DERIVATION OF ESTIMATES OF MARGINAL FACTOR COST FUNCTIONS FOR CREDIT FOR CASH-CROP, DAIRY, AND BEEF CATTLE FARMERS IN SELECTED AREAS OF MICHIGAN 1960

Thesis for the Degree of Ph. D.

MICHIGAN STATE UNIVERSITY

Sidney C. Bell

1961

This is to certify that the

thesis entitled

DERIVATION OF ESTIMATES OF MARGINAL FACTOR COST FUNCTIONS FOR CREDIT FOR CASH-CROP, DAIRY, AND BEEF CATTLE FARMERS IN SELECTED AREAS OF MICHIGAN

presented by

Sidney C. Bell

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Ag. Econ.

Glenn L. Johnson
Major professor

Date May 31, 1961

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by

Sidney C. Bell

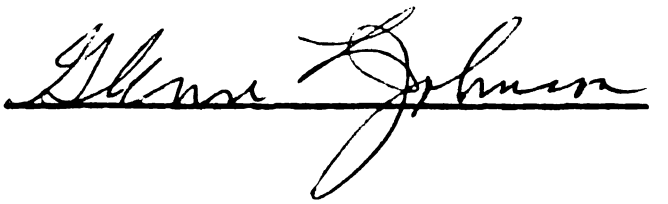
AN ABSTRACT

Submitted to the School for Advanced Graduate Studies of Michigan State University of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Department of Agricultural Economics

1961

Approved 

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ABSTRACT

The primary objective of this study was to derive and describe estimates of the marginal cost functions for credit for cash-crop, dairy and beef cattle farmers in selected areas of Michigan. The necessary data were collected by personal interview from these three types of farms. Therefore, these functions represent the farmers' estimate of the supply of credit available to them at various interest rates. The secondary objective was to determine the factors which affect the quantity of credit the different types of farmers estimated they could borrow.

The areas selected to represent the different types of farms were Saginaw County for cash-crop, St. Clair County for dairy, and Lenawee County for beef cattle farms. A stratified sample was randomly selected within each area to obtain a sample to represent the farmers of that area.

Several regression equations were fitted to the data of the individual type farms and to the data for all farms. These equations were fitted with quantity of credit as the dependent variable. This was done to derive a best fitting equation with the variables that affect the quantity of credit obtainable at a series of interest rates.

A best fitting equation was selected from the equations fitted for each type of farm and for all farms. Items considered in selecting the "best fit" were, (1) the adjusted

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multiple correlation and determination coefficients, (2) standard error of estimate, (3) number of variables whose coefficients were significant and level of significance, (4) value and sign of estimated regression coefficients, (5) distribution of the residuals when plotted about the regression line, and (6) the intercorrelation among the independent variables.

The selected equations indicate that the important factors affecting the quantity of credit farmers estimate they can borrow were, (1) net worth, (2) interest rate, (3) availability of land contracts, (4) credit rating of farmer, (5) gross farm income, (6) net farm income, and (7) age and education.

The variables selected in fitting the above equations were used in fitting regression equations with the interest rate as the dependent variable. These equations were used to derive the marginal factor cost functions for credit for the cash-crop, dairy and beef cattle farmers. The function most representative of the data for cash-crop farmers was curvilinear, while the ones for dairy and beef cattle farmers were straight line functions.

The marginal factor cost functions were also derived for the individual types of farms from the data of all farms using the types of farms as independent variables. The results of fitting these functions indicated they were not

useful as a function to represent a particular type farm.

The two most probable uses of the results of this study are in the areas of: (1) research work -- (a) in farm budgeting and programming and (b) supply response work, and (2) extension work with farmers in the field of credit. Some secondary uses of these functions might be, (1) in the teaching field and (2) as an aid to various lending agencies.

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Sidney C. Bell

A THESIS

Submitted to the School for Advanced Graduate Studies of Michigan State University of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

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Department of Agricultural Economics

1961

To

My Wife, Doris

And my three children

Betty, Ronnie and Bonnie

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ACKNOWLEDGMENTS

The author is grateful to the many persons who gave their time and assistance in the development of this study. The guidance of Dr. Glenn L. Johnson was very helpful and the author is especially grateful for having been associated with him for the period of his graduate study.

Appreciation is expressed to Dr. L. L. Boger, Head of the Department of Agricultural Economics, for financial aid in the form of a research assistantship.

The author would like to acknowledge the assistance received from Dr. John Brake who read the rough drafts of this thesis and made many helpful suggestions. Also to Dr. R. L. Gustafson who aided in formulating part of the statistical procedure used in this study.

Appreciation is expressed to the secretaries who typed the rough draft and to the statistical pool of the Department of Agricultural Economics for doing the computational work.

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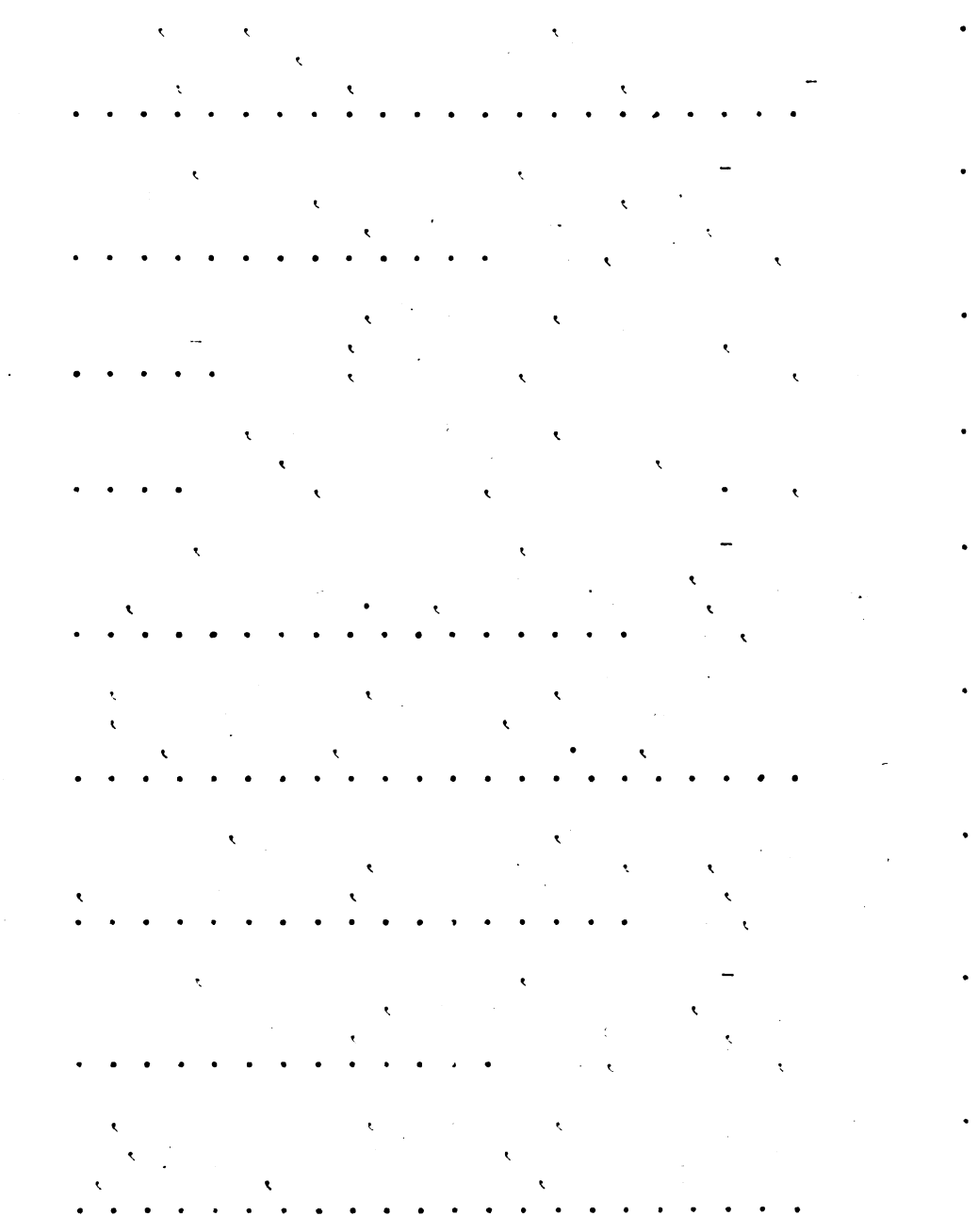

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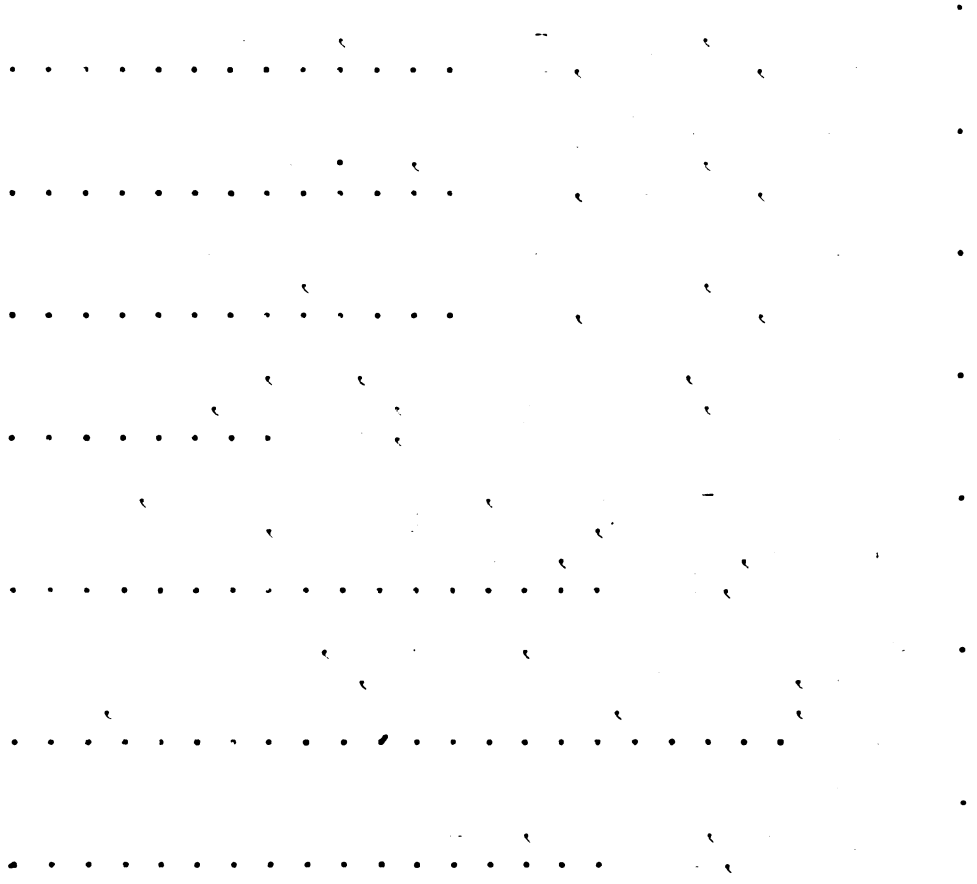

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CHAPTER I

INTRODUCTION

Credit plays a very important part in the general field of agriculture and is indispensable to most individual farmers. The adoption of many new and improved scientific and technical developments in recent years in Michigan's agriculture has required larger and larger capital investments in establishing and maintaining an economical size farming unit. Capital, in many cases, must be obtained through regularly established lending institutions in the form of credit.

The relative importance of credit and the need[1] in research for empirically derived marginal factor cost functions of credit were the factors that brought this problem to the author's attention. There has been much speculation about the shape and type of marginal factor cost function for credit that farmers are facing in the capital market.

In analyses employing the assumptions of static theory of a perfectly competitive firm, the supply of credit is often assumed to be unlimited at the going interest rate. Under these assumptions, the quantity of credit used does not affect the interest rate. Hence, the individual farmer

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[1]Hildebrand, Peter E., Farm Organization and Resource Fixity: Modifications of the Linear Programming Model, Unpublished Ph.D. Thesis, Michigan State University, 1959 and McKee, Dean E., Economic Appraisal of Adjustments in Dairying in Michigan to Meet Changing Conditions, Project in current progress at Michigan State University.

can acquire unlimited funds by paying the market rate of interest. These assumptions have been used in models of agricultural organizations. For example, Clark Edwards' thesis[2], makes limited use of this assumption, stating,

> "perfectly elastic, continuous supply functions are used for variable services in model 1. Numerous imperfections in the factor and money market exist in the farm economy and perfectly elastic functions for inputs are far less realistic than perfectly elastic demand functions for products. The perfectly elastic functions are frequently used in analysis of the farm economy and they are included here for comparison with the results of the other models."

Edwards used two other types of supply functions in his models. One was an upward sloping continuous supply function. The other function had a point of discontinuity. The supply function was formed by the acquisition function for quantities of services greater than the initial quantity on the farm and by the salvage function for quantities less than initial, the point of discontinuity being determined by the initial use of the service. This problem has been treated by M. Kalecki, where he discusses the effect of risk on cost of credit.[3]

In most linear programming models used for farms, the supply of credit is assumed fixed or a quantity is assumed

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[2]Edwards, Clark, Resource Fixity, Credit Availability and Agricultural Organization, Unpublished Ph.D. Thesis, Michigan State University, 1958.

[3]Kalecki, M., "The Principle of Increasing Risk," Economica, XI (new ser., 1944), pp. 55-62.

available to carry out certain programs for the farm. Smith[4] assumes in one of his models that the farmer was willing and able to borrow $7,500, plus whatever extra funds may be required for carrying one feeding program to completion simultaneously with starting a new lot (should systems taking more than a year prove profitable).

In recent linear programming work, there has been an improvement over the methods mentioned above. For example, Hildebrand[5] in his study of modifications of the linear programming model assumed a supply function for credit based on credit for land mortgage, credit for purchasing additional land (there were 2 land contracts, one based on 6 per cent interest, the other on 7 per cent both requiring 10 per cent down payment): a chattel mortgage and credit from machinery and silo dealers. The sources of credit had varied interest rates with interest paid annually.

In another linear programming study, Dvorak used an assumed supply function for credit.[6] He compiled a supply curve for credit based on values from previous studies

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[4]Smith, Victor E., "Perfect vs Discontinuous Input Markets," Journal of Farm Economics, Vol. 27, (August 1955), p. 538.

[5]Hildebrand, Peter E., op. cit.

[6]Dvorak, F. E., Programming The Organization and Capital Use For a Cash Crop Farm in the Saginaw Valley and Thumb Area of Michigan, Unpublished M.S. Thesis, Michigan State University, 1959.

(which used assumed values), or suggested values by bankers, machinery dealers, and professors of Michigan State University acquainted with the area. Dvorak had two sources of credit, a general source where credit could be obtained without purchases and a specialized source where credit could be obtained only if assets were purchased. His supply function, like the others mentioned, did not take into consideration such characteristics of the farmer as his ability to earn, his age, education, etc. Although net worth was considered, Dvorak assumed that every farmer could borrow the same percentage of his net worth in terms of credit and at the same interest rate.

Trant[7], in his study of institutional credit for dairy farmers considered the supply function of credit from the lender's viewpoint only. He considered only institutional lenders and did not take into consideration other sources of credit such as land contracts with individuals, feed, machinery, and livestock dealers, friends and families.

These and other studies have used somewhat inadequate supply functions for credit. The models used were unrealistic in that the amount of money a farmer could borrow was not related to his characteristics. This study is designed to consider the personal characteristics, age, education, credit

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[7]Trant, G. I., Institutional Credit and The Efficiency of Selected Dairy Farms, Unpublished Ph.D. Thesis, Michigan State University, 1960.

rating, etc., of the farmer and will attempt to estimate their effects upon the quantity of credit.

In summary, there is a growing need for credit because of increasing capital requirements in farming in Michigan. With this increase in use of credit in financing farming operations comes a need to know more about the credit or capital market Michigan farmers are facing. Further, the increased number of research studies, linear programming and otherwise, that are using supply functions for credit as a variable input is the primary reason why an attempt should be made to derive supply functions for credit for the principal types of Michigan farmers.

Organization of Thesis

In the first part of Chapter I, the description and location of the sample area will be discussed with details on selection of survey areas, stratification of sample, and how the data were collected. In the last part of Chapter I, the design of the questionnaire, the reliability of the data, and details on processing the data to derive the marginal factor cost functions will be presented.

Chapter II will present the various regression equations used to derive marginal factor cost functions for the cash-crop, dairy and beef cattle farms. The best fitting equations, the basis for selecting them, and a detailed discussion of their "fit" and acceptability will be presented. In the last section of Chapter II the derived marginal factor cost

functions of the three types of farms will be presented mathematically and graphically.

The general organization of Chapter III will be similar to Chapter II except that the marginal factor cost functions for cash-crop, dairy and beef cattle farms will be derived from the combined data of all the farms.

Chapter IV includes the summary and conclusions derived from the data of the thesis. The final section of the chapter presents some possible implications of the results.

Objectives of the Study

The primary objectives of this study are:

1. To derive and describe estimates of the marginal factor cost functions for credit for cash-crop, dairy and beef cattle farmers in selected areas on the basis of data collected from individual types of farms in these areas.
2. To derive and describe estimates of the marginal factor cost functions for credit for cash-crop, dairy and beef cattle farmers using the data from all farms. This will be accomplished by using the type of farm as an independent variable, thus the general function can be used for cash-crop, dairy, or beef cattle farms.
3. To compare (1) and (2).

The secondary objectives of this study are:

1. To determine the factors which affect (a) the

quantity of credit the different types of farmers estimate they can borrow and (b) the interest rates they have to pay.

2. To derive estimates of the quantitative effects of each of these factors.
3. To determine if there are any differences in factors and in their quantitative effects among the different types of farmers.

Description and Location of Sample Areas

The sample areas were Saginaw County for cash-crop farmers, St. Clair County for dairy farmers, and Lenawee County for beef cattle farmers.[8] These counties were selected because they are the leading counties in dollar volume of sales within the state in their respective type of farming, with the exception of St. Clair in dairying. Sanilac is the number one dairy county in terms of dollar volume of dairy products sold, but a survey was carried out with dairy farmers there in 1959. Therefore, to avoid the possibility of contacting the same farmers again this year, it was not chosen. St. Clair County, the number two county in terms of dairy products, was selected for dairy farmers in lieu of Sanilac County.

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[8]Beef cattle farmers are defined in this study as farmers that buy feeders (calves, heifers, or steers) and feed them out before selling them, and who have greater than 40 per cent of their gross farm income from sale of beef cattle.

Relevant Characteristics of Saginaw County

Saginaw County is the fourth largest county in Michigan in terms of tillable acres[9]; it is located in the mid-western portion of the "thumb" (see map figure 1). The soils of Saginaw County were developed under poor natural drainage conditions from loam, clay loam or silty clay loam parent material. The soils are relatively high in organic matter, nitrogen and lime. They are moisture retentive, have good natural fertility, and are durable under cultivation. The principal soil series are Sims, Parkhill, and Kawkawlin.

About 65 per cent of the area of the county is occupied by excellent agricultural soils. They were developed on nearly level clayey plains where natural drainage was sufficiently slow to permit a relatively rich accumulation of organic matter and to prevent severe loss of nutrients by leaching. Most of these soils require artificial drainage. When tile drainage with adequate outlets is provided the soils are very productive.

Saginaw County had about 60 per cent of its total farm income from the sale of field crops in 1954.[10] The major factors accounting for the type of farming in this area are the level, generally highly productive soils (when drained);

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[9]Hill, Elton B., and Mawby, Russell G., Types of Farming in Michigan, Special Bulletin 206 (second edition) September, 1954.

[10]Michigan Statistical Abstract - Bureau of Business and Economic Research MSU, Second edition 1958, p. 88.

the nearby good markets; the sugar beet processing plants; the length of growing season which ranges from 130 to 160 days; and the moderated temperatures which favor dry field bean production. Crop yields are well above the state average.

