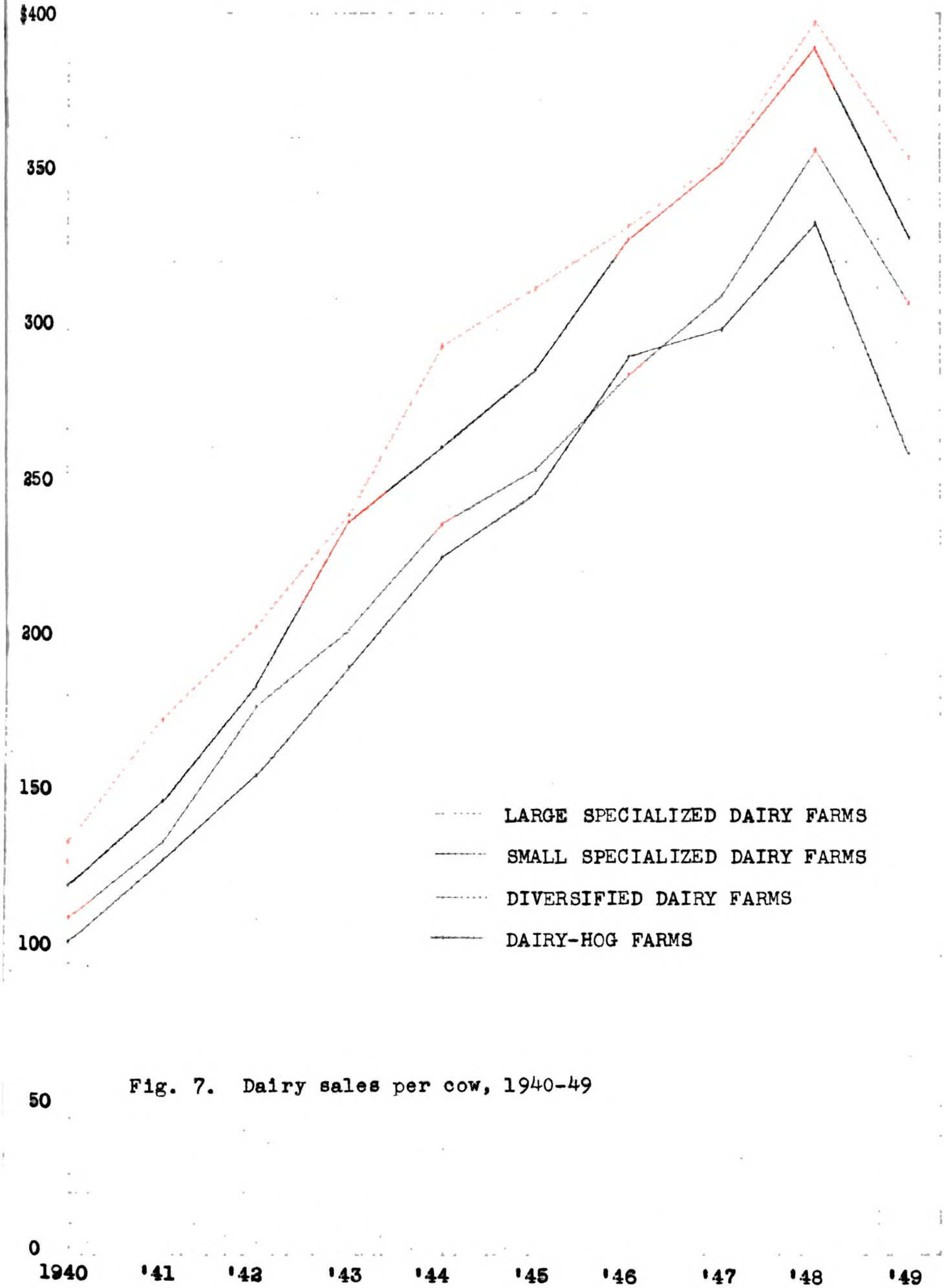


Fig. 7. Dairy sales per cow, 1940-49

The diversified dairy farms had the next to the lowest dairy sales per cow for nine years during the period and the lowest the remaining year. Their average for the period, $235 per cow, was 15.5 per cent lower than the large specialized dairy farms.

The dairy-hog farms had the lowest average for nine years during the period and next to the lowest one year. Their average dairy sales per cow of $222 was 20.1 per cent lower than the large specialized dairy farms and 5.5 per cent lower than the diversified dairy farms.

These data show that throughout the period both the large and small specialized dairy farms had a higher dairy sales per cow than did the diversified dairy farms or the dairy-hog farms. The available data do not indicate whether this difference was due to the speicalized dairy farmers getting a higher production per cow or having a better market for their product. It is likely that both of these factors were of importance, but this can only be assumed.

Another question which the data do not answer is whether the difference between groups is due to the degree of specialization or to the size of the dairy herd. Since both the large and small specialized dairy farms have larger herds than the diversified dairy farms and dairy-hog farms, it is impossible to tell whether the degree of specialization or the size of the herd had the most influence on dairy sales per cow.

Hypotheses No. 4 -- The number of pigs weaned per litter was largest on the dairy-hog farms. It was expected that the dairy-hog farms would wean a larger number of pigs per litter because a farm operator who had a larger number of hogs was apt to take a greater interest in them and care for them better. He was also apt to have better housing for his hogs, an important factor in weaning more pigs per litter.

The data in Table XII fail to uphold his hypothesis; these data are presented graphically in Figure 8.

TABLE XII

AVERAGE NUMBER OF PIGS WEANED PER LITTER, 1940-49

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	6.24	6.85	6.14	6.31
1941	6.77	5.63	7.21	5.84
1942	7.58	6.89	6.62	6.70
1943	7.26	6.03	6.70	5.98
1944	6.05	8.05	5.80	6.09
1945	6.25	6.71	6.45	7.06
1946	6.50	7.50	6.30	6.63
1947	6.00	5.00	6.50	6.18
1948	----	8.50	6.44	6.66
1949	----	6.67	6.46	6.06
Average	6.58	6.78	6.46	6.35