Relevant Characteristics of St. Clair County

St. Clair County is the eighth largest county in Michigan in terms of tillable acres. It is located in the lower eastern portion of the "thumb" (see map figure 1). The soils of St. Clair County were developed under very poor natural drainage conditions from loam, clay loam, or silty clay loam parent materials. The soils are relatively high in organic matter, nitrogen, and lime, are moisture retentive, have good natural fertility and are durable under cultivation. The principal soil series are Brookston, Blount and Hoytville. The Roscommon, AuGres, and Peats soil series occur in the northwest corner of the county.

The topography is nearly level with some low depressions and narrow sandy ridges. The principal problems in crop production are poor drainage and maintenance of good soil structure. When tile drainage with adequate outlets is provided, the soils are very productive because the surface is deep, fine-textured and well supplied with humus.

Dairying is the most important enterprise for St. Clair County with greater than 40 per cent of its total farm income

Figure 1. Outline map of Michigan showing location of sample areas.

from the sale of dairy products in 1954.[11] It is close enough to the large nearby markets to favor dairy production and general farming yet not close enough to have a large percentage of part-time farmers.

Relevant Characteristics of Lenawee County

Lenawee County is the third largest county in Michigan in terms of tillable acres. It is located in the southeastern part of the state (see map figure 1). The soils of Lenawee County were formed mainly from clay loam, silty clay loam, silty clay or clay parent materials. The drainage of these soils ranges from moderately well to imperfectly-drained with the latter conditions generally associated with the more level soils. The principal soil series are St. Clair, Nappanee, Morley and Blount with some Fox, Oshtemo, Wauseon, and Berrien.

The topography is level to rolling and is generally favorable for farming operations. The soils are deep, high in fertility, and durable under cultivation except on the steeper slopes. The tightness of the clay which reduces the rate of water movement through the soil and maintenance of good soil structure on the surface are problems in the use of this land for cropping purposes.

The most important source of farm income is from the sale of livestock, mostly cattle, hogs, and sheep. The major

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[11] Ibid.

factors influencing the selection of farm enterprises in this area are the generally productive soils, the relatively long growing season (150 to 170 days), and the good local and nearby markets.

Survey areas

Survey areas were selected within each sample county. Five townships were randomly selected (using a table of random numbers) within each sample county. Two sections were randomly selected from each township, the first section selected became a survey area and the second section an alternate area to be used if the desired number of qualified farmers was not located in the first section. This made a total of five survey areas and five alternate survey areas for each county selected for a particular type of farming area.

Stratification of sample

A stratified sample was randomly selected within each survey area. The sample for the cash-crop type of farming was stratified by size of farm measured in acres, with three divisions, 0-80 acres, 81-160 acres and 161 acres and over. An attempt was made to sub-stratify by size of gross income, under $7,500 and $7,500 and over, to minimize the intercorrelation of these two factors.

There were six records collected from each survey area or its alternate survey area, two for each size of farm division, with an attempt to get one each of these in the two

divisions of gross income. The latter was not possible in every instance but was accomplished in most survey areas. With five survey areas this made a total of 30 records for the cash-crop farmers.

The survey of the other types of farming areas was accomplished in much the same procedure. The dairy farm sample was stratified by size of herd, with breakdowns of under 20 cows, 20-30 cows, and over 30 cows. Sub-stratification by gross income was carried out as possible. The beef-cattle sample was stratified by number of feeders the farmer purchased and fed out each year as well as by gross income. There was a total of 30 records collected from both dairy farmers and beef cattle farmers. Thus a grand total of 90 schedules was completed. Two schedules, one cash-crop farm and one beef cattle farm, were later discarded because of incomplete data.

Field Techniques

The confidential nature of some of the information required in the study created certain interviewing problems. The time of the year the survey was taken, a very busy season, created additional problems. To overcome these difficulties each qualified farmer contacted was given the opportunity to designate the most convenient time for the interview. It was explained and re-emphasized that this information would be used in a strictly confidential manner. Approximately 90 per cent of the qualified farmers who were

contacted gave interviews.

Schedules were obtained in each survey area by starting in a randomly selected corner of the section and working in a counter clock-wise direction. A schedule was taken from each qualified farmer in succession until the required number in each group was obtained. Unqualified farmers were omitted and the next farmer contacted. Farmers were contacted until six schedules were obtained from each sample area or until all farmers in that area had been contacted. This same procedure was used in working the alternate areas to obtain records for strata not filled in the regular survey area.

A farm qualified as (1) a cash-crop type of farm if greater than 40 per cent of total farm income was derived from sale of crops as cash crops rather than through livestock, (2) a dairy farm if greater than 40 per cent of total farm income was derived from the dairy enterprise, and (3) a beef cattle type farm if greater than 40 per cent of total farm income was derived from the sale of cattle. The census definition of a farm was used to determine the smallest farm that could qualify for the sample.

If a farm qualified by census definition and by type, a schedule was completed provided the farmer would cooperate. Every effort was made to complete a schedule if the farm qualified.

A farm was considered within the sample area if the farm

house was within the sample area regardless of where the majority of the farm land was located. The farm was not considered within the sample area, regardless of the per cent of the farm land in the sample area if the farm dwelling was not in the sample area.

Design of the Questionnaire[12]

The questionnaire was designed with a two-fold purpose in mind. The first purpose was to collect data on independent variables considered to affect the dependent variable, quantity of credit. It was decided, based on knowledge gained from 19 years on the farm and six years of intensive study of agricultural economics along with consulting with members of the Department of Agricultural Economics, that the following independent variables should be considered in this study.

1. Interest rate
2. Net worth
3. Farmer's credit rating
4. Gross farm income
5. Net farm income
6. Size of farm
7. Age
8. Education
9. Farming experience
10. Off-farm income

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[12]A complete copy of the schedule is included in the Appendix.

11. Availability of land contracts

The first part of the schedule was designed to produce direct and indirect information about these variables.

The second part of the questionnaire was designed to produce estimates of the amount of credit individual farmers could borrow under existing conditions. A general question, asking the farmer to estimate the maximum amount of money he could borrow from all possible sources, was asked first. Most of the credit agencies were listed to aid the farmer in his recall of these agencies. These were individual loans and were not cumulative. Each one was based on the present equity position of the farmer and was used primarily to get the respondent thinking in terms of the sources of credit available to him. The next question was, "consider for a few minutes that you are going to borrow all the money that you can possibly get. Now tell me the details of these loans." The amount of the loan and interest rate, starting with the source of lowest interest rate first, were recorded until the farmer indicated that he could not borrow any more money regardless of the interest rate.

The questionnaire, when completed, had data for all the independent variables, except the farmer's credit rating. The credit bureaus of the respective counties were contacted to get these ratings. They had agreed in advance to supply this information. The credit ratings were grouped into four general categories, poor, fair, good and excellent and these

later were quantified to 1, 2, 3 and 4 respectively to facilitate function fitting. There was one question on the questionnaire relating to this variable. Respondents were asked to name three credit or business references to be used in case the credit bureau did not have a record or enough information on any of the farmers to give a general credit rating.

Reliability of the Data

The estimates on quantity of credit secured from the farmers were considered by the author to be reliable estimates for several reasons.

1. Some of the farmers, especially the beef cattle farmers, had established "credit limits" at their banks. The banker had taken net worth statements from these farmers and had told them how much their credit limit would be in advance so the farmer would not have to fill out forms, etc., to find out how much credit he could get when he wanted to make a loan. These credit limits were not verified. The quantity was recorded and used as reported by the farmer.
2. Data were collected from the individual farmers on outstanding real estate and chattel loans as of December 31, 1959. This information, as supplied by the farmer, was checked against the information the various credit bureaus had and generally the

quantities agreed. This indicated that the farmers were in a cooperative mood and were attempting to give true answers to factual questions.

3. The land contracts included in the estimates were contracts the farmers had been offered or had been discussed by the farmers with the potential seller of the additional land.
4. Most of the farmers had a fair estimate on how much the Federal Land Bank would loan them because of loans made by farmers within the neighborhood or because they had loans outstanding with the Federal Land Bank at present. They were not sure in some instances what the present interest rate was on Federal Land Bank loans.
5. The additional quantities of credit above loans for land such as for purchase of machinery, equipment, livestock, etc., were fairly good estimates because a very high percentage of all farmers had at one time or another used this type of credit. They seemed to know the source of this type of credit and to have a good idea of how much of these types of purchases they could procure on credit.
6. One of the weakest estimates was the amount of open account credit or installment buying they could do considering all the other loans. Usually this quantity was small.

7. The data used to derive gross farm income and net farm income were checked, in almost all interviews, against the farmer's income tax returns for 1959.

The quantities of credit used to derive the marginal factor cost functions were based on accumulative combinations of the above types of loans. This is the weakest point of the estimates because it is difficult for anyone to estimate the quantity of credit he can get after two or three loans have been made. Also, in some instances the farmers were not aware of credit sources that will extend credit at high interest rates after other loans have been made. The interest rates payable for certain types of loans were not well known by some farmers. The smaller farmers with less credit experience than the larger farmers did not appear as well informed about the various credit opportunities as the larger farmers.

This study was carried out with farmers rather than lenders of farm credit for various reasons. The author wanted to get an estimate of what the farmers thought they could get in quantities of credit and the interest rates they would have to pay. The relationship between the characteristics of the farmer and the quantity of credit that he can get on the capital market can be determined better from farmers than from lenders' information. The typical response of lenders when given a hypothetical farm and asked how much they will lend is that they do not know without knowing

something about the man. If this study had been carried out with lenders of farm credit, the many individuals who make up the largest source of agricultural credit outside the Federal lending agencies would have been omitted. Thus biases are likely to arise from the lender's viewpoint as well as in a study with the present orientation.

Processing the Data

As pointed out above, the questionnaire was designed to get direct information on most of the independent variables considered in this study. The data on these variables, net worth, size of farm, age, farming experience and off-farm income were used in the form collected from the farmers. The value of two variables, gross farm income and net farm income, had to be computed from basic data on cash farm receipts and cash expenses as supplied by the farmers. (Almost all of these figures were checked against the income tax form for 1959 as reported by the particular farmer.) The farm was charged with depreciation on all machinery and equipment, inventory changes (plus or minus) on equipment and livestock, and family labor to derive net farm income for the farm.[13]

The data for quantities of credit were collected in the form of a series of loans that the farmer estimated would give him the maximum amount of credit. For each separate loan of the series the interest rate was estimated by the

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[13]See schedule in Appendix.

farmer. In all instances after a farmer had related the details of these loans, he was asked, "Is there another combination of loans that would give you more than this amount of money if you were willing to pay higher interest rates?" The combination of loans that gave the farmer the maximum amount of credit was used in deriving the marginal factor cost function of credit.

The loans, as pointed out repeatedly to the farmer during the interview, were on a cumulative basis. Each additional loan of each combination was made with the provision that all prior loans had been made. One separate series of loans or one combination was used in deriving the marginal factor cost function. This was the combination that gave the farmer (as estimated by him) the maximum amount of credit. Cross combinations, that is using two or three sources from one combination of loans and then shifting to another combination, were not used. If cross combinations had been used the estimates of interest rate would probably have been somewhat smaller. This is because the farmer could possibly have obtained a smaller quantity of credit, if this was all he desired to obtain, at a lower interest rate.

To make these data comparable for all combination loans secured, the weighted average interest rate was computed for the combination of loans for each farmer. This combination loan for most farmers consisted of five separate loans with applicable interest rates. This gave all farms approximately

five observations or values for interest rate and quantity of credit. In processing the data or using the data to fit a regression equation, each one of these values was used as a separate observation, with the fixed values of the other variables, net worth, credit rating, gross farm income, etc., repeated for each value of interest rate and quantity of credit for that particular farm. Therefore, the 30 farms of each group have approximately 150 observations or an N of 150 when fitting the regression equations.

All of these observations were not considered as independent observations when testing for significance. Student's "t" test was used for testing the level of significance. This is the ratio of the estimated regression coefficients and their respective standard errors. When using this "t" test the number of farms was considered as N which gave approximately 25 degrees of freedom for each test of significance. Therefore the statistical significance tests are biased somewhat toward the low side.

Computing the weighted average interest rate converted the cost of credit into average factor cost units. Therefore, after the best fitting regression equation had been selected with quantity of credit as the dependent variable and then recalculated with interest rate as the dependent variable, this interest rate was in terms of AFC (average factor cost). To derive the marginal factor cost function of credit the following procedure was used.

The equation for interest rate was:

$$\text{Interest rate } (Y) = a + b_1 Q(\text{quantity of credit}) + \sum_{i=2}^{d^*} b_1 X_1 = AFC$$

To convert to total cost multiply both sides by Q (quantity of credit) because interest rate (Y) multiplied by quantity of credit (Q) = total cost

$$QY = aQ + b_1 Q^2 + \sum_{i=2}^{d} b_i X_i Q$$

to convert to MFC (marginal factor cost) take derivative with respect to Q

$$MFC = \frac{\partial (QY)}{\partial Q} = \frac{\partial (aQ + b_i Q^2 + b_i X_i Q)}{\partial Q}$$

$$\therefore \quad MFC = a + 2b_1 Q + \sum_{i=2}^{d} b_i X_i$$

By varying the quantity of credit (Q) and using the values of the b's as computed from the regression equation with interest rate as the dependent variable, and using the mean value of the other variable in the equation, the supply schedules were computed.

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*d=number of independent variables.

CHAPTER II

ESTIMATING MARGINAL FACTOR COST FUNCTIONS FOR CREDIT FOR CASH-CROP, DAIRY, AND BEEF CATTLE FARMERS

In this chapter, a marginal factor cost function of credit will be derived for cash-crop, dairy and beef cattle farmers based on the data collected from these respective types of Michigan farmers. In the first section of this chapter, following this introduction, the three types of farms will be described and compared by size of farm for most of the variables considered in this study. The second section of this chapter will present the regression equations that were fitted. The selection of the best fitting equations for each type of farm will also be discussed in that section. The third section will present the derived mathematical marginal factor cost functions with graphs of these functions.

General Description of the Cash-Crop Farms

The records obtained from the sample of cash-crop farm operators were sorted into three groups according to the size of farm, in acres, and comparisons were made between small, medium, and large farms, Table 1.

The small farms (average size -- 74.4 acres), were operated by older men than the medium size farms (average size -- 122.6 acres), or the large farms (average size -- 200.6 acres). The average age for the operators of the small farms

was 46.9 years compared to 43.3 years for the operators of medium farms and 41.2 years for large farm operators. This was not caused by the operators of small farms beginning to farm late in life. The average years of farming experience was 18.4 for the operators of small farms compared to 19.1 and 17.0 years for the operators of medium and large farms, respectively.

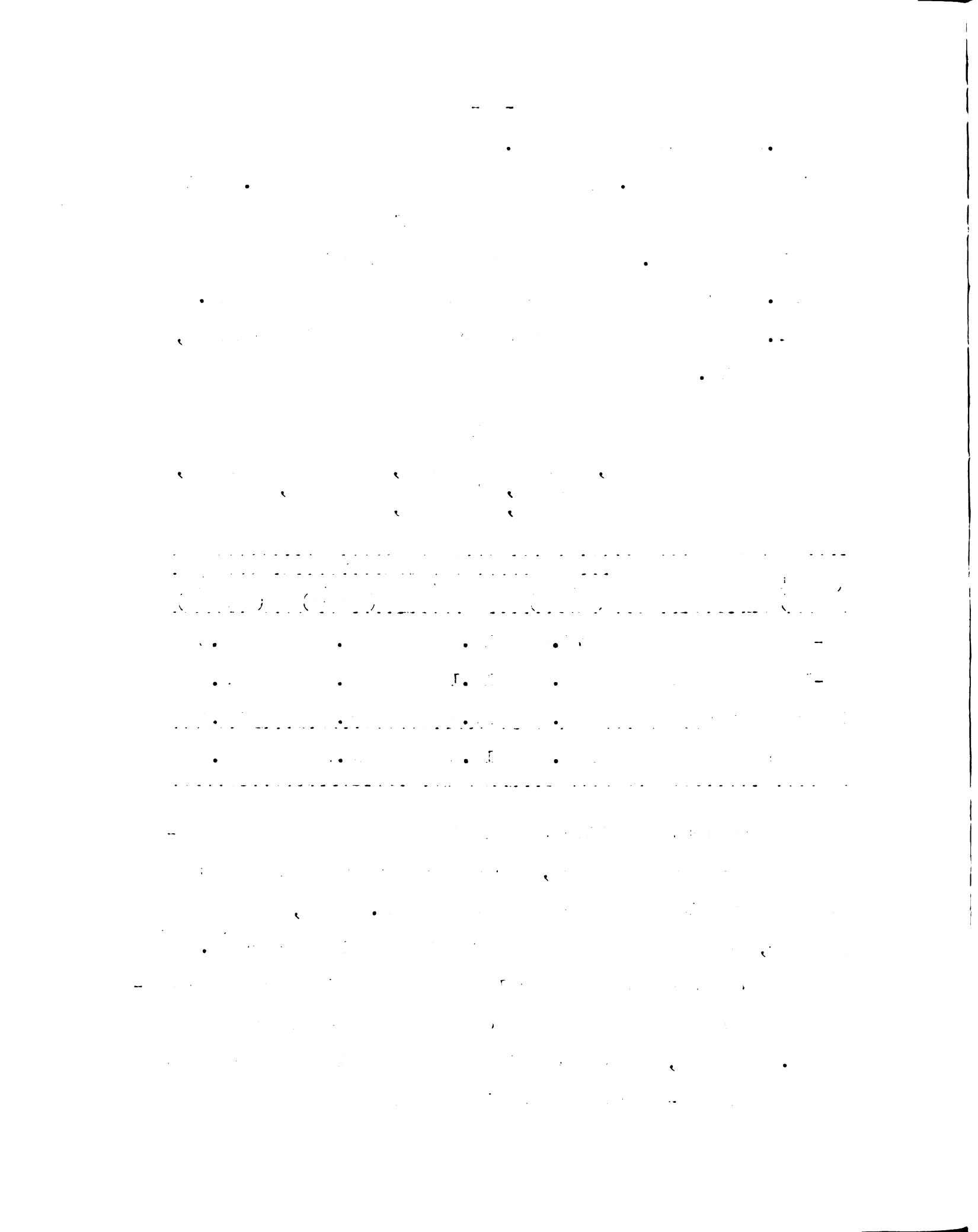
TABLE 1

AVERAGE TOTAL ACREAGE, YEARS OF FARMING, AGE AND EDUCATION, BY SIZE OF OPERATION, 29 CASH CROP FARMS, SAGINAW COUNTY, MICHIGAN, 1960

Size (Total Acres)	Number of Farms	Average Size (Acres)	Average Years of Farming	Average Age (Years)	Average Education (Grades)
0-80	9	74.4	18.4	46.9	8.3
81-160	10	122.6	19.1	43.3	9.6
160 and over	10	200.6	17.0	41.2	10.1
Average		134.5	18.2	43.7	9.4

There was a negative correlation between age and education of the farm operators, the older farmers having less formal education than the younger farmers. Thus, the younger, more educated men were farming the larger farms.

The operators of the small farms had a higher average off-farm income than the operators of the medium or large size farms. In fact, six out of nine of the small farm operators had a regular 8-hour a day job in town which they held down



in addition to their farming operations. Their farm work was done in the afternoons, after work, at night and weekends. There was a high negative correlation between off-farm income and size of farm for the cash-crop farmers, Table 2.

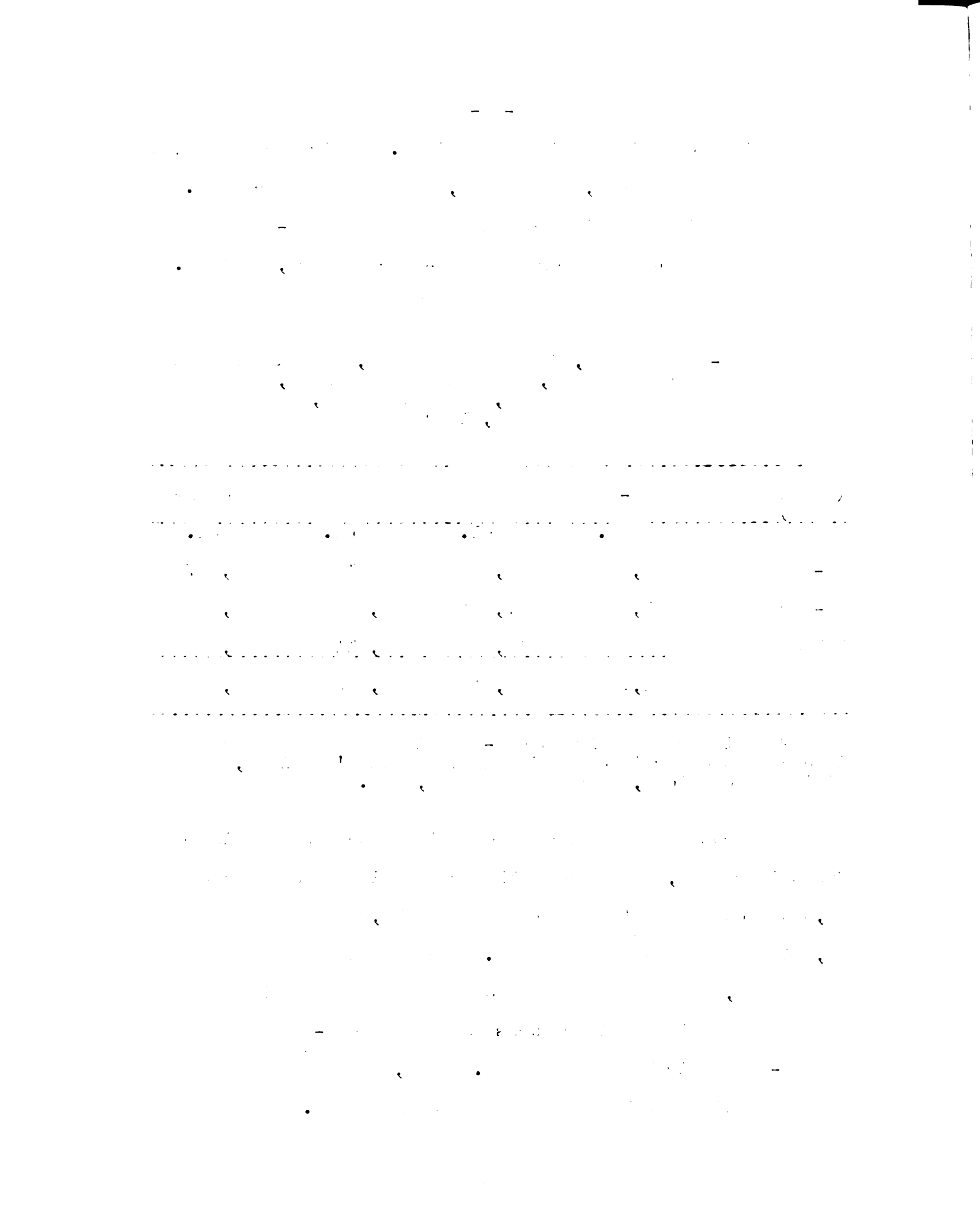
TABLE 2

AVERAGE OFF-FARM INCOME, GROSS FARM INCOME, NET FARM INCOME AND TOTAL INCOME, BY SIZE OF OPERATIONS, 29 CASH CROP FARMS, SAGINAW COUNTY, MICHIGAN, 1960

Size (Total Acres)	Off-Farm Income	Gross Farm Income	Net Farm Income	Total* Income
	Dol.	Dol.	Dol.	Dol.
0-80	2,762	4,330	814	3,627
81-160	1,549	7,541	2,440	3,989
161 and over	965	15,006	4,511	5,482
Average	1,724	9,119	2,649	4,392

*Total income includes off-farm income and net farm income plus other income which included wife's salary, dividends on stock, interest on bonds, etc.

The gross and net farm incomes increased as the size of farms increased, with the small farms having an average of $4,330 gross and $814 net compared to $15,006 gross and $4,511 net for the larger farms. When total income was considered, difference in size of farm was not nearly so great because the smaller farms had enough off-farm income to off-set their low farm income. Thus, they compared favorably with the larger farms in total income. The



smallest (0-80 acres) had an average of $3,627 compared to $3,989 for the medium (80-160 acres) and $5,482 for the larger farms (160 acres and over).

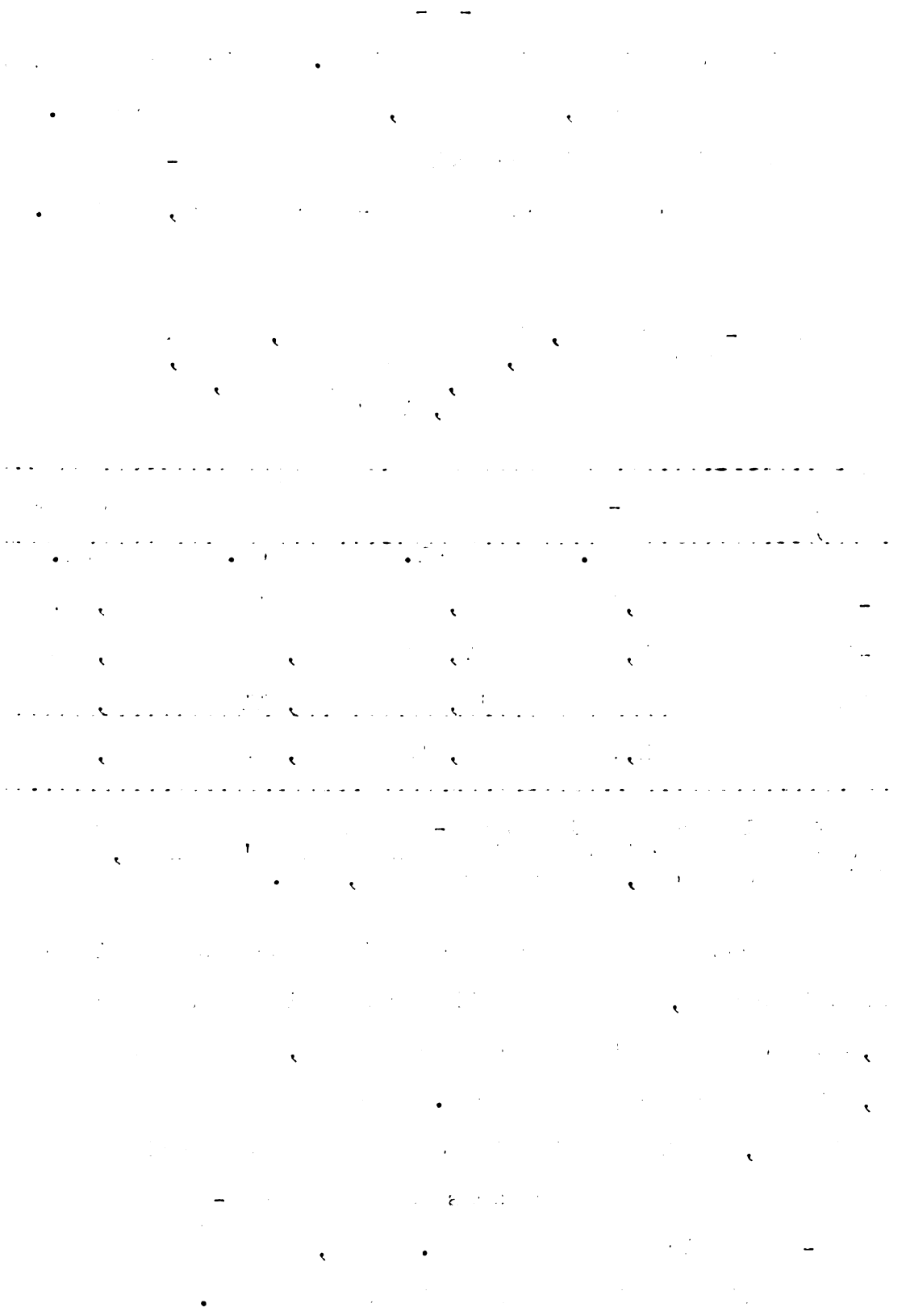
The average credit rating was lowest for the group of small farmers and highest for the large farmers. The credit rating was established by contacting the Saginaw Credit Bureau, which gave general credit ratings in four general classifications, poor, fair, good and excellent, based on their records of the farmer's credit history. These general credit ratings were converted into numerical values by assigning the following values[1]: poor = 1, fair = 2, good = 3 and excellent = 4.

TABLE 3

AVERAGE CREDIT RATING, NET WORTH AND QUANTITY OF CREDIT, BY SIZE OF OPERATION, 29 CASH CROP FARMS, SAGINAW COUNTY, MICHIGAN, 1960

Size (Total Acres)	Average			
	Credit Rating	Net Worth	Interest Rate	Quantity of Credit
		Dol.	Pct.	Dol.
0-80	2.9	30,952	6.5	33,377
81-160	3.5	47,529	6.4	55,400
161 and over	3.7	58,400	6.2	71,750
Average	3.4	46,133	6.4	54,203

[1]The residuals for credit rating, when plotted about the straight regression line substantiated this assumption of linearity with the "units" in which this variable is measured.



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161 and over	3.7	58,400	6.2	71,750
Average	3.4	46,133	6.4	54,203

[1]The residuals for credit rating, when plotted about the straight regression line substantiated this assumption of linearity with the "units" in which this variable is measured.

The average credit rating was lowest for the small farmers and highest for the large farmers. This indicated that the operators of the larger farms, probably through more extensive use of credit, had built up a better credit rating than the operators of smaller farms. Credit rating was also correlated with the net worth of farmers. The group of large farmers had an average net worth of $58,400 and an average credit rating of 3.7, compared with the smaller farmers with an average net worth of $30,952 and an average credit rating of 2.9.

Net worth and credit rating were positively correlated with quantity of credit and negatively correlated with interest rate. The group of small farmers estimated they would have to pay the highest average interest rate for the smallest quantity of credit, compared to the estimates of the medium and large size group of farmers.

General Description of the Dairy Farms

The records obtained from the sample of dairy farm operaters were sorted into three groups according to the size of farms, based on average number of cows during the year and comparisons were made between small, medium and large dairy farms. These classifications were made to determine by inspection if there were serious correlations among the independent variables under consideration.

The small size dairy farm (0-20 cows) had an average of 15.4 cows, the medium size (21-30 cows) had an average of 25.6

cows and the large size dairy farms (31 cows and over) had an average number of 36.6 cows, Table 4. Size of farm, in terms of acres operated, was closely related to size of farm in terms of cows milked, the small size group (0-20 cows) had an average size of 127 acres compared to an average of 308 acres for the large size group (31 cows and over).

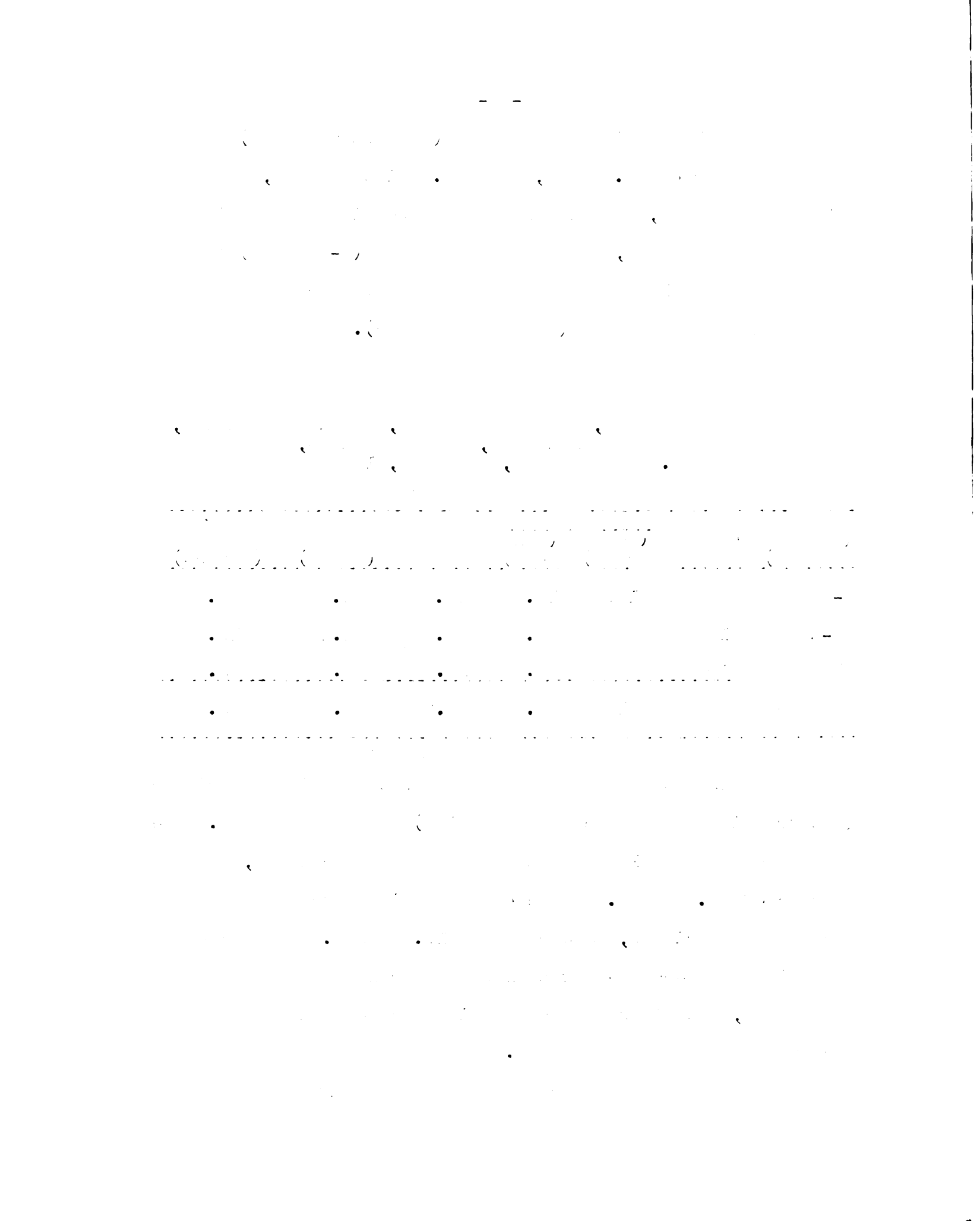
TABLE 4

AVERAGE TOTAL ACREAGE, YEARS OF FARMING, AGE AND EDUCATION, BY SIZE OF OPERATION, 30 DAIRY FARMS, ST. CLAIR COUNTY, MICHIGAN, 1960

Size (Number of cows)	Number of Farms	Size (total acres)	Size (milk cows)	Years Farming	Age (Years)	Education (Grades)
0-20	10	127	15.4	24.2	52.5	8.8
21-30	10	206	25.6	17.5	41.1	10.4
31 and over	10	308	36.6	18.4	45.8	9.0
Average	30	214	25.9	20.0	46.5	9.4

There was not much correlation between farming experience (measured in terms of years of farming) and size of farm. The farmers on the smallest farms had the most experience, an average of 24.2 years. Those on the medium size farms had the least experience, an average of 17.5 years. The age of the dairy farm operators was closely correlated with their experience, the oldest farmers having the most experience and the youngest farmers the least.

Education of farm operators was not closely related to



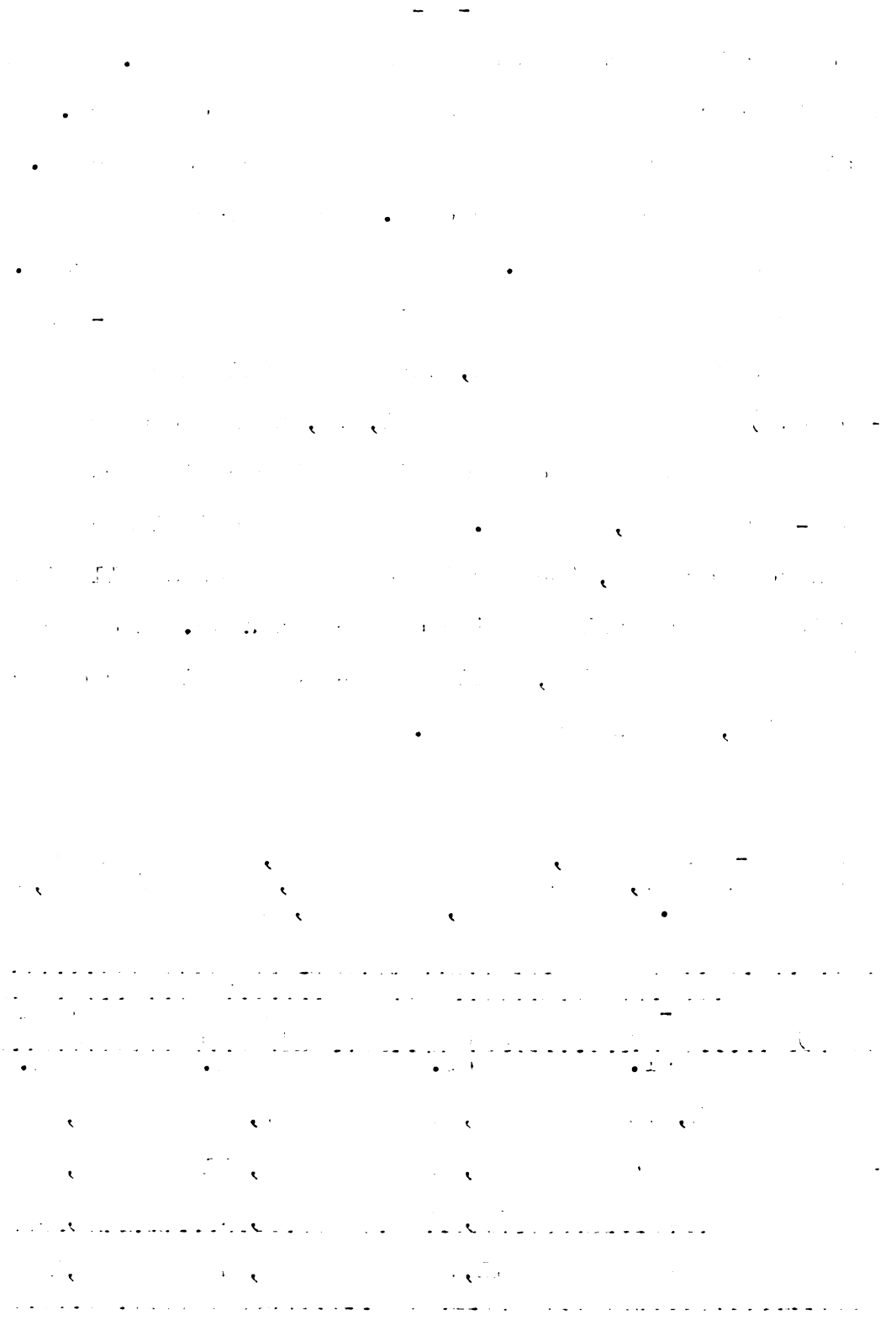
size of farming operations or to farming experience. It was inversely correlated with the age of the farm operators. The oldest group of farmers had an average education of 8.8 grades compared to an average of 9.0 grades for medium age group and an average of 10.4 grades for the youngest group.

There was a wide difference in the amount of off-farm income by size of dairy farms, with the small size group (0-20 cows) having an average of $1,272, while no operators in the medium group and only one in the large size group had any off-farm income, Table 5. This seemed to indicate that with 21 cows or more, the farming operation was a full time job which required all the time of the operator. Another factor was that dairying, unlike cash-crop farming or other type farming, is a 12 months job.