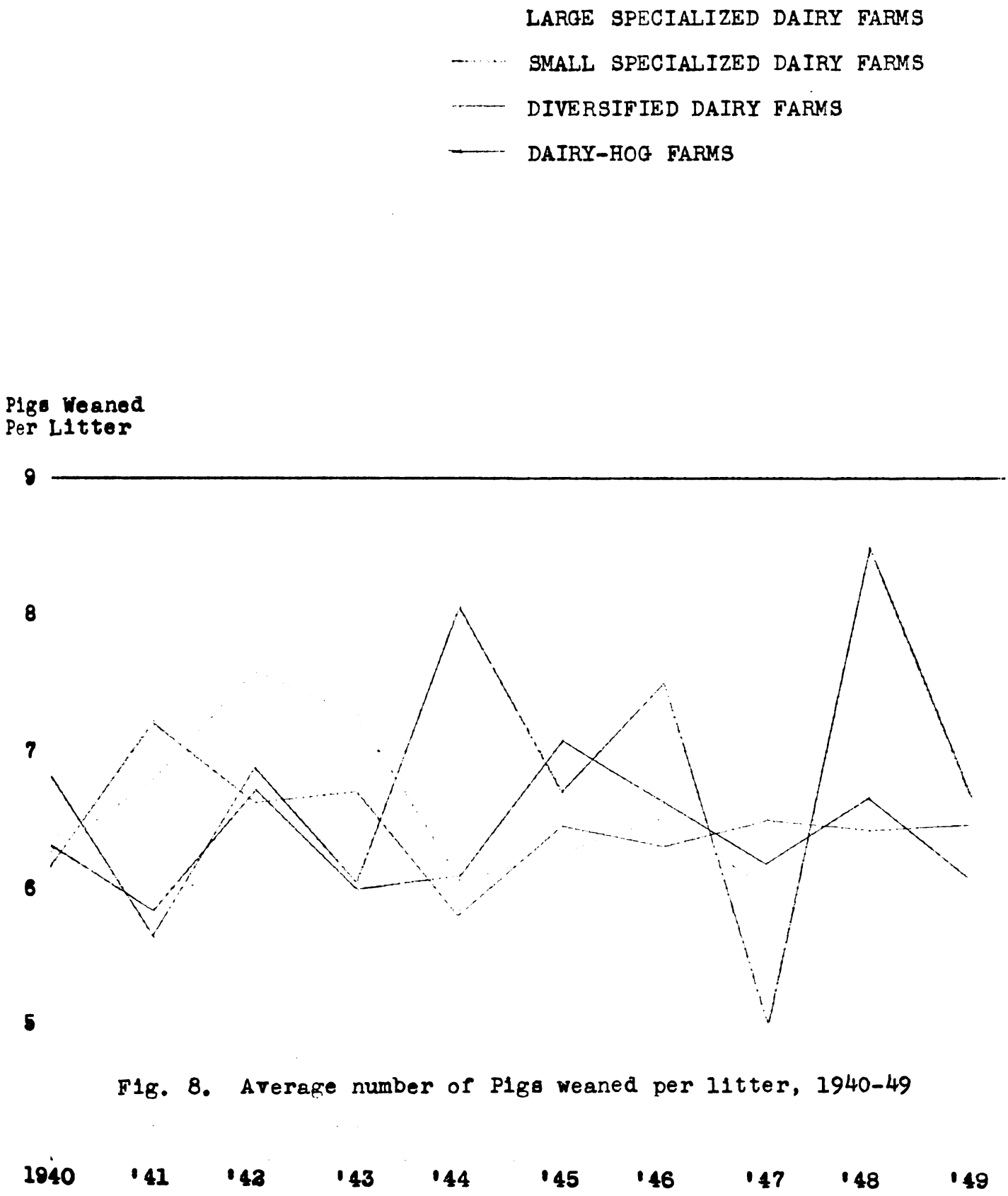


Fig. 8. Average number of Pigs weaned per litter, 1940-49

The small specialized dairy farms weaned the largest number, with an average of 6.78 pigs per litter, during the period. The large specialized dairy farms were next with an average of 6.58. The diversified dairy farms weaned the third largest number per litter, with an average of 6.46, and the dairy-hog farms weaned the smallest number with an average of 6.35.

The small specialized dairy farms had the highest average five years and the lowest one year. The large specialized dairy farms had the highest average two years and the lowest one year. The diversified dairy farms had the highest average two years and the lowest five years while the dairy-hog farms had the highest average one year and the lowest two years.

The extreme year to year variations in these figures indicate that degree of specialization had little effect on the number of pigs weaned per litter on the farms in this study.

Does this mean that specialization in hogs does not pay? Probably not. It is possible that many of the sows on the dairy-hog farms farrowed earlier in the spring when then weather was colder and higher losses resulted. These losses may have been more than offset by a higher price received when the pigs were sold.

It is also possible that the degree of specialization in swine on the dairy-hog farms was not great enough to influence the number of pigs weaned per litter. Perhaps farms highly specialized in swine have equipment and methods that help them save more pigs per litter. The success of many of the corn belt "pig hatcheries" would indicate that this is true.

Hypotheses No. 5 -- The income per $1,000 invested in power and machinery was highest on the dairy-hog farms. Income per $1,000 invested in power and machinery is a measure of how efficiently the machinery and equipment on a farm are used.

The dairy-hog farms were expected to have the highest income per $1,000 invested in power and machinery because hogs require very little equipment which would not be on any dairy farm. The specialized dairy farms were also expected to have a high income per $1,000 invested in machinery. This is because they have few side lines that require extra equipment. The value of the equipment used in the dairy enterprise, however, is often very high. The data in Table XIII fail to uphold this hypothesis; these data are presented graphically in Figure 9.

The dairy-hog farms had an average gross income of $2,665 per $1,000 invested in power and machinery. The figure for the large specialized dairy farms, however, was only 0.6 per cent lower and the figure for the small specialized

dairy farms was but 1.4 per cent lower. The figure for the diversified dairy farms is $2,478, which is 7.0 per cent lower than the dairy-hog farms. Even this difference is not significant due to the extreme year to year variation in the data. This lack of significance disproves the idea that dairy-hog farms can obtain a much greater income with the same level of machinery investment as farms in the other three groups.

TABLE XIII

INCOME PER $1,000 INVESTED IN POWER AND MACHINERY, 1940-49

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	$1,823	$2,239	$2,034	$2,046
1941	2,510	2,159	2,620	2,485
1942	2,648	2,674	2,852	3,010
1943	2,594	2,541	2,672	2,582
1944	2,970	2,965	2,332	2,619
1945	3,054	2,847	2,740	2,775
1946	3,286	2,901	2,831	3,112
1947	2,911	3,281	2,586	3,469
1948	2,728	2,720	2,350	2,584
1949	1,968	1,948	1,763	1,965
Average	2,649	2,628	2,478	2,665