TABLE 5

AVERAGE OFF-FARM INCOME, GROSS FARM INCOME, NET FARM INCOME AND TOTAL INCOME, BY SIZE OF OPERATIONS, 30 DAIRY FARMS, ST. CLAIR COUNTY, MICHIGAN, 1960

Size (Number of cows)	Average per Farm			
	Off-farm Income	Gross farm Income	Net farm Income	Total Income
	Dol.	Dol.	Dol.	Dol.
0-20	1,272	6,862	1,938	3,333
21-30	0	10,716	2,811	2,838
31 and over	190	17,666	5,670	6,373
Average	488	11,748	3,473	4,181



Gross farm income and net farm income were positively correlated with size of farming operations (in terms of cows milked), The small number group had $6,862 gross and $1,938 net compared to the largest number group having $17,666 gross and $5,670 net farm income.

Total income, which included off-farm income, net farm income and other income, such as interest payments, dividends, wife's salary, etc., was somewhat correlated with size of farming operations or number of cows milked. But this correlation was not high because the small size group had enough off-farm income to bring their average total income above the medium size group, which did not have any operators with any outside income. The net farm income of the large size group was high enough to more than off-set the outside income of the small dairy farmers. Their total income averaged $6,373 compared to only $2,838 for the medium size group and $3,333 for the small size group.

The average credit rating for the operators of dairy farms was not highly correlated with size of operations or net worth (see Table 6). There was an increase in the average credit rating from 3.4 to 3.8 from the small to the medium size group. But there was a decrease from 3.8 to 3.4 from the medium size group to the large size group. The average net worth increased from $57,236 to $86,950 from the medium to the large size group.

Net worth was correlated with the size of operation as

it increased about 75 per cent from the small size group to medium size group and again from medium size to large size group. Interest rate was not closely related to the net worth of the operators or to the quantity of credit. The average interest rate decreased from the small size group to the medium size group and then increased from the medium to the large size group. Although the average net worth and average quantity of credit increased from the small to the medium to the large size group. There was a negative correlation between the average credit rating and average interest rate, with the farmers having the highest credit rating (the medium size group) having to pay the lowest average interest rate.

TABLE 6

AVERAGE CREDIT RATING, NET WORTH, INTEREST RATE AND QUANTITY OF CREDIT, BY SIZE OF OPERATIONS, 30 DAIRY DARMS, ST. CLAIR COUNTY, MICHIGAN, 1960

Size (Number of cows)	Credit Rating	Net Worth	Interest Rate	Quantity of Credit
		Dol.	Pct.	Dol.
0 - 20	3.4	31,511	6.2	30,390
21 - 30	3.8	57,236	6.0	49,245
31 and over	3.4	86,950	6.1	80,485
Average	3.5	58,566	6.1	53,374

The quantity of credit farm operators estimated they could

borrow on the capital market, from friends, and from other sources was very highly correlated with their net worth.

General Description of the Beef Cattle Farms

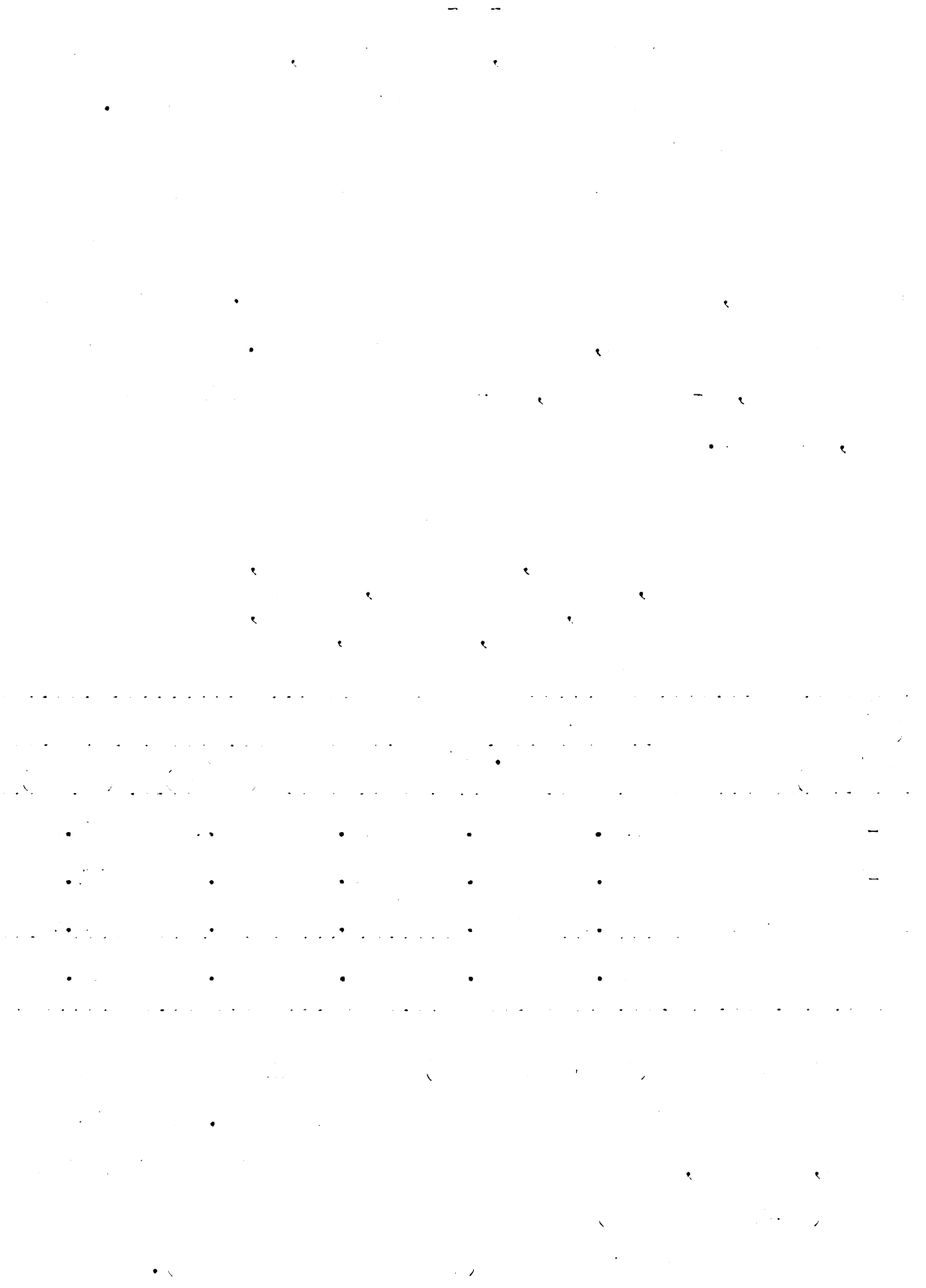
The records obtained from the sample of beef cattle farmers were sorted into three groups according to the size of operation, based on number of feeder cattle. Comparisons were made among small, medium and large farms. The three groups were, 0-50 feeders, 51-150 feeders and 151 feeders and over, Table 7.

TABLE 7

AVERAGE TOTAL ACREAGE, NUMBER OF FEEDERS, YEARS OF FARMING, AGE AND EDUCATION, BY SIZE OF OPERATION, 29 BEEF CATTLE FARMS, LENAWEE COUNTY, MICHIGAN, 1960

Size (Number of Feeders)	Number of Farms	Size		Average		
		Total Acres	No. of Feeders	Years Farming	Age (Years)	Education (Grade)
0-50	10	175.9	34.2	19.6	42.7	11.0
51-150	9	244.2	100.8	17.6	42.0	11.0
151 & over	10	223.7	196.8	24.4	53.1	9.7
Average		213.5	110.9	20.6	46.1	10.6

Size of farm (in total acres) is normally closely related to size of operations based on number of feeders. In this sample, however, the average size of farm for the medium size group (51-150 feeders) was larger than the average size of farm for the large size group (151 feeders and over). There



were two unusually large farms in terms of acreage in the medium size group. Thus, the data do not show much correlation between these factors. Size of farm operations in terms of number of feeders was only slightly correlated with farming experience. The operators of the largest farms had the most experience but the operators of the medium size farms had the least.

Age, as usual, was closely related to farming experience. It seems that most farm operators start farming at about the same age regardless of what size farm they operate. Age and education were negatively correlated, with the youngest group of farmers (average age -- 42.0) having completed 11.0 grades of school as compared to the oldest group of farmers (average age -- 53.1 years) having completed only 9.7 grades of school.

Average off-farm income was positively correlated with size of farm measured in terms of number of feeder cattle, Table 8, which was quite unusual, because normally these two factors are negatively correlated. As to number of farmers having off-farm income, there were four out of ten for the small size group, compared to only one out of nine for the medium size group and two out of ten for the large size group. Thus, it was the relative size of non-farm income earned by the medium and large size groups that caused this unusual correlation, rather than the percentage of the farmers working off the farm for each group.

Gross farm income, as in most instances, was highly correlated with size of farm, but net farm income was not highly correlated with this factor. Net farm income actually declined from an average of $3,769 for the small size group to an average of $1,836 for the medium size group, with the large size group having an average of $10,050. Total income was similar to net farm income as the smaller farms did not have enough off-farm income to offset the higher net farm income of the larger farms.

TABLE 8

AVERAGE OFF-FARM INCOME, GROSS FARM INCOME, NET FARM INCOME AND TOTAL INCOME, BY SIZE OF OPERATION, 29 BEEF CATTLE FARMS, LENAWEE COUNTY, MICHIGAN, 1960

Size (Number of Feeders)	Average Per Farm			
	Off-farm Income	Gross Farm Income	Net Farm Income	Total Income
	Dol.	Dol.	Dol.	Dol.
0 - 50	493	13,835	3,769	4,032
51 - 150	533	31,577	1,836	2,880
151 and over	800	66,536	10,050	11,295
Average	611	37,513	5,335	6,179

The average credit rating for the operators of different size groups was positively correlated with size of farm, net worth and quantity of credit, Table 9. The average credit rating increased from 3.5 for the small size group, to a perfect 4.0 for the largest size group. Every farmer in the

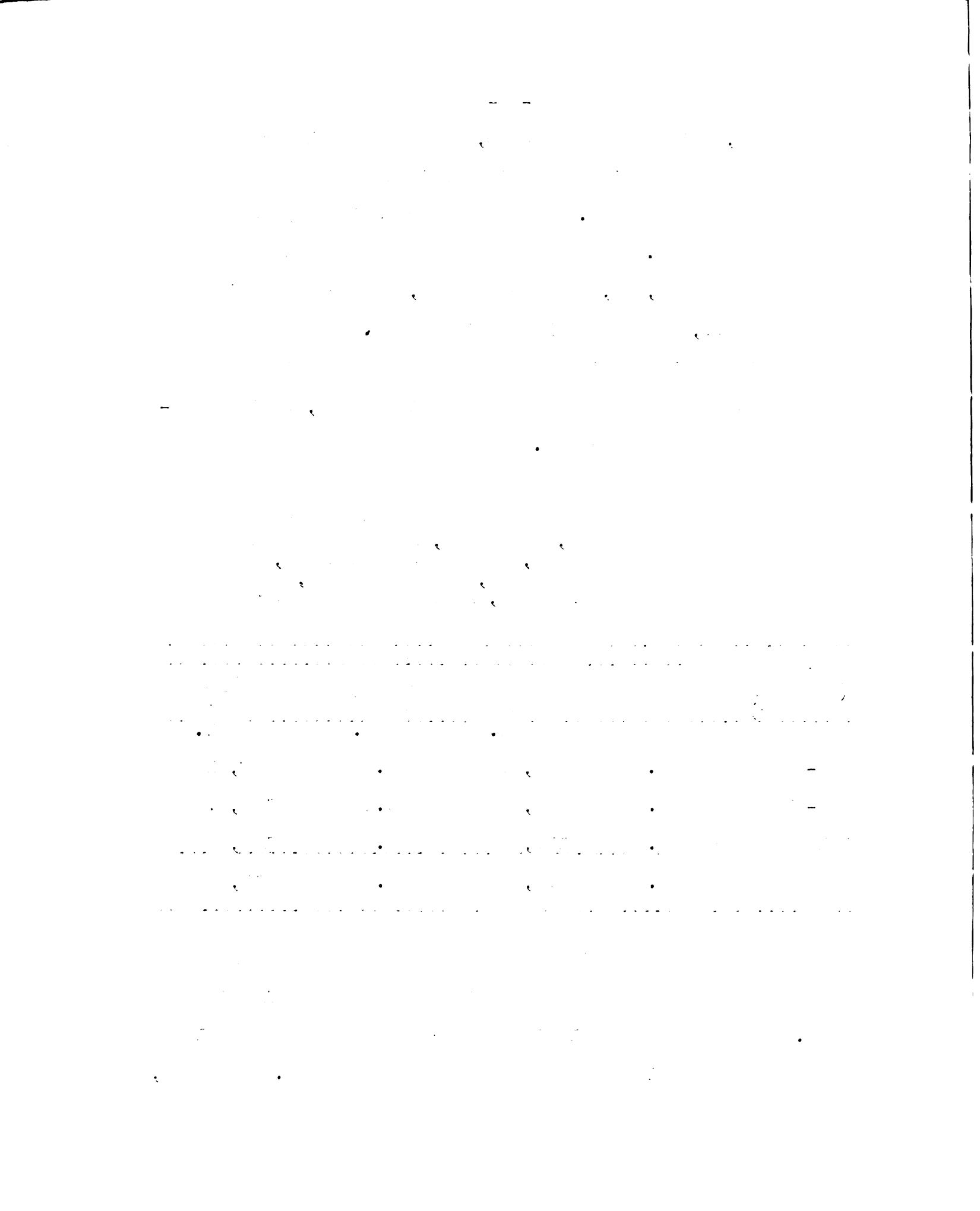
size group, 151 feeders and over, had an "excellent" credit rating or the very highest rating assigned by the various credit bureau exchanges. Net worth was positively correlated with size of farm. The smaller farms had an average net worth of only $34,170, compared to $85,204 for the medium size and $177,416 for the large size group. Although farmers in the large size group had not been farming many more years than those in the smaller size group, their operators had greater net worths.

TABLE 9

AVERAGE CREDIT RATING, NET WORTH, INTEREST RATE AND QUANTITY OF CREDIT, BY SIZE OF OPERATION, 29 BEEF CATTLE FARMS, LENAWEE COUNTY, MICHIGAN, 1960

Size (Number of Feeders)	Average			
	Credit Rating	Net Worth	Interest Rate	Quantity of Credit
		Dol.	Pct.	Dol.
0 - 50	3.5	34,170	6.2	53,910
51 - 150	3.9	85,204	6.1	126,978
151 and over	4.0	117,416	6.0	156,520
Average	3.8	78,713	6.1	111,980

Net worth and credit rating were positively correlated with quantity of credit and negatively correlated with interest rate. The group of small size farmers estimated they would have to pay the highest average interest rate of 6.1 per cent,



while being able to borrow only $53,910, compared to 6.1 per cent for $126,978 and 6.0 per cent for $156,520, for the medium and large size groups, respectively. The farmers with the lowest credit rating estimated they would have to pay the highest interest rates for credit and that a smaller quantity of credit would be available to them on the capital market.

Simple Correlations Among the Independent Variables

To get a more accurate measure of the simple correlations which exist among the various independent variables than presented in the above description, it was necessary to compute the simple correlations of these variables. Standard errors of the regression coefficients are positive functions of the intercorrelations of the independent variables. Inspection of the simple correlations among the various independent variables aids in selecting the variables to be included in the revised equations. These were computed between each pair of variables used in the various equations for the different types of farms and appear in Tables 10, 11 and 12.

As it can be readily seen, the simple correlations among some of the independent variables were high enough to affect the estimated coefficients for these variables tending to cause them to have compensating errors. An effort was made not to use both of the variables where high intercorrelation existed. In a few instances, pairs of variables were used which had fairly high simple correlations. This does not bias the regression coefficient estimates but it does tend

TABLE 10

SIMPLE CORRELATIONS AMONG THE INDEPENDENT VARIABLES
29 CASH CROP FARMS, SAGINAW COUNTY, MICHIGAN, 1960

Independent variable / Independent variable	Interest rate	Net worth	Credit rating	Gross farm income	Net farm income	Size of farm	Age	Education	Land contract
Interest rate	1.00	-.23	-.35	-.14	-.17	-.11	.11	-.10	-.36
Net worth		1.00	.45	.73	.82	.35	-.11	.04	.14
Credit rating			1.00	.39	.38	.34	NC*	.36	.10
Gross farm income				1.00	.87	.76	-.38	.23	.36
Net farm income					1.00	.59	NC	.14	NC
Size of farm						1.00	NC	.38	NC
Age							1.00	NC	NC
Education								1.00	NC
Land contract									1.00

*NC = the simple correlations for these variables were not computed.

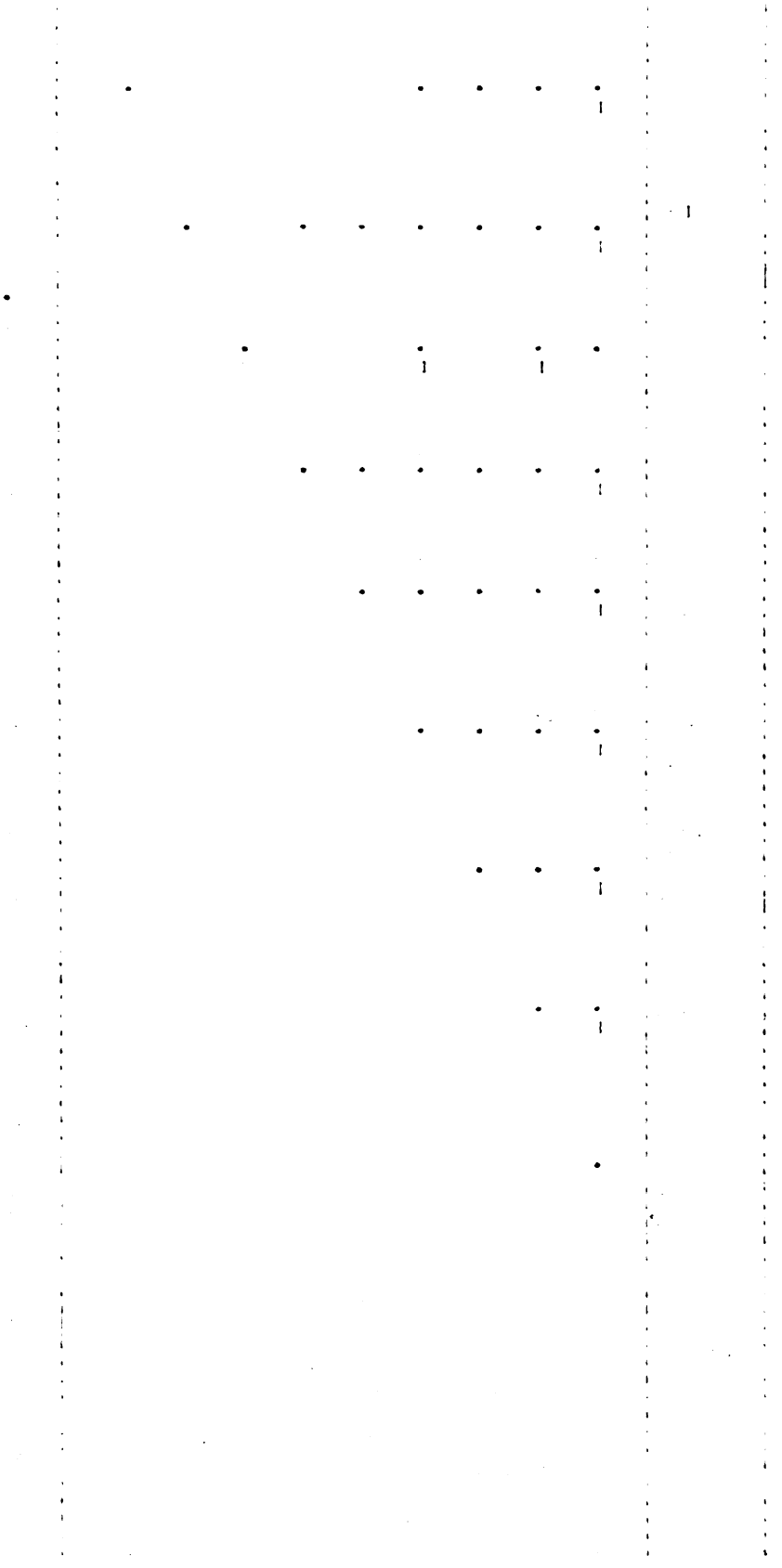


TABLE 11

SIMPLE CORRELATIONS AMONG THE INDEPENDENT VARIABLES
30 DAIRY FARMS, ST. CLAIR COUNTY, MICHIGAN, 1960

Independent variable / Independent variable	Interest rate	Net worth	Credit rating	Gross farm income	Net farm income	Size of farm	Age	Education	Land contract
Interest rate	1.00	-.03	-.25	-.13	-.24	-.21	.05	-.12	-.31
Net worth		1.00	-.08	.71	.23	.74	.28	.09	.15
Credit rating			1.00	.16	.04	-.09	-.09	.19	.19
Gross farm income				1.00	.47	.71	NC	.30	.19
Net farm income					1.00	.33	NC	.28	NC
Size of farm						1.00	NC	.21	NC
Age							1.00	-.32	-.24
Education								1.00	.24
Land contract									1.00