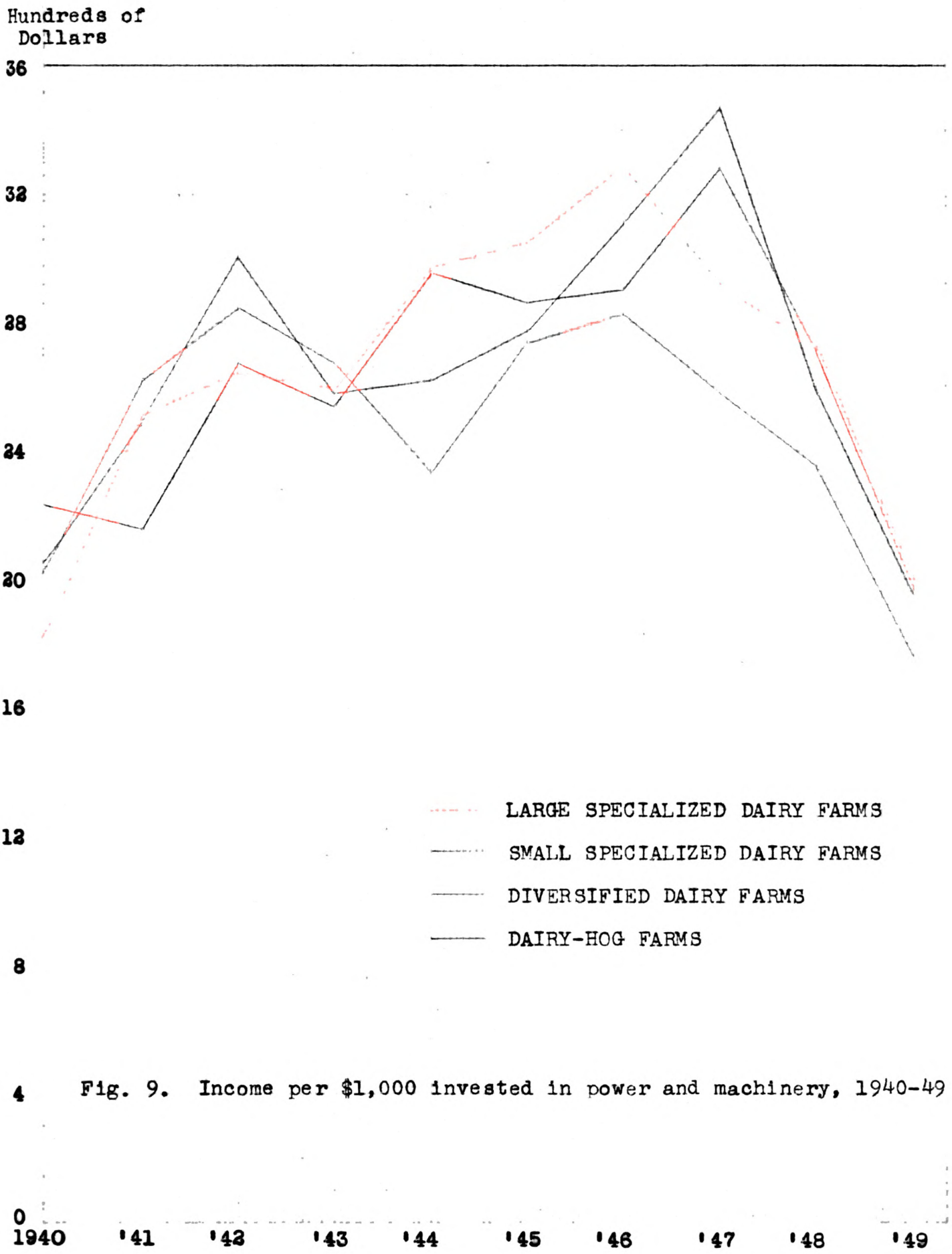


Fig. 9. Income per $1,000 invested in power and machinery, 1940-49

Hypotheses No. 6 -- The income per $1,000 invested in improvements was highest on the diversified dairy farms. This factor is used as a measure of how efficiently such improvements as building, fences and tiling were used. The highest income per $1,000 invested in improvements was expected on the diversified dairy farms because, being diversified, they could fit in complementary or supplementary enterprises which would more fully utilize existing buildings. By increasing business without increasing buildings, the diversified dairy farms could have a higher income per $1,000 invested in improvements, even though the total income was lower than the farms in the other groups.

The data in Table XIV (see, also, Figure 10) disprove this hypothesis. The small specialized dairy farms had the highest average seven years during the period and an average income of $1,538 per $1,000 invested in improvements during the period. The diversified dairy farms were 3.1 per cent lower with an average of $1,490. The large specialized dairy farms had an average of $1,390 for the period and the dairy-hog farms were slightly lower with an average of $1,356.

The year to year variation is again high, thus reducing the significance of the data. The period 1945 through 1947 accounts for the differences in the averages. During this part of the ten year period the income per $1,000 invested

in improvements on the small specialized dairy farms and the dairy-hog farms was comparatively low. If the figures for the three year period 1945 through 1947 were removed from the data the difference in the averages would be less than 6 per cent.

TABLE XIV

INCOME PER $1,000 INVESTED IN IMPROVEMENTS, 1940-49

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	$ 840	$ 939	$ 846	$ 769
1941	1,147	934	1,058	1,116
1942	1,256	1,449	1,394	1,569
1943	1,362	1,450	1,515	1,417
1944	1,595	1,665	1,443	1,441
1945	1,493	1,771	1,768	1,392
1946	1,471	1,941	1,794	1,535
1947	1,569	1,915	1,958	1,354
1948	1,660	1,732	1,717	1,559
1949	1,507	1,588	1,411	1,412
Average	1,390	1,538	1,490	1,356

One reason for these results is the variation between the farms in each group. While many farms in each group make efficient use of their improvements, others are poorly organized and overbuilt.

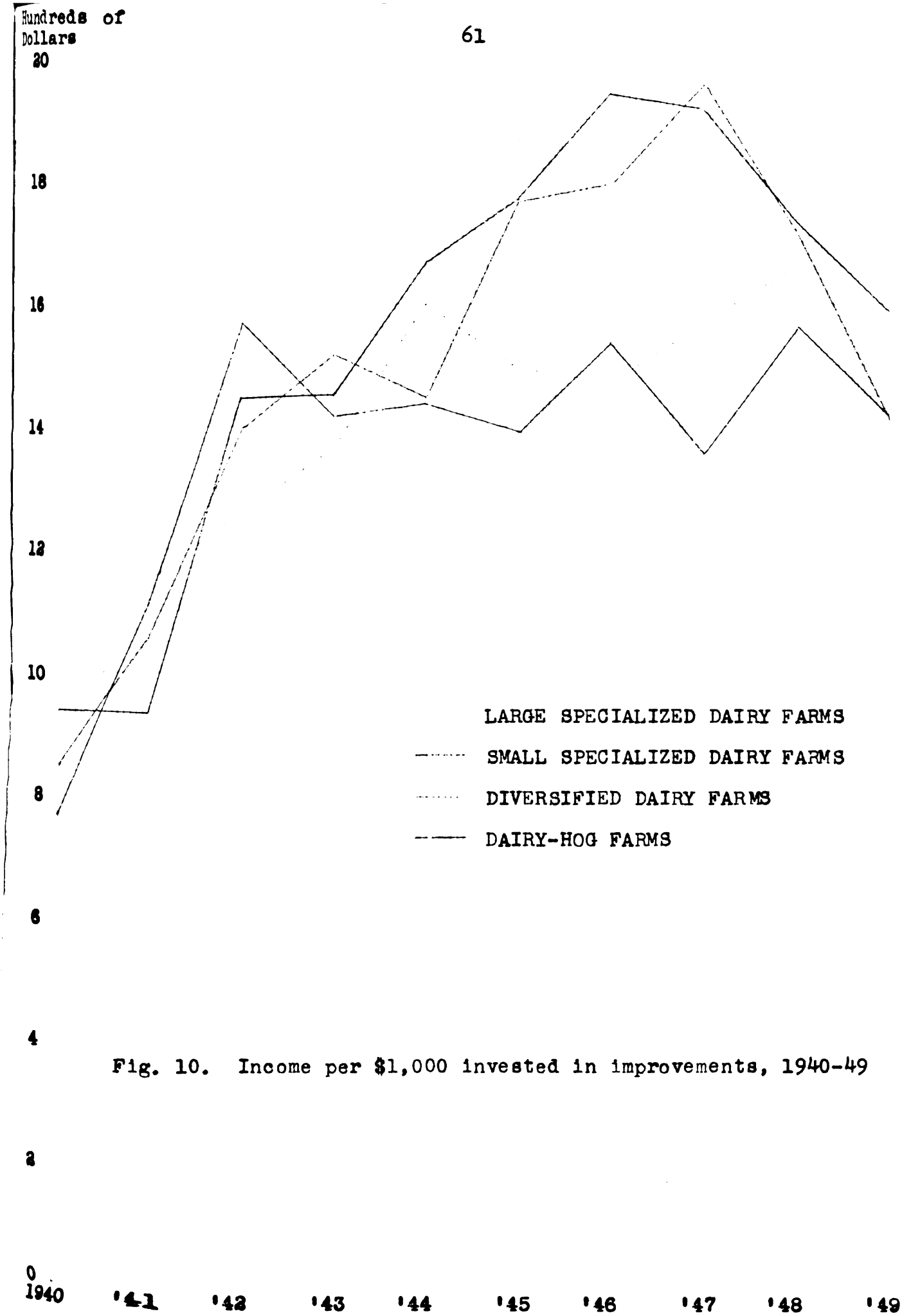


Fig. 10. Income per $1,000 invested in improvements, 1940-49

Hypotheses with Respect to Specialization and Efficiency Factors

This third group of hypotheses deals with the relationship between the degree of specialization in the dairy enterprise and certain efficiency factors. The relationship will be measured by the coefficient of correlation found between the per cent of productive man work units spent on the dairy enterprise and the efficiency factors. The degree of coorelation was determined for three years: 1940, the first year of the period and the year when the parity ratio was 85, the lowest for the period; 1947, the year when the parity ratio was 121, the highest for the period; and 1949 the last year of the period when the parity ratio was 104.

Hypotheses No. 1 -- The dairy sales per cow were positively correlated with the percentage of productive man work units spent on the dairy enterprise. This relationship is to be expected because farmers who spend a high percentage of their productive man work units on the dairy enterprise could be expected to be interested in dairy cattle and to do a good job with them. They could also be expected to have a better than average herd of dairy cows.

This relationship is expected on farms with both large and small herds. That is, a small herd on a farm highly specialized in dairy is expected to yield a higher return per cow than a herd of the same size on a farm less specialized

in dairy. The degree of correlation, however, was not expected to be high because of the other variable factors involved.

The data in Table XV uphold this hypothesis. There was a positive correlation between the factors each of the three years the correlation was studied. The degree of correlation was so small it only shows that some relationship existed.

TABLE XV

COEFFICIENTS OF CORRELATION BETWEEN THE PERCENTAGE OF THE PRODUCTIVE MAN WORK UNITS SPENT ON THE DAIRY ENTERPRISE AND CERTAIN EFFICIENCY FACTORS, 1940, 1947 AND 1949

Efficiency Factor	Coefficient of Correlation		
	1940	1947	1949
Dairy Sales Per Cow	.404	.505	.541
Number of Productive Man Work Units Per Man	-.132	-.112	.040
Improvement Investment Per Animal Unit	.096	.038	.00015

The data for 1949 are plotted in Figure 11. The coefficient of correlation is 0.54 and it can be seen that there is very little grouping around the regression line. An inspection of Figure 11 reveals seven of the 92 farms had less than 30 per cent of the productive man work units spent on dairy, also the dots representing six of these

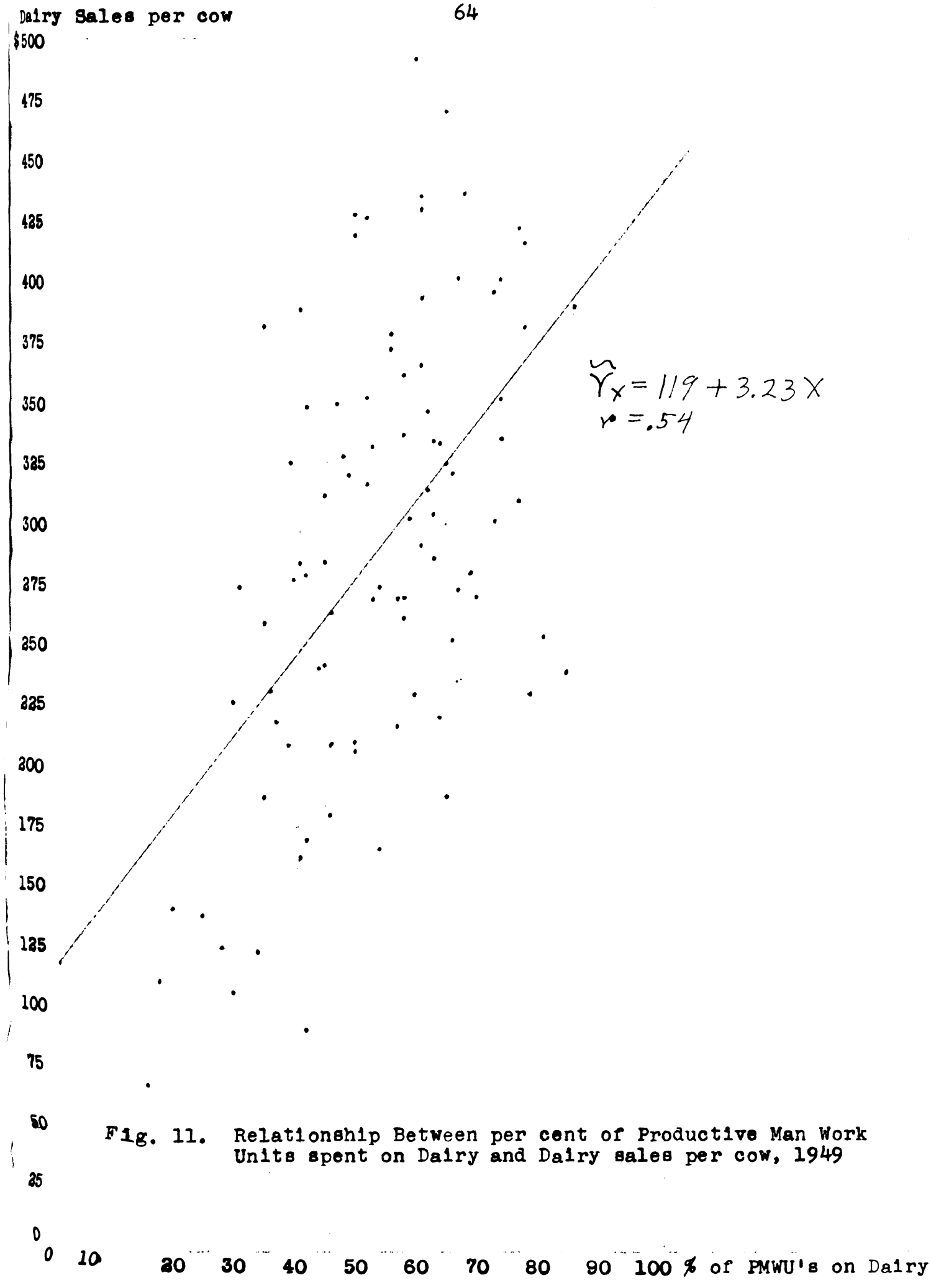


Fig. 11. Relationship Between per cent of Productive Man Work Units spent on Dairy and Dairy sales per cow, 1949

seven are well below the regression line. To determine the effect these seven farms had on the regression line they were removed and the correlation determined for the farms having 30 per cent or more of their productive man work units from dairy. With these residual farms the coefficient of correlation dropped to 0.36.