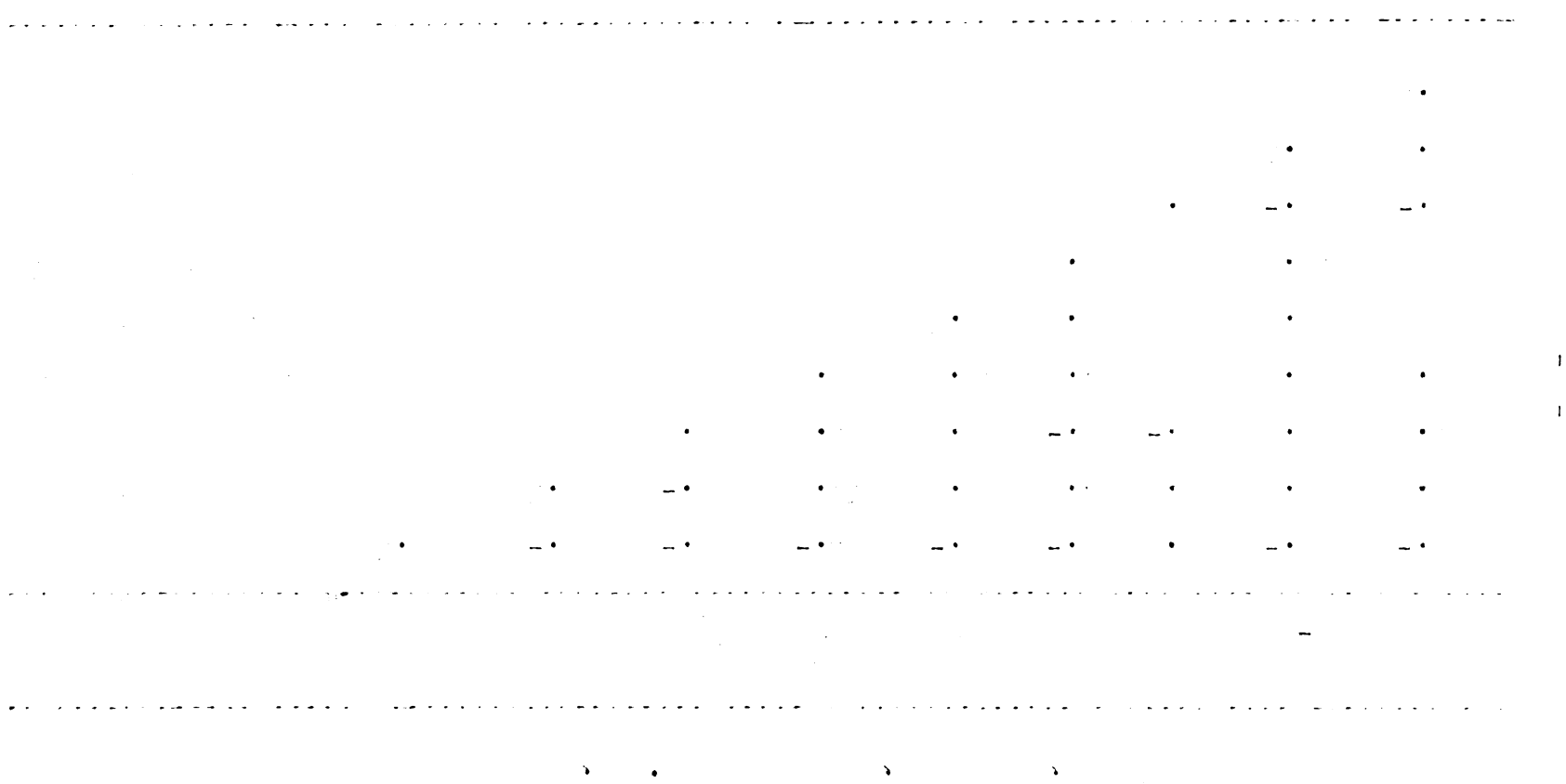
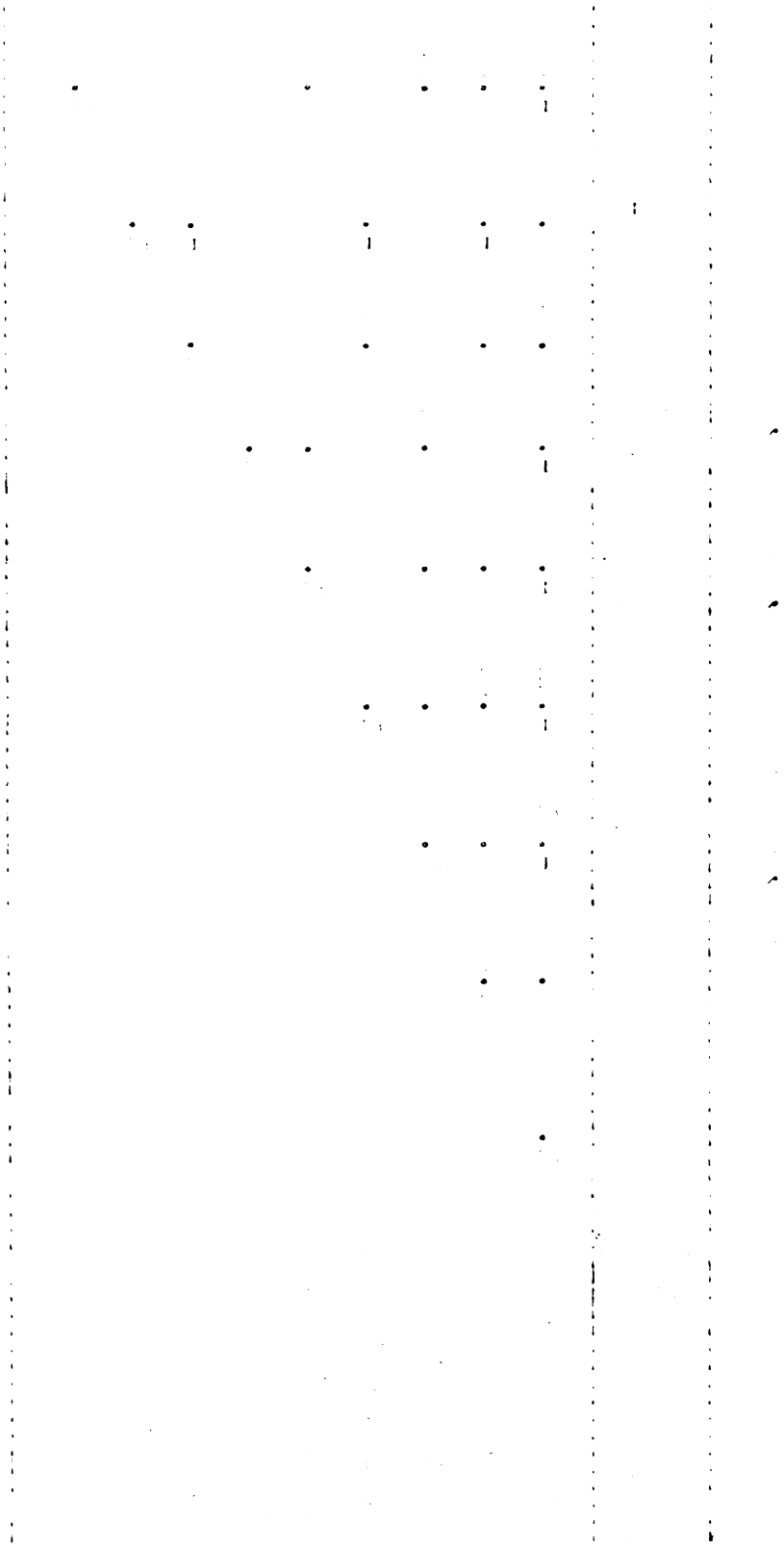


TABLE 12

TABLE 12

SIMPLE CORRELATIONS AMONG THE INDEPENDENT VARIABLES
29 BEEF CATTLE FARMS, LENAWEE COUNTY, MICHIGAN, 1960

Independent variable / Independent variable	Interest rate	Net worth	Credit rating	Gross farm income	Net farm income	Size of farm	Age	Education	Land contract
Interest rate	1.00	.02	-.01	-.11	-.23	-.12	.03	.02	-.38
Net worth		1.00	.42	.61	.25	NC	.44	-.29	.33
Credit rating			1.00	.40	.24	.11	NC	NC	.17
Gross farm income				1.00	NC	NC	.31	-.07	NC
Net farm income					1.00	.33	NC	NC	.49
Size of farm						1.00	NC	NC	NC
Age							1.00	-.39	NC
Education								1.00	NC
Land contract									1.00



to cause the estimated coefficients of these variables to be less reliable. High correlations between two independent variables increase the standard error of the estimated regression coefficients and thus tend to cause these variables to be less statistically significant.

Regression Equations Fitted

As indicated in the introduction, the independent variables to be used in deriving a supply function of credit in this study were:

1. interest rate
2. net worth
3. farmer's credit rating
4. gross farm income
5. net farm income
6. size of farm
7. age
8. education
9. availability of land contracts
10. off-farm income
11. farming experience

First Fit

After a preliminary examination of the data and plotting of scatter diagrams for each of the independent variables against quantity of credit, two variables, farming experience and off-farm income, were eliminated from consideration in the equations for the first fit. The first set of equations

consisted of three equations to be used for all three types of farms and for all farms as a group. These equations were simple linear regressions and were fitted by the least squares method. The three equations were:

(1) quantity of credit (Y) = f[interest rate (X_1), net worth (X_2), credit rating (X_3), gross farm income (X_4)]

with the following results:

<u>cash-crop farms</u>

$$Y = -13,357.16 + \underset{(1,162.20)}{1,743.44X_1} + \underset{(.08)}{.11X_2} + \underset{(1,859.00)***}{7,945.81X_3} + \underset{(.29)***}{2.05X_4}$$

$\bar{R} = .76$, $\bar{R}^2 = .58$, standard error of estimate $14,249

<u>dairy farms</u>

$$Y = -10,386.92 + \underset{(2,430.97)*}{4,793.36X_1} + \underset{(.04)***}{.72X_2} - \underset{(1,699.08)*}{3,497.23X_3} - \underset{(.30)}{.033X_4}$$

$\bar{R} = .89$, $\bar{R}^2 = .79$, standard error of estimate $14,475

<u>beef farms</u>

$$Y = -77,251.22 + \underset{(3,906.65)*}{9,372.85X_1} + \underset{(.06)***}{.86X_2} + \underset{(5,186.07)*}{12,463.54X_3} + \underset{(.11)}{.20X_4}$$

$\bar{R} = .87$, $\bar{R}^2 = .76$, standard error of estimate $27,903

(2) quantity of credit (Y) = f[interest rate (X_1), credit rating (X_3), net farm income (X_5), size of farm (X_6)]

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* = Significantly different from zero at the five per cent probability level.

** = Significant at the one per cent probability level.

*** = Significant at the .1 per cent probability level.

with the following results:

cash-crop farms

$$Y = -17{,}431 + 1865.79X_1 + 8{,}509.78X_3 + 3.78X_5 + 114.25X_6$$
$$(1{,}183.70) \quad (1{,}868.22)^{***} \quad (.66)^{***} \quad (26.02)^{***}$$

$\bar{R} = .75$, $\bar{R}^2 = .56$, standard error of estimate \$14,691

dairy farms

$$Y = -56{,}268.79 + 12{,}624.34X_1 - 2{,}969.85X_3 + .35X_5$$
$$(4{,}187.44)^{**} \quad (2{,}581.43) \quad (.52)$$
$$+186.40X_6$$
$$(18.55)^{***}$$

$\bar{R} = .65$, $\bar{R}^2 = .43$, standard error of estimate \$23,968

beef cattle farms

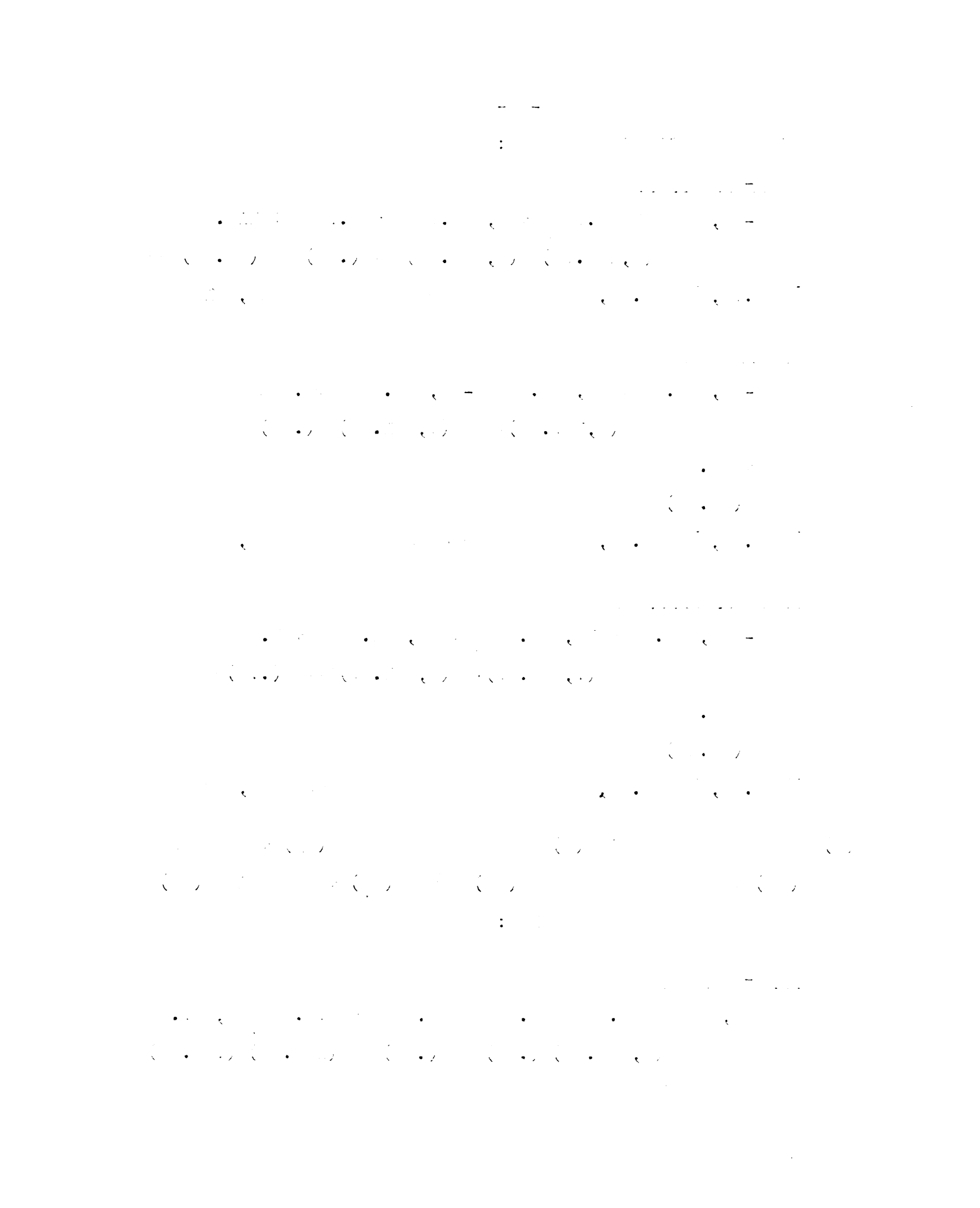
$$Y = -201{,}038.52 + 16{,}063.30X_1 + 49{,}241.05X_3 + 1.93X_5$$
$$(7{,}006.27)^{*} \quad (8{,}391.67)^{***} \quad (.76)^{*}$$
$$+ 55.62X_6$$
$$(39.12)$$

$\bar{R} = .50$, $\bar{R}^2 = .25$, standard error of estimate \$49,233

(3) quantity of credit (Y) = f interest rate (X_1) + net worth (X_2) + gross farm income (X_4) + age (X_7) + education (X_8) with the following results:

cash-crop farms

$$Y = 18{,}714 + 494.53X_1 + .20X_2 + 2.14X_4 + 272.50X_7 + 2{,}437.80X_8$$
$$(1{,}153.98) \ (.08)^{*} \quad (.33)^{***} \ (162.24) \ (767.26)^{**}$$



$\bar{R}$ = .75, $\bar{R}^2$ = .56, standard error of estimate $14,653

dairy farms

$$Y = -26{,}058.26 + 4{,}763.96X_1 + .74X_2 + .20X_4 - 268.15X_7 - 4{,}228.37X_8$$
$$(2{,}022.61)^* \quad (.04)^{***} \quad (.28) \quad (1.05.67)^* \quad (518.28)^{***}$$

$\bar{R}$ = .92, $\bar{R}^2$ = 85, standard error of estimate $12,320

beef cattle farms

$$Y = 48{,}882.83 + 9{,}188.77X_1 + .89X_2 + .24X_4 + 167.34X_7 + 809.09X_8$$
$$(3{,}985.22)^* \quad (.06)^{***} \quad (.11)^* \quad (226.21) \quad (1{,}061.54)$$

$\bar{R}$ = .87, $\bar{R}^2$ = .76, standard error of estimate $28,400

The results of fitting the first set of equations indicated that none of the equations fitted were good fits: (1) the multiple correlation coefficient was very low in some of the equations, (2) in all of the equations there were only one or two regression coefficients significant at the one per cent probability level, (3) the standard error of estimate was fairly high in all of the equations and (4) there were several high intercorrelations among the independent variables in the equations.

Second Fit

The first set of regression equations furnished the

basis for determining which variables should be included in the second fit. The most important criterion in selecting the independent variables was the degree of significance of their estimated coefficients as indicated by the "t" test used. The simple correlation between a particular variable and quantity of credit along with the simple correlations among the independent variables were also considered in selecting variables to use in the second fit.

The equations used in the second fit were not the same for all types of farms. The first equation for cash-crop and dairy farms was fitted with seven variables. All the variables did not have significant estimated coefficients. This fit permitted determination of simple correlations among the seven independent variables and how much the multiple correlation coefficient was increased when this many variables were considered. The second revised equation fitted to the data of the cash-crop and dairy farms was fitted using only the variables whose estimated coefficients were significant in at least one of the three equations used in the first set. This criterion was applied to the variables for both the first and second equation of the second fit for beef cattle farms.

The equations used in the second fit were simple linear regression equations fitted by the least squares method. The equations were:

<u>for cash-crop farms</u>

(1) quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3), gross farm income (X_4), net farm income (X_5), size of farm (X_6), education (X_8)]

with the following results:

$$Y = -23{,}837.60 + 1{,}920.43X_1 + .25X_2 + 6{,}466.26X_3 + 1.07X_4 - .11X_5 + 89.56X_6 + 593.36X_8$$
$$(1{,}146.47) \quad (.10)^* \quad (1{,}968.54)^{**} \quad (.54)^* \quad (1.21) \quad (36.53)^* \quad (715.19)$$

$\bar{R} = .77$, $\bar{R}^2 = .59$, standard error of estimate, $14,019

(2) quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3), net farm income (X_5), education (X_8)]

with the following results:

$$Y = -24{,}527.54 + 2{,}176.02X_1 + .18X_2 + 7{,}326.73X_3 + 3.91X_5 + 1{,}691.32X_8$$
$$(1{,}236.28) \quad (.10) \quad (2{,}119.21)^{**} \quad (.95)^{***} \quad (738.22)^*$$

$\bar{R} = .72$, $\bar{R}^2 = .52$, standard error of estimate $15,192

<u>for dairy farms</u>

(1) quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3), gross farm income (X_4), net farm income (X_5), size of farm (X_6), education (X_8)]

with the following results:

$$Y = 15{,}322.37 + 5{,}097.40X_1 + .69X_2 - 2{,}025.71X_3$$
$$(2{,}214.34)^* \quad (.04)^{***} \quad (1{,}453.86)$$
$$+ .30X_4 + .65X_5 + 1.15X_6 - 3{,}972.67X_8$$
$$(.31) \quad (.30)^* \quad (15.30) \quad (511.79)^{***}$$

$\bar{R} = .92$, $\bar{R}^2 = .85$, standard error of estimate \$12,329

(2) quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3), size of farm (X_6), age (X_7)]

with the following results:

$$Y = 3{,}940.34 + 3{,}931.26 + .76X_2 - 4{,}212.15X_3 - 18.62X_6$$
$$(2{,}562.39) \quad (.05)^{***} (1{,}646.29)^* \quad (17.96)$$
$$- 126.08X_7$$
$$(124.83)$$

$\bar{R} = .89$, $\bar{R}^2 = .79$, standard error of estimate \$14,454

<u>for beef cattle farms</u>

(1) quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3), net farm income (X_5)]

with the following results:

$$Y = -82{,}688.59 + 10{,}130.01X_1 + .90X_2 + 12{,}873.36X_3$$
$$(3{,}970.97)^* \quad (.05)^{***} (5{,}130.88)^*$$
$$+ 8.12X_5$$
$$(4.20)$$

$\bar{R} = .87$, $\bar{R}^2 = .76$, standard error of estimate \$27,865

(2) quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3)]

with the following results:

$$Y = -74,944.14 + 8,299.12X_1, + .92X_2 + 14,364.19X_3$$
$$(3,888.30)^* \quad (.05)^{***} \quad (5,114.43)^{**}$$

$\bar{R} = .87$, $\bar{R}^2 = .76$, standard error of estimate $28,095

The results of fitting the second set of equations showed a slight improvement over the first set of equations. There were a few more variables that were significant in these equations, especially in the equation fitted to the data of the beef cattle farms. These were the result of the elimination of highly correlated variables. The standard error of estimates in most instances remained about the same, not showing any important improvements. Therefore, as a group the second fit did not show any improvement over the first fit. Only one equation showed enough improvement to be considered better than the equations of the first set. This was equation one for beef cattle farms.

The results of this fit indicated, (1) that at least one important variable was not included in the various equations used, or (2) that the right list of variables had not been used, or (3) there were too many highly intercorrelated variables in the equations used.

Third Fit

The procedure for selecting and fitting the first equation for the third fit was the same for cash-crop, dairy, and beef cattle farms. The best fitting equation from the first

two fits was selected and the residuals of this equation were computed and plotted to determine if there were any revisions, additions or deletions that might possibly improve the fit of this equation. From plotting the residuals, it was evident that at least one fairly important variable had been omitted. The availability of land contracts, when plotted on a scatter diagram with quantity of credit, seemed worth including in the equation to get a better fit.

Cash-crop farms

The equation selected as the best fitting of the first and second fits was equation one of the first set. A land contract variable was added to this equation to form the first equation for the third fit, which was quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3), gross farm income (X_4), land contract (X_9)].

The results of fitting this equation were:

$$Y = -38{,}796.51 + 4{,}716.54X_1 + .23X_2 + 9{,}319.39X_3 + 1.22X_4 + .31X_9$$
$$(1{,}136.97)^{***} \quad (.07)^{**} \quad (1{,}669.56)^{***} \quad (.29)^{***} \quad (.05)^{***}$$

$\bar{R} = .82$, $\bar{R}^2 = .67$, standard error of estimate $12,685

Dairy farms

The best fitting equation of the first and second fits, equation three of the first fit, was selected and land contract was added to this to form the first equation of the

third fit. This equation was quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), gross farm income (X_4), age (X_7), education (X_8), land contract (X_9)]. The results of fitting this equation were:

$$Y = 15{,}288.64 + 6{,}836.42X_1 + .79X_2 - .14X_4 - 265.18X_7 - 4{,}436.02X_8 + .37X_9$$
$$(2{,}033.89)^{**} \quad (.04)^{***} \quad (.28) \quad (101.87)^{**} \quad (502.96)^{***} \quad (.10)^{***}$$

$\bar{R} = .93$, $\bar{R}^2 = .86$, standard error of estimate \$11,876

Beef cattle farms

The best fitting equation from the first and second fits was equation one of the second fit. With the addition of land contract this equation became quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3), net farm income (X_5), land contract (X_9)]. The results of fitting this equation were:

$$Y = -121{,}550.88 + 16{,}747.32X_1 + .84X_2 + 13{,}713.64X_3 + .007X_5 + .29X_9$$
$$(3{,}997.29)^{***} \quad (.05)^{***} \quad (4{,}835.85)^{**} \quad (.43) \quad (.06)^{***}$$

$\bar{R} = .89$, $\bar{R}^2 = .79$, standard error of estimate \$26,245

The equations used in the third fit were better fitting equations for all types of farms, in almost every respect. The multiple correlation coefficient improved in each equation for all types of farms, compared to the prior best

fitting equation. There was a greater number of significant variables, with a higher degree of significance, in each of these equations for the different types of farms. Also, there was a slight improvement in the reliability of the estimating quality of these equations as the standard error of estimates were reduced for each equation, compared to all prior fits.

Selection and Acceptability of Best Fitting Equations

The regression equations computed above were fitted to the data for the particular type farm for the purpose of selecting the best fitting equation to be used in computing the marginal factor cost function of credit for that particular type of farm.

The basis for selecting the best fitting equation was primarily the "goodness of fit" of the equation. Things considered in the goodness of fits were, (1) the adjusted multiple correlation coefficient and coefficient of multiple determination, (2) standard error of estimate, (3) number of variables whose coefficients were significant and level of significance, and (4) distribution of the residuals when plotted about the regression line. Other items considered in selecting the best fitting equation were, (1) the signs and values of the estimated regression coefficients, and (2) the intercorrelation among the independent variables.

Cash-crop Farms

The best fit of the above equations for cash-crop farms

was the equation of the third fit, which was quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3), gross farm income (X_4), land contract (X_9)]. The results of fitting this equation were Y = -38,796.51 + 4,716.54X_1 + .23X_2 + 9,319.39X_3 + 1.22X_4 + .31X_9
(1,136.97)***(.07)** (1,669.56)***(.29)*** (.05)***

The equation was acceptable because: (1) The adjusted multiple correlation coefficient was .82 with an $\bar{R}^2$ of .67. (This was the highest of any equation fitted to cash-crop farms data.) (2) The standard error of estimate was $12,685, which was fairly low considering the range of data was from $1,000 to $115,000 with a mean of $48,053.25. (3) All of the variables in this equation had estimated coefficients which were significant at less than one per cent probability level. (4) The signs of the estimated coefficients agreed with the expected sign in each case. All of the estimated coefficients had positive signs, which would indicate as net worth, credit rating, gross farm income, and size of land contract available increases in quantity the estimate of the quantity of credit a cash-crop farmer could borrow increases.

One of the questionable features of this equation was the value of some of its coefficients. For example: (1) the coefficient for net worth was only .23, which seems to be on the low side, because one would expect, as the net worth of a cash-crop farmer increases he should be able in

fact to borrow a greater portion of it than 23 per cent as indicated by this equation. (2) The coefficient of 9,319.39 for credit rating seems to be reasonable. A change from a "fair" to a "good" credit rating probably would enable a cash-crop farmer to borrow this additional money. (3) The coefficient of 1.22 for gross farm income seems to be somewhat on the high side. This could be in compensation for the low coefficient of net worth, because these two factors had a simple correlation of .73, although when making real estate loans, farmers can easily borrow more than their estimated gross income. (4) The coefficient of .31 for land contracts seems to be low because a farmer probably would be able to get more than 31 per cent credit when buying land on a land contract. Two of the estimated coefficients seemed to be high and two low compared to expected values. The high coefficients tend to compensate for the low coefficients when considering the complete equation.

Dairy Farms

The best fit of the above equations for dairy farms was the equation of the third fit which was quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), gross farm income (X_4), age (X_7), education (X_8), land contracts (X_9)]. The results of fitting this equation were Y =

$$15{,}288.64 + 6{,}836.42X_1 + .79X_2 - .14X_4 - 265.18X_7 - 4{,}436.02X_8 + .37X_9$$

(2,033.89)** (.04)*** (.28) (101.87)*** (502.96)*** (.10)***

This equation was acceptable because: (1) The adjusted multiple correlation coefficient was .93 with an $\bar{R}^2$ of .86 (this was the highest of any equation fitted to the dairy farms data). (2) The standard error of estimate was $11,876, which was fairly low considering the range of data was from $5,000 to $156,500 with a mean of $46,248.42. (3) All of the variables except gross farm income had estimated coefficients which were significant at less than the one per cent probability level. (4) The signs of the estimated coefficients agreed with the expected signs for almost all variables. One exception to this was the negative coefficient for gross farm income. This coefficient was positive in equation three of the first fit. This was the equation picked as best fitting prior to adding available land contracts as a variable. The simple correlation between gross farm income and land contract was .19, table 11. Therefore, although this simple correlation was low, the addition of land contracts changed the sign of the regression coefficient for gross farm income. Gross farm income and net worth had a simple correlation of .71. Therefore, some of the effect of gross farm income could be reflected in the coefficient of net worth. Another negative coefficient that was not expected was that of education. This negative coefficient is easier to rationalize than for gross farm income. In the first place, there was not too much variation in the quantity of education among the farmers. Secondly, the

younger farmers had the most education, (-.32 intercorrelation between age and education), also the intercorrelation between quantity of credit and education was -.16. Therefore, the negative coefficient for education was not too illogical.

The values of the estimated regression coefficients seemed to be fairly close to the expected values, for example: (1) The coefficient of net worth was .79, which indicates that as the net worth of a dairy farmer increases, he could borrow 79 per cent of the increase. For some farms of net worth this would be too high, while for other forms, too low. Therefore the .79 seems to be reasonable as an average value for this coefficient. (2) The coefficient of -.14 for gross farm income is too low. It indicates that as gross farm income increases, a dairy farmer can borrow less credit than before; this is illogical and in disagreement with reality. This negative coefficient compensates for one of the other coefficients that is too high, probably net worth, which is highly intercorrelated with gross farm income. (3) The coefficient of -265.18 for age seems reasonable as an average expected value, although this would vary for different age groups. With an increase in age from 59 to 60 the quantity of credit would probably drop as much as $265.18. On the other hand, however, an increase in age from 25 to 26 would probably increase the quantity of credit a dairy farmer could borrow. This indicates that a

curvilinear equation with first a positive slope and then a negative slope might fit this better. The straight line form equation does not reflect adequately all the effects of age. (4) The coefficient of -4,436.02 for education seems to have the wrong sign in view of economic and logical reasoning. This coefficient indicates that as a dairy farmer increases his education by one year, the quantity of credit available to him is reduced by $4,436.02. This regression coefficient is probably reflecting the effects of some other variable or variables. The simple correlation between age and education was -.32. This negative correlation indicates confounding effects with respect to education, though there were no clear indications of compensating errors for other variables in the coefficient of education. Another possible reason for this negative coefficient for education could be bias in the respondents' answers, i.e., the lower educated farmers could have over estimated their quantities of credit as compared to the estimates of the higher educated farmers. (5) The coefficient of 6,836.42 for interest rate seems to be reasonable as an average expected value. This indicates that if the farmer is willing to pay an average of one per cent more he can acquire $6,836.42 more credit. By shifting to different combinations of loans, some of which require higher interest rates, a farmer is usually able to obtain more credit with resulting higher interest rate.

Beef Cattle Farms

The best fit of all the equations computed for beef cattle farms was the equation of the third fit, which was quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3), net farm income (X_5), land contract (X_9)]. The results of fitting this were Y = -121,-550.88 + 16,747.32X_1 + .84X_2 + 13,713.64X_3 + .007X_5 + .29X_9.

(3,997.29)*** (.05)***(4,835.85)** (.43) (.06)***

This equation was acceptable because: (1) the adjusted multiple correlation coefficient was .89 with an $\bar{R}^2$ of .79; (this was the highest for any equation fitted to beef cattle farms data), (2) the standard error of estimate was $29,245, which was fairly low considering the range from $8,000 to $239,500 with a mean value of $99,904.12, (3) all of the variables, except net farm income, had coefficients which were significant at less than the one per cent probability level, (4) the sign of the estimated coefficients agreed with the expected sign in each case. The coefficients of all variables had positive signs, which indicates as a beef cattle farmer's net worth, credit rating, net farm income and size of land contract available increases in quantity, the estimate of the quantity of credit he could borrow increases.

The values of the estimated regression coefficients seemed to be fairly close to the expected values in most instances. For example: (1) The coefficient of net worth was .84 which indicates that as net worth of a beef cattle

farmer increases, he could borrow 84 per cent of its increase. For some forms of net worth as pointed out in the discussion of this factor for dairy farms, this would be too high while for other forms too low. Therefore this coefficient of .84 seems reasonable as an expected value of this coefficient. (2) The coefficient of 13,713.64 for credit rating seems to be reasonable as an average expected value. This indicates a beef cattle farmer could borrow an additional $13,713.64 without any change in his net worth or other factors as his credit rating changes from say "fair" to "good". (3) The coefficient of .007 for net farm income seems to be very low. Further, the coefficient of this variable was not significant at even the 10 per cent probability level. This coefficient indicates that as a beef cattle farmer's net income or his expected net farm income increases by $1,000, he can borrow only an additional $7, which as pointed out above seems very low. (4) The coefficient of .29 for land contract seems to be low as a farmer should be able to borrow more than 29 per cent of a land contract with usual down payments. (5) The coefficient of 16,787.32 for interest rate seems to be high. This indicates if a farmer is willing to pay one per cent more in interest rate he can acquire $16,747.32 more credit. By shifting to different combinations of loans which require higher interest rate in some cases, the farmer is usually able to obtain additional credit with resulting higher interest rate. The quantity $16,787.32 seems to be a high

estimate of this additional quantity.

Comparison of the Best Fits

One of the first differences evident among the best fitting equations was that the variables included in these equations were different for each type of farm. Only three variables, interest rate, net worth, and land contract were included in all the equations, while two variables, credit rating and gross farm income, were included in two of the three types of farm equations. Net farm income, age and education were included in only one equation. All other variables were eliminated before the final equation. Therefore, based on the number of best fitting equations the variables were used in, interest rate, net worth and land contract were the more important variables which affected the quantity of credit. Second in importance, based on number of equations, was credit rating and gross farm income, followed by net farm income, age and education.

One of the causes of different variables in the final equations for cash-crop, dairy and beef cattle farmers was the process of eliminating highly correlated variables. In the instances of two highly correlated variables, for example gross farm income and net farm income, only one variable was selected for the revised equation. Thus some variables that were fairly important to the different types of farms may have been eliminated before the final equation. Omission of a factor from the final equation for a particular type of

farm does not mean this factor is insignificant or unimportant. The effects of the variables that were eliminated were reflected in the values of the remaining variables which were correlated with the omitted variable.

Another difference was in the values of the different regression coefficients for net worth, which was only .23 for cash-crop farmers as compared to .79 for dairy farms and .84 for beef cattle farms. This seems to indicate that net worth is not as important to a cash-crop farmer as it is to a dairy or beef cattle farmer in determining the quantity of credit he can borrow on the capital market. These coefficients indicate as the cash-crop farmer's net worth increases he can borrow only 23 per cent of the increase compared to 79 per cent for dairy and 84 per cent for beef cattle farmers. The low coefficient for cash crop farmers indicates that there was a possibility of some other factor reflecting part of the effects of net worth. The high coefficients for dairy and beef cattle farmers indicates that there was a possibility their values reflected some positive effects of another factor or factors.

Gross farm income and net worth in the cash-crop equation had a simple correlation of .73. The estimated coefficient of gross farm income was 1.22 which seems high based on economic and logical reasoning. When these two factors are considered together they seemed to indicate that part of the effect of net worth was reflected in the coefficient of

gross farm income. Another possible reason for the low coefficient of net worth was that the simple correlation between net worth and size of farm was .35, while the simple correlation between gross farm income and size of farm was .76. Therefore gross farm income rather than net worth is more likely to reflect the effect of size of farm.

On the other hand, the coefficient of -.14 for gross farm income for dairy farmers indicated that all the effects of this factor were reflected in values of other coefficients. The simple correlation between gross farm income and net worth was .71. This and a fairly high .79 coefficient for net worth seemed to indicate in terms of economics that part of the effects of gross farm income were reflected in the coefficient of net worth. For dairy farmers, net worth probably also reflected most of the effects of size of farm. Little of the effect of size of farm could have been reflected in the gross farm income coefficient which was -.14.

The coefficient of .007 for net farm income for beef cattle farmers indicated most of the effect of net farm income was reflected in another variable or variables. This coefficient was reduced from 8.12 to .007 as a result of adding land contract as a variable. This and the fact that the simple correlation between land contract and net farm income was .49 indicates that part of the effects of net farm income was probably reflected in the coefficient for land contracts.

Another factor that could be reflecting part of the

effects of net farm income is net worth. The simple correlation between net farm income and net worth is only .25 but that between gross farm income and net worth is .61. Gross farm income was not included in the final equation but its effects should be reflected in net farm income (their simple correlation was not computed) based on a prior knowledge. Therefore, the coefficient of .84 for net worth which is relatively high in terms of economic and logical reasoning probably reflects part of the effects of gross and net farm income.

Even though there are indications that the regression coefficients for net worth, gross farm income, and net farm income have compensating errors, the results indicate that net worth is not as important to cash-crop farmers as to dairy and beef cattle farmers in determining the quantity of credit they can borrow. This conclusion is also supported by the types of net worth these farmers own. For example: A much higher percentage of a cash-crop farmer's net worth is machinery and equipment than either dairy or beef cattle farmers' net worth. A relative high percentage of the dairy and beef cattle farmers' net worth is cattle, either dairy cows or feeder cattle. Agricultural lenders will loan a much higher percentage of value for cattle than for machinery and equipment which depreciates fairly rapidly.

There was quite a degree of difference in the coefficients of interest rate, with 4,716.54 for cash-crop farmers

compared to 6,836.42 for dairy and 16,747.32 for beef cattle farmers. These coefficients indicate that interest rate had more effect upon the quantity of credit a beef cattle farmer could borrow than for either a cash-crop farmer or a dairy farmer; by paying a one per cent increase in interest rate, the beef cattle farmer estimated he had available almost three times more additional credit than either of the other type farmers.

The coefficient of credit rating was 9,319.29 for cash-crop farmers and 13,712.64 for beef cattle farmers. Inter-correlations do not appear important in this instance. This difference seems to be caused primarily by the differences in the type of individual managing these respective types of farms. For example, practically all the beef cattle farmers were fairly well established farmers with a wide range of credit experience as compared to quite a number of the cash-crop farmers who were part time and/or "in and out" farmers. Generally, cash-crop farmers surveyed appeared to be poorer managers than beef cattle farmers. This difference is based primarily on personal observations by the author during the study.