This drop in the value of the coefficient of correlation would seem to indicate that on farms where 30 per cent or more of the productive man work units were spent on dairy there was only a slight relationship between dairy sales per cow and per cent of the productive man work units spent on dairy. This lack of relationship is the result of many factors that effect dairy sales per cow on a given farm. On farms where dairy was an important enterprise, these factors were more important than degree of specialization.

Hypotheses No. 2 -- The number of productive man work units per man were positively correlated with the percentage of productive man work units spent on the dairy enterprise. This relationship was expected because farmers specialized in dairy can concentrate their efforts on fewer enterprises and develop a higher degree of efficiency than can farmers on the less specialized farms.

This relationship was expected to be greatest during the later years of the study because more labor saving equipment had become available. This extra labor saving equipment

would probably reduce the time spent on the dairy enterprise more than on other enterprises such as swine and poultry. The fact that operators of less specialized farms with large dairy herds also take advantage of labor saving equipment and methods is expected to result in a low correlation.

The data in Table XV disprove this hypothesis. There was no significant correlation between the per cent of productive man work units spent on the dairy enterprise and the productive man work units per man. This supports the data in Table IX which show that over the ten year period the number of productive man work units per man on the dairy-hog farms and diversified dairy farms was greater than on the large and small specialized dairy farms.

Hypotheses No. 3 -- The more specialized dairy farms, as measured by the percentage of total productive man work units spent on dairy cattle, had a lower improvement investment per animal unit. This correlation was expected because dairy cattle require good housing and, on most farms, a milkhouse. The expense per animal unit would be reduced if this expense were spread over a larger number of cows. This would reduce the improvement investment per animal unit.

Included in the data utilized are those for a number of specialized dairy farms with small herds and a large

improvement investment. The data from these farms would reduce the degree of correlation.

The data in Table XV disprove this hypothesis. For the three years studied there was no correlation between the improvement investment per animal unit and the percentage of the productive man work units spent on the dairy enterprise. These results are due to the varied value, valuation and use of improvements on the different farms. This would hold true even if more exact valuations were used. Some operators, regardless of type of farm, would prefer less expensive buildings while others would feel that more expensive buildings would pay for themselves in the long run.

Perhaps different results would have been obtained if size of herd had been used instead of percentage of productive man work units spent on the dairy enterprise. Such a correlation would have shown if farms with larger herds have the same overhead per unit as those with smaller herds.

Hypotheses with Respect to Size of Enterprise and Efficiency Factors

This fourth group of hypotheses involves the relationships between the size and the efficiency of the dairy and hog enterprises. Again, as with the preceding group of hypotheses, the years 1940, 1947, and 1949 were the basis for analysis.

This part of the study should help to determine whether the size of enterprise, regardless of the degree of specialization, is an important factor. The two hypotheses in this group will be considered separately.

Hypotheses No. 1 -- There was a direct correlation between the number of litters of pigs raised and the number of pigs weaned per litter. Although this may seem to be a hypothesis with little relation to the subject of dairy farms, it is an integral part of the problem with respect to the dairy-hog farms under consideration. The correlation between number of litters and number of pigs weaned is expected because farmers who raise a greater number of litters are probably more experienced hog men and could be expected to put more time and effort into saving more pigs per litter. They could also be expected to have buildings and equipment better adapted to swine.

One factor that may tend to reduce the correlation is, the farmers who raise a larger number of litters would pay more attention to markets and have their sows farrow earlier to hit a better market. However, having pigs born earlier in the spring they would run a greater risk of losing pigs during cold periods.

The data in Table XVI disprove this hypothesis. Rather than being a direct correlation there was a very slight negative correlation for each of the three years studied.

TABLE XVI

COEFFICIENTS OF CORRELATION BETWEEN NUMBER OF LITTERS FARROWED AND NUMBER OF PIGS WEANED PER LITTER, 1940, 1947 AND 1949

Year	Coefficient of Correlation
1940	-0.285
1947	-0.119
1949	-0.133

One of the possible reasons for this result is mentioned above. Another possible reason is that all the farms studied were dairy farms and, therefore, the hog enterprises on all the farms were relatively small when compared to a specialized hog farm. Pehaps the hog enterprises on the farms studied were too small to show any advantage in specialization.

Hypotheses No. 2 -- There was a direct correlation between the average number of cows in the herd and dairy sales per cow. This correlation is expected because a farmer who has a large dairy herd is probably a better than average dairyman and has a better than average dairy herd. He is also more likely to be equipped to sell fluid milk which will bring a higher price per hundredweight. A farmer with a large herd is more likely to have his cows freshen when the milk will bring a higher price and, if he is on the base and excess plan, he will organize his breeding program

so that more cows freshen in the fall and thus he could be selling a high percentage of base milk the year around.

The data in Table XVII uphold this hypothesis. There was a fair positive correlation between average number of cows and the dairy sales per cow each of the three years the correlation was determined. The average degree of correlation 0.50, was small but it shows that the relationship exists. To find the effect of the smaller farms on the relationship, the correlation was found for 1949 with a few of the smallest farms removed. When the six farms with less than four cows were removed, the correlation dropped to 0.49 and when the ten farms with less than seven and one-half cows were removed the correlation dropped to 0.43.

TABLE XVII

COEFFICIENTS OF CORRELATION BETWEEN AVERAGE NUMBER OF COWS IN HERD AND DAIRY SALES PER COW, 1940, 1947 AND 1949

Year	Coefficient of Correlation
1940	0.420
1947	0.506
1949	0.588

These figures bring up an interesting problem. In Table XI it was shown that dairy sales per cow were highest on the large specialized dairy farms. In Table XV it was

shown that a positive correlation exists between dairy sales per cow and the per cent of the productive man work units spent on the dairy enterprise. In Table XVII it is shown that a slightly higher correlation exists between dairy sales per cow and average number of cows. This indicates that number of cows, rather than degree of specialization, probably is the factor that caused specialized dairy farms to have a higher dairy sales per cow.

The data from 1949 were studied further to find the relationship between the three factors, [a] per cent of productive man work units spent on dairy, [b]average number of cows, and [c] dairy sales per cow.

The correlation between the percentage of productive man work units spent on dairy and average number of cows was found to be 0.67. This relationship, plotted in Figure 12, makes it difficult to determine which factor was responsible for specialized dairy farms having a higher dairy sales per cow. In an attempt to see what effect these two factors together had on dairy sales per cow, another step was taken. The differences between actual dairy sales per cow and the estimated dairy sales per cow shown by the regression line in the graph of Figure 13 were determined. These differences were then plotted against the percentage of productive man work units spent on dairy. The graph in Figure 14 indicates that there was no significant pattern among the farms having thirty per cent or more of the productive man work units spent on dairy.