One of the surprising results was that net farm income was not significant in any of the equations and that it was included in only one best fitting equation. This could be explained by one of several possibilities: (1) there were a few dairy and beef cattle farmers in the sample who had

negative net farm incomes; (2) gross farm income rather than net farm income is often used as a criterion for the farmer's repayment ability by the lending agencies; (3) net farm income is subject to wider percentage fluctuations than gross farm income and (4) high intercorrelations existed between this factor and other factors, thus the coefficients for the other factors probably reflected the influence of net farm income.

The only variable used in all best fitting equations that did not indicate any large degree of difference for the different type of farms was land contract. The various coefficients for land contract were .31 for cash-crop farms, .37 for dairy farms, and .29 for beef cattle farms. Therefore, the availability of land contracts affected the quantity of credit available for all types of farms about the same.

The relatively low regression coefficient for land contracts may be explained by the method used in measuring available land contracts. For example, if a farmer estimated he could purchase $60,000 worth of land on land contract with $20,000 (one-third value) as down payment and if the farmer had the $20,000 to finance the land contract, this was recorded as a $60,000 available land contract which is the independent variable in the study. However, the credit acquired was treated as $40,000. Therefore, the regression coefficient for available land contracts should not be one as land contracts are not 100 per cent financed.

Another possible reason for the low coefficients for land contracts are the simple correlations between land contracts and interest rate. These are -.36, -.31 and -.38 for cash-crop, dairy and beef cattle farmers respectively. Though these simple negative correlations are not so large, the coefficient for interest rate was greatly affected by introducing land contracts. The respective changes were from 2,176.02 to 4,716.54 for cash-crop farmers; from 3,931.26 to 6,836.42 for dairy farmers; and from 8,299.12 to 16,747.32 for beef cattle farmers.

The Marginal Factor Cost Functions

A marginal factor cost function for credit for farmers treats interest rate as a function of the quantity of credit with other variables, net worth, credit rating, etc., held constant. The list of variables used in fitting the average cost functions (from which the marginal cost functions of this study were derived) was based on the regression equations selected as "best" when the quantity of credit was treated as the dependent variable.

Cash-crop Farms

When the best fitting regression equation was recalculated with interest rate as the dependent variable, the equation fitted to the cash-crop farms data was interest rate (Y) = f [quantity of credit (X_1), net worth (X_2), credit rating (X_3), gross farm income (X_4), land contract (X_9)], with the following results:

$$Y = 7.74 + .000022X_1 - .000017X_2 - .62X_3 + .000031X_4$$
$$(.0000053)***(.0000047)***(.11)***(.000021)$$
$$- .000023X_9$$
$$(.0000033)***$$

$\bar{R} = .58$ $\bar{R}^2 = .34$, standard error of estimate .87.

$$\therefore \quad MFC = 7.74 + (2).000022X_1 - .000017X_2 - .62X_3 + .000031X_4$$
$$- .000023X_9$$

(X_1 = Q = quantity of credit)

By varying the quantity of credit (X_1) and using the mean value[1] of the other variables the marginal factor cost schedule was computed and is illustrated in Figure 2.

This marginal factor cost function when plotted, with interest rate on X axis and quantity of credit on Y axis, was a straight line because it was derived from a straight line function. The residuals for this equation were plotted about the regression line and their pattern indicated that a curvilinear function might fit the data better than a straight line.

A curvilinear function was fitted to these data by squaring the quantity of credit term (Q) and then plotting this against the scale of the unsquared term. This permitted the function to curve upward when plotted with interest rate on the Y axis and quantity of credit on the X axis.

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[1]For mean values see Appendix B, Table 1.

The equation fitted was interest rate (Y) = f [quantity of credit $(X_1)^2$, net worth (X_2), credit rating (X_3), gross farm income (X_4), land contract (X_9)].

with the following results:

$$Y = 8.05 + .000000000023X_1^2 - .000018X_2 - .54X_3$$
$$(.000000000052)***(.0000048)***(.11)***$$
$$+ .000023X_4 - .000025X_9$$
$$(.000021) \quad (.0000034)***$$

$\bar{R} = .59$, $\bar{R}^2 = .34$ standard error of estimate .86

$$\therefore \quad MFC = 8.05 + (3)\ .000000000023X_1^2 - .000018X_2 - .54X_3$$
$$+ .000023X_4 - .000025X_9$$

By varying the quantity of credit (X_1) and using the mean value of the other variables, this curvilinear function was computed and is illustrated in Figure 2. The residuals when plotted about the regression line indicated that the curvilinear function fitted the data better than the straight line function. This seems logical because as the cash-crop farmer uses large quantities of credit over $60,000, the interest rate starts to increase quite rapidly. This agrees with the general observation that after a certain limit is reached, farmers are not able to borrow more money regardless of the interest rate they are willing to pay. Thus, eventually the MFC function will be a straight, vertical line with perfect inelasticity.

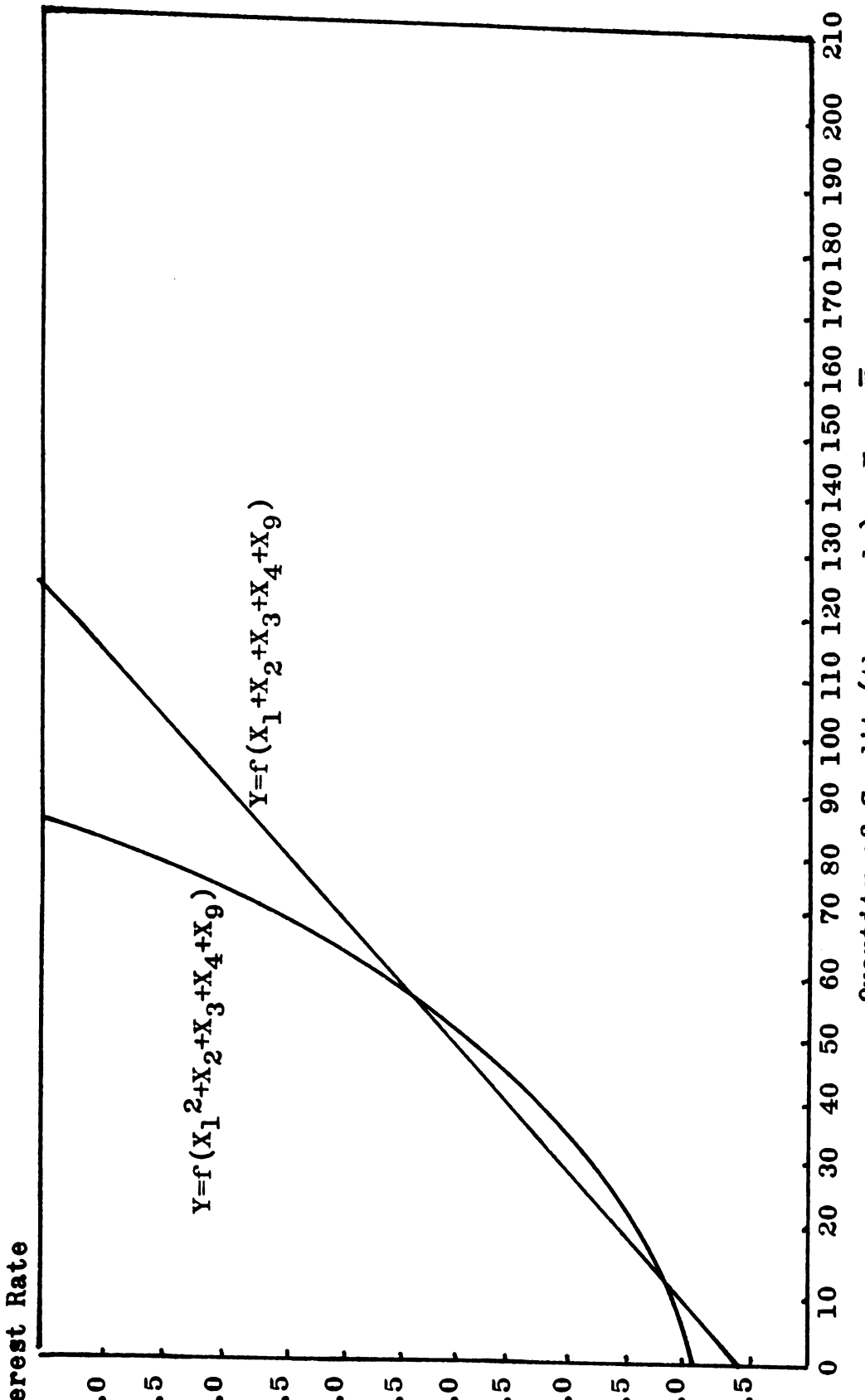

Figure 2. Marginal factor cost functions for cash-crop farmers.

Dairy Farms

When the best fitting regression equation was recalculated with interest rate as the dependent variable, the equation fitted to the dairy farms data was interest rate (Y) = f [quantity of credit (X_1), net worth (X_2), gross farm income (X_4), age (X_7), education (X_8), land contract (X_9)]

with the following results:

$$Y = 5.41 + .000010X_1 - .0000086X_2 + .00000012X_4$$
$$(.0000030)***(.0000028)*** (.000011)$$
$$+.0015X_7 + .036X_8 - .000017X_9$$
$$(.0040) \quad (.023) \quad (.0000039)***$$

$\bar{R} = .37$, $\bar{R}^2 = .14$, standard error of estimate .45.

$$\therefore \quad MFC = 5.41 + (2)\ .000010X_1 - .0000086X_2 + .00000012X_4 + .0015X_7 + .036X_8 - .000017X_9$$

(X_1 = quantity of credit)

By varying the quantity of credit (X_1) and using the mean values[2] of the other variables, the marginal factor cost schedule was computed and is illustrated in Figure 3.

This function when plotted, with interest rate on the Y axis and quantity of credit on the X axis, was a straight line because it was derived from a straight line function. The residuals for this equation were computed and plotted about the regression line and their pattern indicated that a

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[2]For mean values see Appendix B, Table 1.

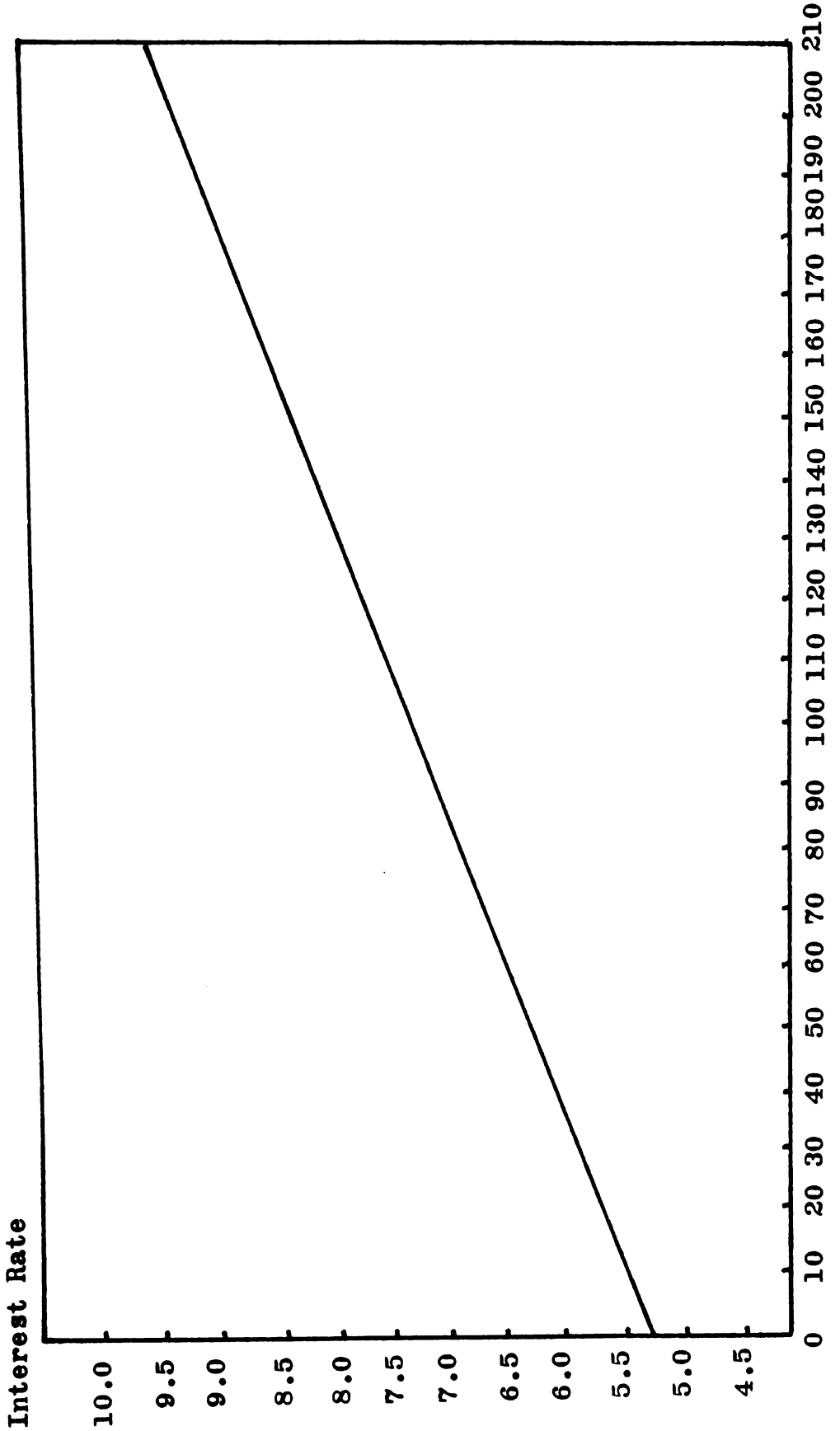

Figure 3. Marginal factor cost function for dairy farmers.

curvilinear function might fit the data better than a straight line function. The results of fitting a curvilinear function were not as good as the straight line function; therefore, the curvilinear function was discarded and the straight line function was selected as the best fitting MFC function for dairy farms.

This straight line function is reliable only over the range of data for the dairy farmers, which was, as indicated above, up to $156,500. Probably after this, the function will be steeper than the slope of this straight line. This conclusion is based on the conviction that after the average dairy farmer surveyed borrows over $150,000, he would not be able to get much more regardless of the interest rate he would be willing to pay. Thus eventually the slope of function should be expected to change from .000020 to infinity.

Beef Cattle Farms

When the best fitting regression equation was recalculated with interest rate as the dependent variable, the equation fitted for the beef cattle farms was interest rate (Y) = f [quantity of credit (X_1), net worth (X_2), credit rating (X_3), net farm income (X_5), land contract (X_9)] with the following results:

$$Y = 5.86 + .0000058X_1 - .0000031X_2 - .081X_3 - .0000063X_5 - .0000065X_9$$
$$(.0000014)^{***}\quad (.0000015)^{*}\quad (.092)\quad (.0000080)\quad (.0000011)^{***}$$

$\bar{R} = .48$, $\bar{R}^2 = .23$, standard error of estimate .487.

$$\therefore \quad MFC = 5.86 + (2)\ .0000058(X_1) - .0000031X_2 - .081X_3 - .0000063X_5 - .0000065X_9$$

By varying the quantity of credit (X_1) and using the mean values[3] of the other variables, the marginal factor cost schedule was computed and is illustrated in Figure 4.

This MFC function, when plotted with interest rate on the Y axis and quantity of credit on the X axis, was a straight line because it was derived from a straight line AFC function. The residuals for this equation were computed and plotted about the regression line. Their pattern indicated that a curvilinear function might fit the data better than a straight line function. However, when a second degree term was fitted for quantity of credit, no important curvilinearity was revealed.

The linear function is reliable only over the range of data for the beef cattle farmers which was, as indicated above, up to $239,500. Beyond this quantity the function will probably turn up.

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[3]For mean values see Appendix B, Table 1.

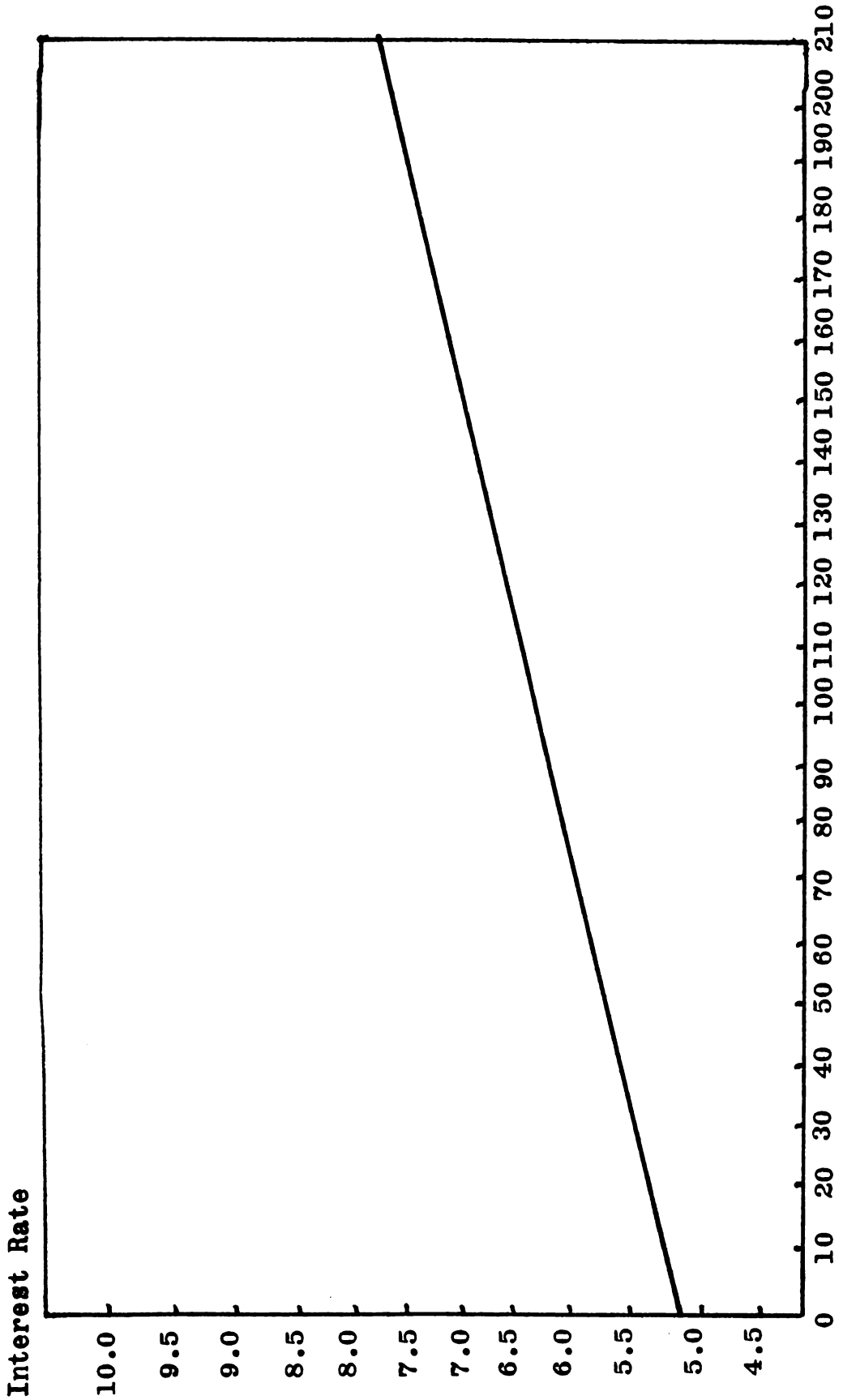


Figure 4. Marginal factor cost function for beef cattle farmers.

CHAPTER III

ESTIMATING A MARGINAL FACTOR COST FUNCTION FOR CREDIT FOR CASH-CROP, DAIRY AND BEEF CATTLE FARMERS FROM DATA FOR ALL FARMS

In this chapter a marginal factor cost function will be estimated on the basis of the data collected from all the farmers included in this study, 29 cash-crop, 30 dairy and 29 beef cattle farmers. This function will treat type of farm as an independent variable.