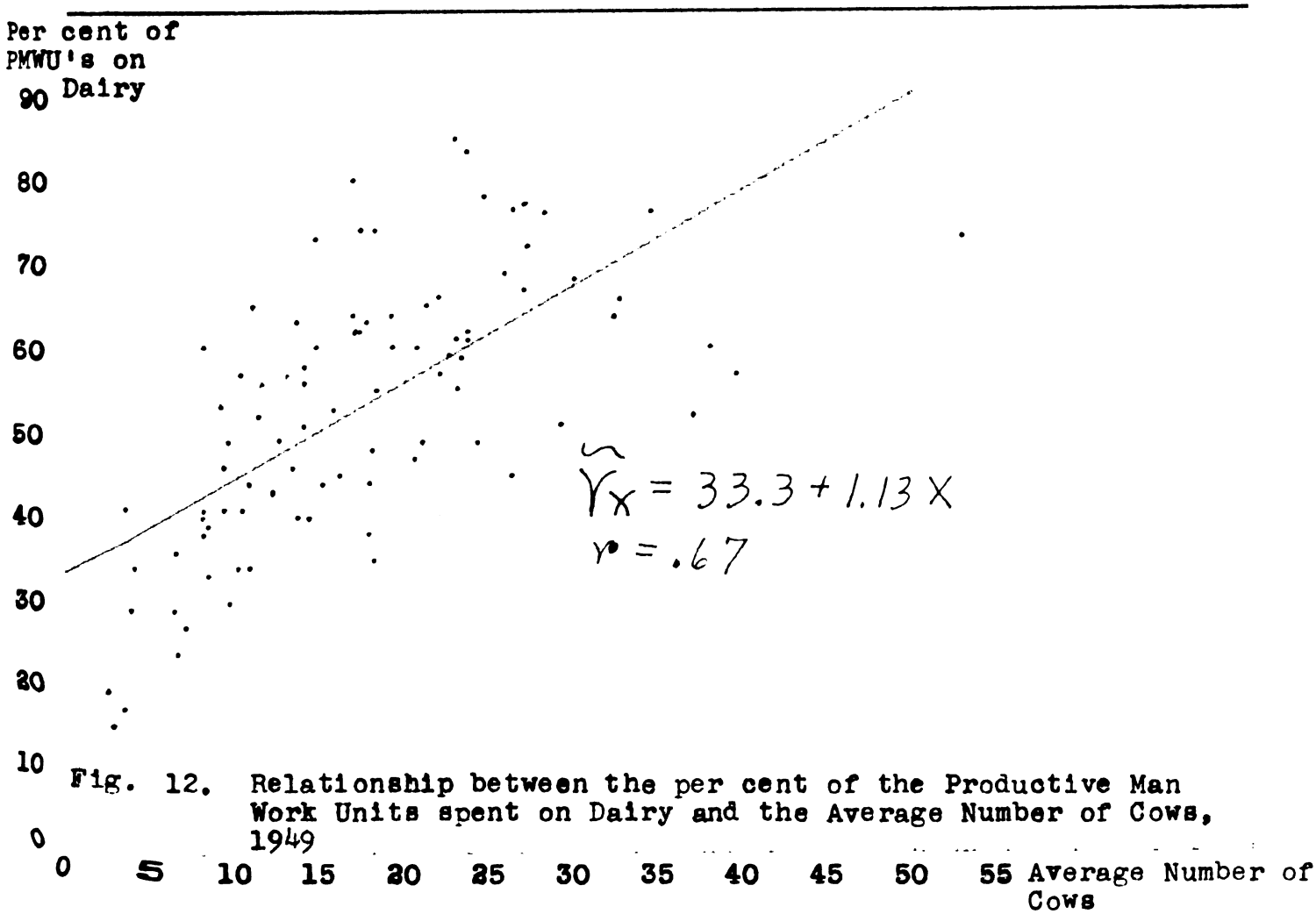


Fig. 12. Relationship between the per cent of the Productive Man Work Units spent on Dairy and the Average Number of Cows, 1949

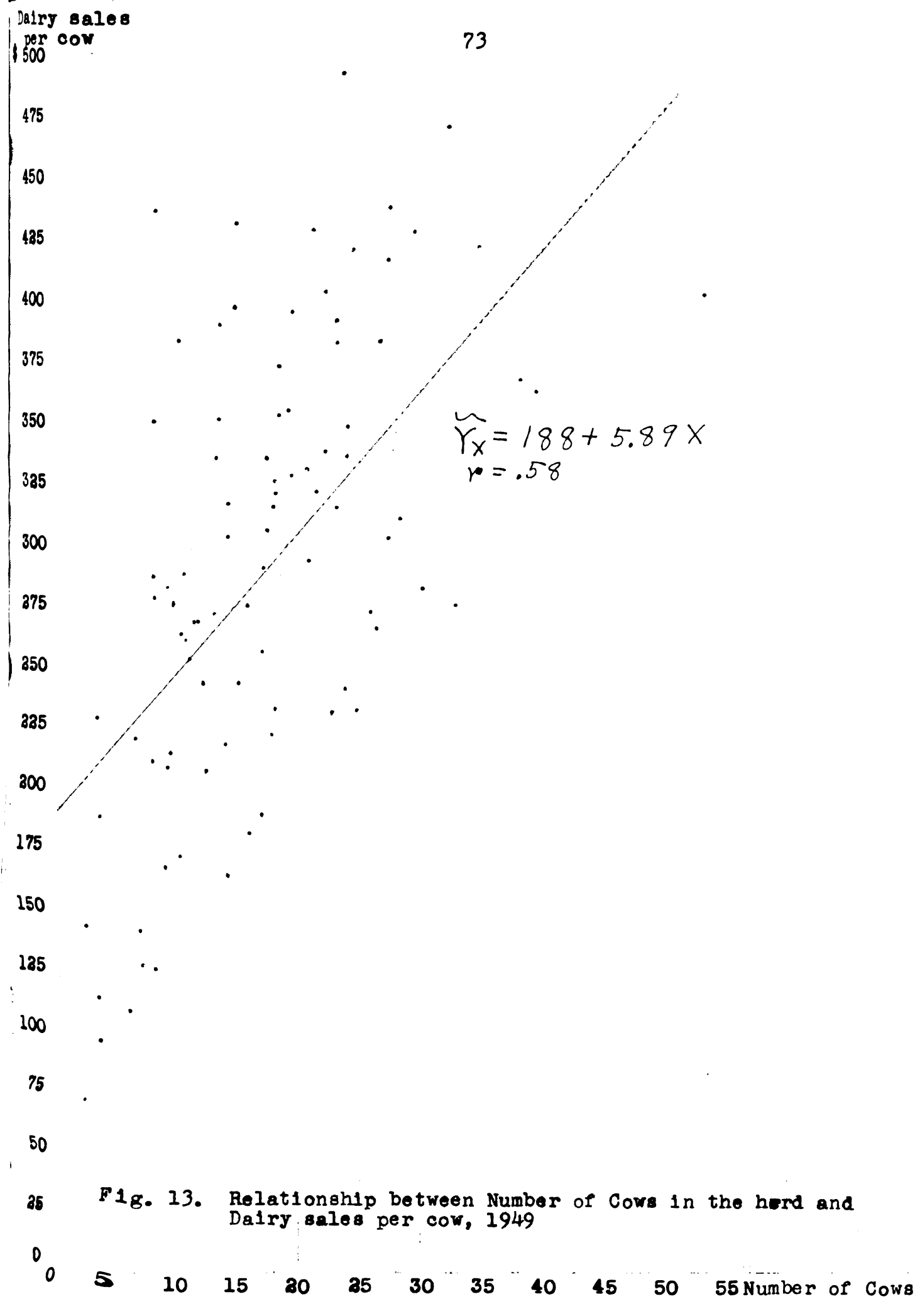


Fig. 13. Relationship between Number of Cows in the herd and Dairy sales per cow, 1949

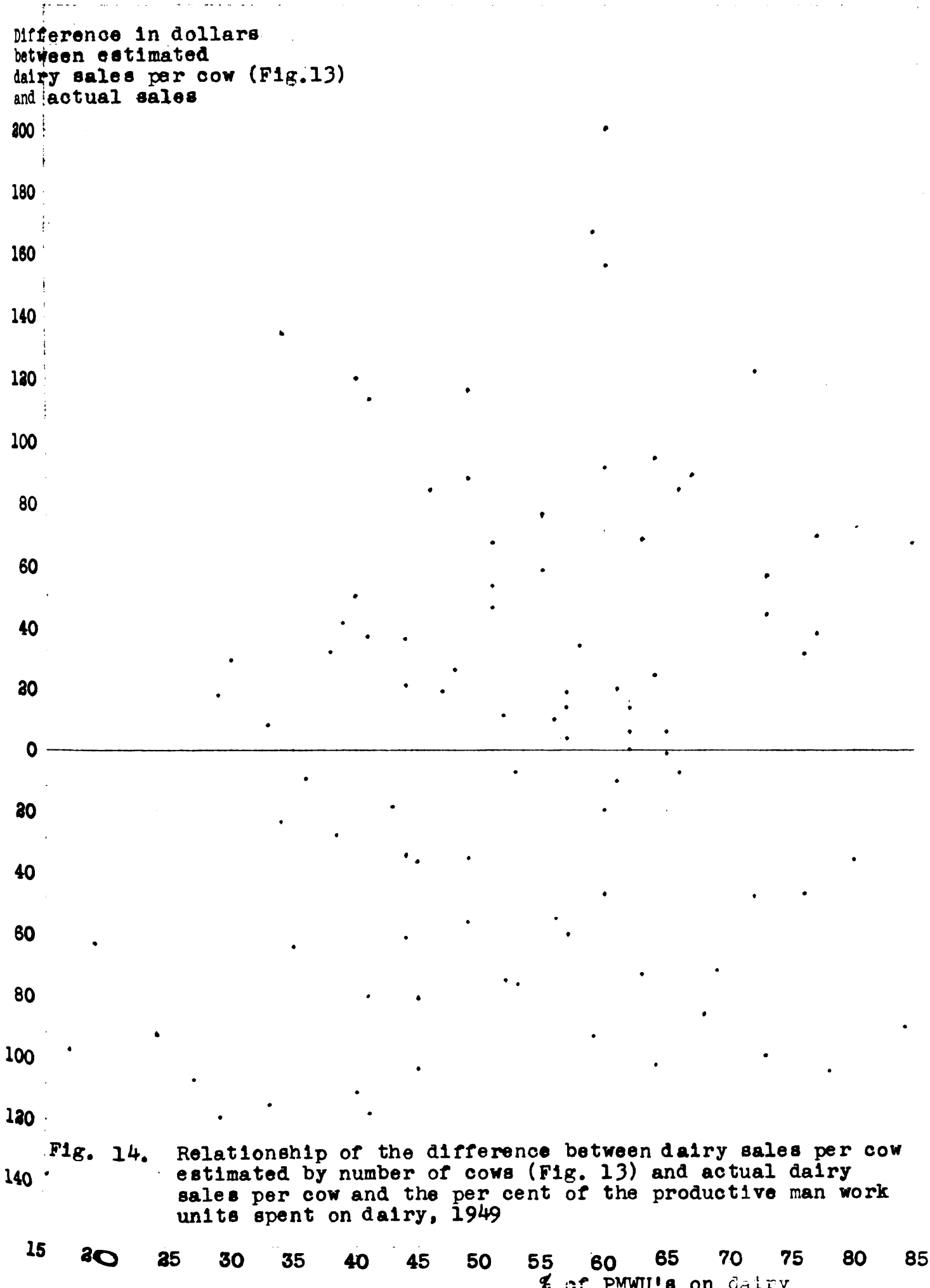


Fig. 14. Relationship of the difference between dairy sales per cow estimated by number of cows (Fig. 13) and actual dairy sales per cow and the per cent of the productive man work units spent on dairy, 1949

SUMMARY

1. This study was undertaken in an attempt to determine the effect of various degrees of specialization on the efficiency and earnings of dairy farmers.

2. Information for this study was obtained from the summary sheets of farm account cooperators on file in the Department of Agricultural Economics.

3. Data from 92 farms for the ten year period 1940 -- 1949 were studied by means of tabular analysis to determine the effect of various types of operational organization upon farm efficiency and income.

4. Data from the summary sheets for 1940, 1947, and 1949 were studied by the correlation analysis method to determine relationships between degree of specialization and efficiency.

5. A trend toward specialization in dairy, during the period 1940 -- 1949, was discovered. This trend was evidenced by [a] a greater number of cows in the dairy herds, and [b] a higher percentage of the productive man work units being spent on the dairy enterprise.

6. Measures of income were related to size of business and relative price levels, rather than to degree of specialization.

7. Specialization in dairy had little effect on the efficient use of buildings, equipment and labor, although it did tend to increase the dairy sales per cow.

8. There was a wide variation between the farms of high and low efficiency at all levels of specialization. This indicates that if a farmer is to derive full advantage from the efficiencies of either specialization or diversification, he must plan his operations carefully.

CONCLUSIONS

Effect of Specialization on Farm Income

Degree of specialization in dairy was but one of many factors that affected a dairy farmers income.

Labor income was influenced by relative price levels and volume of business as well as degree of specialization.

Rate earned on investment was mainly the result of relative price levels.

The correlation between labor income and gross income was highest on the specialized dairy farms. Because of this a specialized dairy farmer is more likely to see his gains in gross income evenly reflected in an increased labor income.

Stability of labor income seemed to be related to size and kind of business as well as degree of specialization. The larger operations with the higher cash expenses had the more variable income. The labor income on the large specialized dairy farms, however, was less variable than on more diversified farms with the same size of business. This was true because dairying is one of the more stable enterprises and diversification, by adding a less stable enterprise, or enterprises, would increase rather than decrease variability of income. This means that when a dairy farmer is deciding

how much to specialize he should think in terms of income, cost of operation, building and equipment expense, and efficiency and not consider diversification solely for the purpose of spreading risk.

Effect of Specialization on Farm Efficiency

Specialization in dairy had a significant positive effect on dairy sales per cow. This relationship, though small, is important. It means that a farmer who enlarges his dairy herd to increase his size of business may also increase his income per cow.

The farmer should be careful, however, to consider in what way enlargement of the herd will increase his sales per cow. Will it enable him to have the equipment for a better market? Will he be able to afford a better herd sire? Or, perhaps justify the equipment to put up grass silage for fall feeding when he is trying to build up his base? The low correlation between size of herd and dairy sales per cow suggests that increasing the size of herd will not automatically increase income per cow; therefore, any increase in herd size should be carefully planned.

The idea that by specializing in dairy a farmer will become more efficient in the use of labor, buildings and equipment was not upheld by this study.

The diversified dairy farmers in this study were just as efficient in the use of buildings, machinery and equipment as the specialized dairy farmers.

The small specialized dairy farms had the lowest labor efficiency. The differences in labor efficiency among the large specialized dairy farms, diversified dairy farms and dairy-hog farms were not significant. Indicating labor efficiency was a product of size rather than degree of specialization.

The above implies that if, by specializing, a farmer can increase his efficiency in the use of labor, machinery and buildings, the specialized dairy farmers who formed the basis for this study did not plan their operations to take advantage of these efficiencies.

The lack of relationship between specialization in dairy and efficiency in the use of labor, buildings and equipment calls for further study of this problem. There are no doubt many specialized dairy farmers in Michigan who make efficient use of all factors of production. These farmers' methods should be studied and the information obtained made available to other farmers in an understandable form. Also the data used in this study covered the period 1940 -- 1949 only. Since 1949 new methods and equipment have come into common use which may aid a specialized dairy farmer in becoming more efficient.

General Conclusions

The question, "Do hogs have a place on a dairy farm?" is not completely answered here. The number of pigs weaned per litter on the farms which formed the basis of this study was lower than desirable. Moreover, increasing the number of litters in the range permitted on most dairy farms did not increase the number of pigs weaned per litter. This seems to indicate that a dairy farmer should study his choices of operational plan carefully before he decides to add or enlarge a hog enterprise. It is entirely possible that addition of, or increase in the size of a hog enterprise would result in a lowered efficiency and a decreased income for himself and his family.

The data assembled and discussed in this study emphasized the importance of volume of business on a farm. Regardless of how efficiently a farm is operated, it is necessary to have a large volume of business before the farmer can have a satisfactory income for himself and his family.

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APPENDIXES

APPENDEX A

AVERAGE EXPENSES PER FARM, 1940 - 1949

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	$ 3,394	$1,875	$2,055	$2,241
1941	3,967	2,024	2,300	2,595
1942	5,081	2,904	3,388	3,730
1943	6,602	3,843	4,452	4,745
1944	7,053	4,212	4,626	5,007
1945	7,123	4,475	4,762	4,789
1946	7,647	5,135	5,286	5,440
1947	10,293	6,006	6,623	6,741
1948	11,046	6,515	7,096	7,691
1949	10,703	6,581	8,433	7,372
Average	7,291	4,357	4,902	5,035

APPENDIX B

AVERAGE GROSS INCOME, 1940 - 1949

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	$ 5,627	$2,941	$3,054	$3,284
1941	8,174	3,081	4,333	4,747
1942	9,498	5,033	5,938	7,161
1943	10,308	5,699	6,648	7,017
1944	11,915	6,172	6,387	7,555
1945	11,813	7,193	7,871	8,098
1946	13,539	8,057	8,507	9,518
1947	15,305	9,509	9,914	11,703
1948	16,516	9,311	10,001	10,893
1949	15,671	8,718	10,938	9,423
Average	11,837	6,571	7,359	7,840

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1947	15,305	9,509	9,914	11,703
1948	16,516	9,311	10,001	10,893
1949	15,671	8,718	10,938	9,423
Average	11,837	6,571	7,359	7,840

APPENDIX C

AVERAGE NUMBER OF MEN PER FARM, 1940 - 1949

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	2.54	1.58	1.58	1.78
1941	2.73	1.51	1.58	1.63
1942	2.67	1.43	1.54	1.73
1943	2.72	1.52	1.61	1.74
1944	2.67	1.56	1.61	1.70
1945	2.39	1.58	1.52	1.61
1946	2.53	1.55	1.47	1.62
1947	2.48	1.50	1.50	1.62
1948	2.45	1.54	1.58	1.71
1949	2.46	1.74	1.71	1.57
Average	2.56	1.55	1.57	1.67

APPENDIX D

TOTAL INVENTORY, 1940-1949

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	$25,523	$12,013	$13,842	$15,925
1941	26,138	12,674	15,013	16,427
1942	27,938	13,905	16,090	18,818
1943	29,579	15,404	17,507	20,615
1944	29,273	15,786	18,047	20,988
1945	29,646	16,743	18,047	21,998
1946	31,921	18,089	19,042	22,864
1947	33,386	19,007	20,148	23,814
1948	34,874	21,159	22,945	26,699
1949	37,899	22,027	28,628	25,806
Average	29,618	16,681	18,931	21,359

APPENDIX E

RETURN FOR INVESTMENT AND MANAGEMENT, 1940 - 1949

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	$2,232	$1,066	$1,000	$1,043
1941	4,207	1,707	2,172	2,152
1942	4,417	2,144	2,549	3,475
1943	4,013	1,866	2,196	2,319
1944	4,861	1,959	1,735	2,549
1945	4,675	2,717	3,110	3,281
1946	5,477	2,922	3,221	4,076
1947	4,961	3,513	3,290	4,961
1948	5,203	2,796	2,904	3,203
1949	4,968	2,147	2,506	2,029
Average	4,501	2,284	2,468	2,909

APPENDIX F

ACRES IN SOD CROPS, 1940 - 1949

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	79.4	50.0	48.3	53.1
1941	79.3	52.8	51.0	49.7
1942	88.4	49.3	49.1	54.7
1943	109.7	62.5	52.7	55.2
1944	88.5	59.7	47.3	50.3
1945	93.9	58.8	46.1	55.4
1946	95.5	64.7	49.0	53.5
1947	97.7	65.3	56.7	52.6
1948	83.0	64.0	57.2	50.7
1949	95.6	62.2	61.1	50.3
Average	91.10	58.93	51.85	52.55

APPENDIX G

ACRES IN CULTIVATED CROPS, 1940 - 1949

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	51.7	22.5	30.1	36.0
1941	54.5	22.6	35.4	35.2
1942	51.1	21.9	32.6	37.8
1943	50.4	24.2	32.9	24.4
1944	62.2	27.5	40.1	45.9
1945	49.2	30.2	37.7	45.6
1946	48.0	27.7	27.2	42.9
1947	48.8	23.4	30.0	40.0
1948	45.1	24.2	32.9	42.7
1949	40.7	23.5	37.5	38.6
Average	50.18	24.77	33.64	38.91

APPENDIX H

ACRES IN SMALL GRAINS, 1940 - 1949

Year	Large Specialized Dairy Farms	Small Specialized Dairy Farms	Diversified Dairy Farms	Dairy-Hog Farms
1940	49.3	30.6	32.5	37.5
1941	43.9	33.9	32.2	40.6
1942	52.1	36.5	33.0	46.1
1943	32.7	30.8	25.9	39.7
1944	45.6	37.3	35.1	48.4
1945	53.4	31.1	40.3	50.1
1946	47.7	35.6	36.6	45.1
1947	36.5	33.9	28.0	46.2
1948	58.8	35.1	42.2	59.2
1949	52.2	31.8	44.3	57.5
Average	47.62	34.16	35.01	47.04