In this chapter the first section following this introduction will present a general comparison of the three types of farms, cash-crop, dairy and beef cattle. The second section will present the results of the first set of equations used for the individual farm types, when fitted to the data from all farms. The third section will present the results and a discussion of the revised equations. In the fourth section the equation selected as best fit will be presented. Also, in that section this best fitting equation will be used to derive the marginal factor cost function for credit.

General Comparison of the Cash-Crop, Dairy and Beef Cattle Farms

The cash-crop farms were smaller in total acres operated than either the dairy or beef cattle farms, averaging only 134.5 acres compared to 214.0 for dairy and 213.5 for beef cattle, Table 13. This was caused in part by the stratified sample of cash-crop farms, which required one-

third of the farms to be 80 acres or under. The dairy and beef cattle farm samples required only a farm with a few milk cows (20 or under) or a few feeders (50 or under) and this did not necessarily require a smaller farm in total acreage.

TABLE 13

AVERAGE SIZE, YEARS OF FARMING, AGE, AND EDUCATION, BY TYPE OF FARM, 88 FARMS, SELECTED AREAS OF MICHIGAN, 1960

Type of Farm	Number of farms	Size (total acres)	Farming Experience (years)	Age (years)	Education (grades)
Cash-crop	29	134.5	18.2	43.7	9.4
Dairy	30	214.0	20.0	46.5	9.4
Beef-cattle	29	213.5	20.6	46.1	10.6

Within the individual type of farm breakdowns, the younger farmers had more education and in some instances operated larger farms. When the three types of farms were compared, the cash-crop farm operators were the youngest with the least education while the beef-cattle farm operators were the oldest with the most education. Thus, there was a high correlation between education and type of farm as well as between education and age of farmer.

The cash-crop farmers had the highest average off-farm income of the three types of farms, about 250 per cent greater than either the dairy or beef cattle farmers. This

was because of the large percentage of operators of small cash-crop farms had either a full-time or a part-time job in addition to their farm operation.

For gross farm income, net farm income and total income, averages per acre were calculated in addition to the average per farm to give a better comparison among the types of farm. The average cash-crop farm was much smaller than the average dairy or beef cattle farm. The beef cattle farmers had a very much higher average gross farm income per farm and per acre, with the dairy farmers having the second highest per farm and the cash-crop farmers having the second highest per acre, Table 14.

TABLE 14

AVERAGE OFF-FARM INCOME, GROSS FARM INCOME, NET FARM INCOME AND TOTAL INCOME, BY TYPE OF FARM, 88 FARMS, SELECTED AREAS OF MICHIGAN, 1960

Type of Farm	Off-farm Income	Gross Farm Income		Net Farm Income		Total Income	
		Per farm	Per acre	Per farm	Per acre	Per farm	Per acre
	(dol.)	(dol.)	(dol.)	(dol.)	(dol.)	(dol.)	(dol.)
Cash-crop	1,724	9,119	67.80	2,649	19.69	4,392	32.60
Dairy	488	11,748	54.90	3,473	16.23	4,181	19.56
Beef-Cattle	611	37,513	175.70	5,335	25.00	6,179	28.92

The beef cattle farmers also had the highest net farm income, as measured by both average per farm and per acre, although the difference was not nearly as great as in gross

farm income. The average net farm income per acre was $25.00 for beef cattle farms compared to an average of $19.69 for cash-crop farms and $16.23 for dairy farms. When the total income was compared by type of farm, the cash-crop farmers had enough off-farm income to more than off-set the higher net farm income of the beef cattle farmers on an average per acre basis but not on an average per farm basis.

The average credit rating by type of farm was positively correlated with net worth, with the cash crop farmers having the lowest average net worth of $46,133 and lowest credit rating of 3.4, compared to an average net worth of $58,566 and credit rating of 3.5 for dairy farmers and a net worth of $78,713 and credit rating of 3.8 for beef cattle farmers, Table 15, The average interest rate farmers estimated they would have to pay for credit was negatively correlated with credit rating and net worth. The interest rate was also negatively correlated with quantity of credit, with the quantity of credit being positively correlated with credit rating and net worth.

The most significant difference among the types of farms was the percentage of net worth the different types of farmers estimated they could borrow. The beef cattle farmers estimated they could borrow 142.3 per cent of their net worth, compared to 117.5 per cent for cash-crop farmers and only 91.3 per cent for dairy farmers. Thus, the type of farm should be a significant variable when estimating the

marginal factor cost function for credit.

TABLE 15

AVERAGE CREDIT RATING, NET WORTH, INTEREST RATE AND QUANTITY OF CREDIT, BY TYPE OF FARM, 88 FARMS, SELECTED AREAS OF MICHIGAN, 1960

Type of Farm	Credit Rating	Net Worth (dol.)	Interest Rate (pct.)	Quantity of Credit (dol.)
Cash-crop	3.4	46,133	6.4	54,203
Dairy	3.5	58,566	6.1	53,374
Beef-cattle	3.8	78,713	6.1	111,980

Simple Correlations Among the Independent Variables

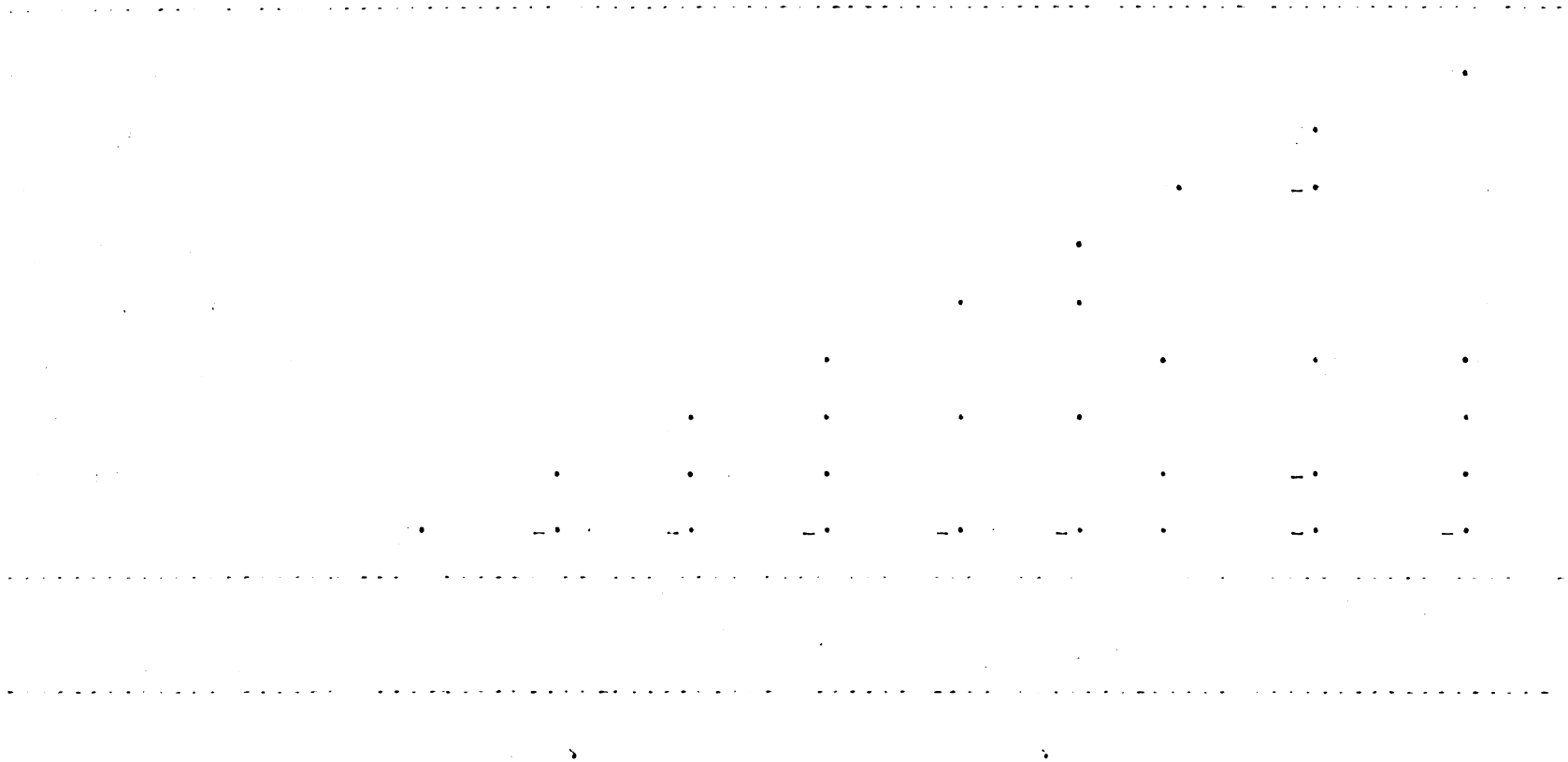
There were some high simple correlations among the various independent variables when these were computed for the variables used in the equations fitted to the data of the individual type farms. Therefore to determine if these or other variables have high simple correlation when used in equations fitted to all farms data, the simple correlations among the variables used in the various equations were computed. These appear in Table 16.

The simple correlations among the independent variables were much lower for all farms than those for the particular types of farms. There was only one simple correlation above .40. This was between net worth and gross farm income with a simple correlation of .62.

TABLE 16

SIMPLE CORRELATIONS AMONG THE INDEPENDENT VARIABLES
88 FARMS, SELECTED AREAS OF MICHIGAN, 1960

Independent variable / Independent variable	Interest rate	Net worth	Credit rating	Gross farm income	Net farm income	Size of farm	Age	Education	Land contract
Interest rate	1.00	-.07	-.24	-.08	-.17	-.12	.06	-.06	-.30
Net worth		1.00	.26	.62	NC	NC	.29	-.02	.25
Credit rating			1.00	.33	.21	.12	NC	NC	.12
Gross farm income				1.00	NC	NC	.13	.18	.33
Net farm income					1.00	.40	NC	NC	NC
Size of farm						1.00	NC	NC	NC
Age							1.00	-.38	NC
Education								1.00	NC
Land contract									1.00



Regression Equations Fitted

The data from all the farms were combined and used to derive a marginal factor cost function with the type of farm as one of the independent variables. The equations fitted for all farms were, as for the individual type farm, simple linear regression equations fitted by the least squares method.

The First Fit

The equations used in the first fit for all farms data were the same as the equations used in the first fit for the individual type farms. The equations fitted and results of these were:

(1) quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3), gross farm income (X_4)] with the following results:

$$Y = 35{,}497.95 + 5{,}346.84X_1 + .71X_2 + 3{,}150.62X_3 + .74X_4$$
$$(1{,}487.51)^{***} \quad (.03)^{***} \quad (1{,}704.84) \quad (.07)^{***}$$

$\bar{R} = .87$, $\bar{R}^2 = .76$, standard error of estimate $23,478

(2) quantity of credit (Y) = f [interest rate (X_1), credit rating (X_3), net farm income (X_5), size of farm (X_6)] with the following results:

$$Y = 78{,}988.34 + 8{,}633.13X_1 + 16{,}850.11X_3 + 2.37X_5 + 133.33X_6$$
$$(2{,}634.42)^{**} \quad (2{,}874.87)^{***} \quad (.49)^{***} \quad (20.38)^{***}$$

$\bar{R} = .50$, $\bar{R}^2 = .25$, standard error of estimate $41,177

(3) quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), gross farm income (X_4), age (X_7), education (X_8)]

with the following results:

$$Y = -17{,}464.02 + 47{,}404.07X_1 + .72X_2 + 7.68X_4 - 525.77X_7 - 1{,}962.64X_8$$

(14,591.53)** (.04)***(.69)***(1,144.15) (5,563.10)

$\bar{R} = .87$, $\bar{R}^2 = .75$, standard error of estimate $23,580

One of the apparently surprising results of this fit was that the estimated coefficients of all the variables in equation two were highly significant, although the $\bar{R}^2$ was very low, .25, and the standard error of estimate high, $41,177. The first and third equations indicated a fairly good fit with $\bar{R}^2$ of.75, and standard error of estimates of approximately $23,000, although both of these equations included some variables whose estimated coefficients were not significant even at the 10 per cent probability level.

Improving the standard error of estimates and increasing the number of significant variables, for the same equation, were two factors considered in selecting new equations to be fitted to all farms data.

Second Fit

There were not any equations fitted to all farms data

comparable to the second fit of the individual type farms. The procedure for the second fit involving the data for all farms was similar to the procedure used for the third fit for the individual type farms. The best fitting equation from prior fits, in this instance from the three equations used in the first fit, was selected and modified to include available land contracts and type of farm as independent variables. The equation fitted was quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3), gross farm income (X_4), land contract (X_9), cash-crop farm (X_{10}), dairy farm (X_{11}), beef cattle farm (X_{12})] with the following results:

$$Y = -50{,}191.14 + 8{,}310.01X_1 + .75X_2 + 3{,}437.75X_3 + .24X_4$$
$$(1{,}341.05)^{***} \quad (.03)^{***} \quad (1{,}467.69)^{*} \quad (.07)^{*}$$
$$+ .29X_9 - 3{,}757.72X_{10} - 10{,}999.35X_{11} + 13{,}821.12X_{12}$$
$$(.03)^{***} \quad \text{NC} \quad \text{NC} \quad \text{NC}$$

$\bar{R} = .91$, $\bar{R}^2 = .82$, standard error of estimate $20,139

The dummy variable technique was used for the type of farm, for example, for cash-crop farms data $X_{10} = 1$; $X_{11} = 0$; $X_{12} = 0$, while for dairy farms data $X_{10} = 0$; $X_{11} = 1$; and $X_{12} = 0$. The computer would not handle three dummy variables; therefore, X_{12} was deleted from computer computation and the regression coefficient for X_{12} was computed later.[1] When the

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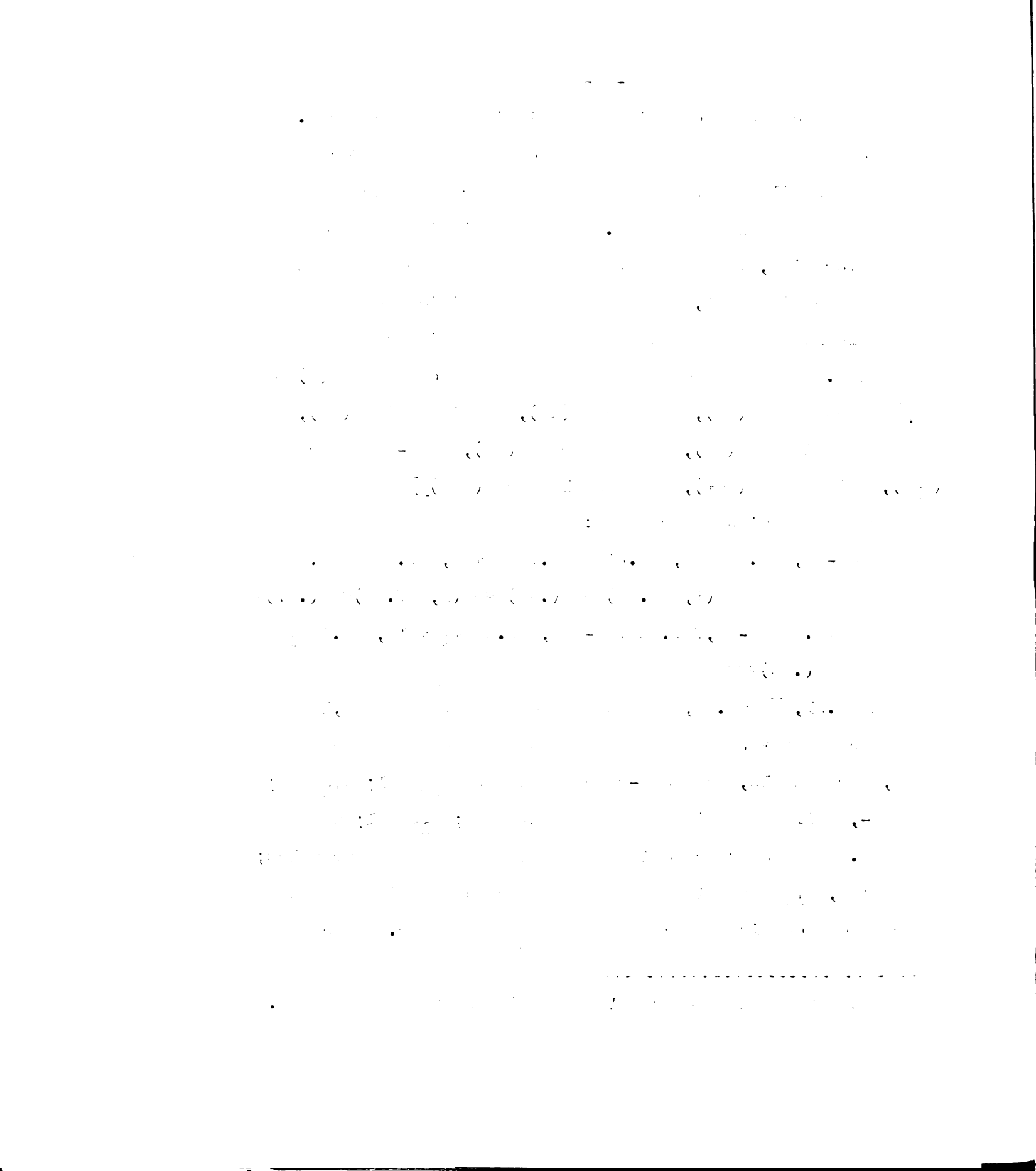
[1]See Appendix A for complete details of the method used.



coefficient for X_{12} was computed, the coefficients of X_{10} and X_{11} and the "A" value had to be adjusted. Since the coefficients of X_{10} and X_{11} had to be adjusted, the standard errors for these variables were not accurate, therefore, neither the standard error nor the "t" test values are presented for X_{10}, X_{11} and X_{12}. The standard errors computed for X_{10} and X_{11}, even though not applicable, indicated that the type of farm variables were highly significant.

This equation indicated improvement in three important aspects over the prior best fitting equation. These improvements were: (1) The coefficient of multiple determination improved from .76 to .82. (2) More variables were significant and at a higher level of significance. (3) The standard error of estimate decreased from $23,478 to $20,139, which improved the estimating quality of the equation.

Selection and Acceptability of Best Fitting Equation

The regression equations computed from the data of all farms were fitted to these data for the purpose of selecting the best fitting equation to be used in computing the marginal factor cost function for credit. The best fit of all the equations computed from the data of all farms was the equation of the second fit which was quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3), gross farm income (X_4), land contract (X_9), cash-crop farm (X_{10}), dairy farm (X_{11}), beef cattle farm (X_{12})]. The results of fitting this equation were Y = -50,191.14 +

$8,310.01X_1 + .75X_2 + 3,437.45X_3 + .24X_4 + .29X_9 - 3,757.72X_{10} - 10,999.35X_{11} + 13,821.12X_{12}$.

The bases for selecting the best fitting equation were the same as those for selecting the best fitting equation for the individual type farm. These were: (1) the adjusted multiple correlation coefficient and multiple determination coefficient, (2) standard error of estimate, (3) number of variables whose coefficients were significant and level of significance, (4) distribution of the residuals when plotted about the regression line, (5) the signs and values of the estimated regression coefficients and (6) the simple correlations among the independent variables.

This equation was acceptable because: (1) The adjusted multiple correlation coefficient was .91 with an $\bar{R}^2$ of .82. (2) The standard error of estimate was $20,139 which was not too high considering the range of data was from $1,000 to $239,500. (3) The variables all had coefficients which were significant. (4) The signs of the estimated coefficients agreed with the signs expected on the basis of theory and a prior knowledge. The variables, interest rate, net worth, credit rating and land contract had positive coefficients. This is in agreement with what farmers can in fact do. The type of farm variable had cash-crop and dairy farms with negative coefficients and beef cattle farms with a positive coefficient. This agrees with the expected because of the higher gross farm income and type of net worth the

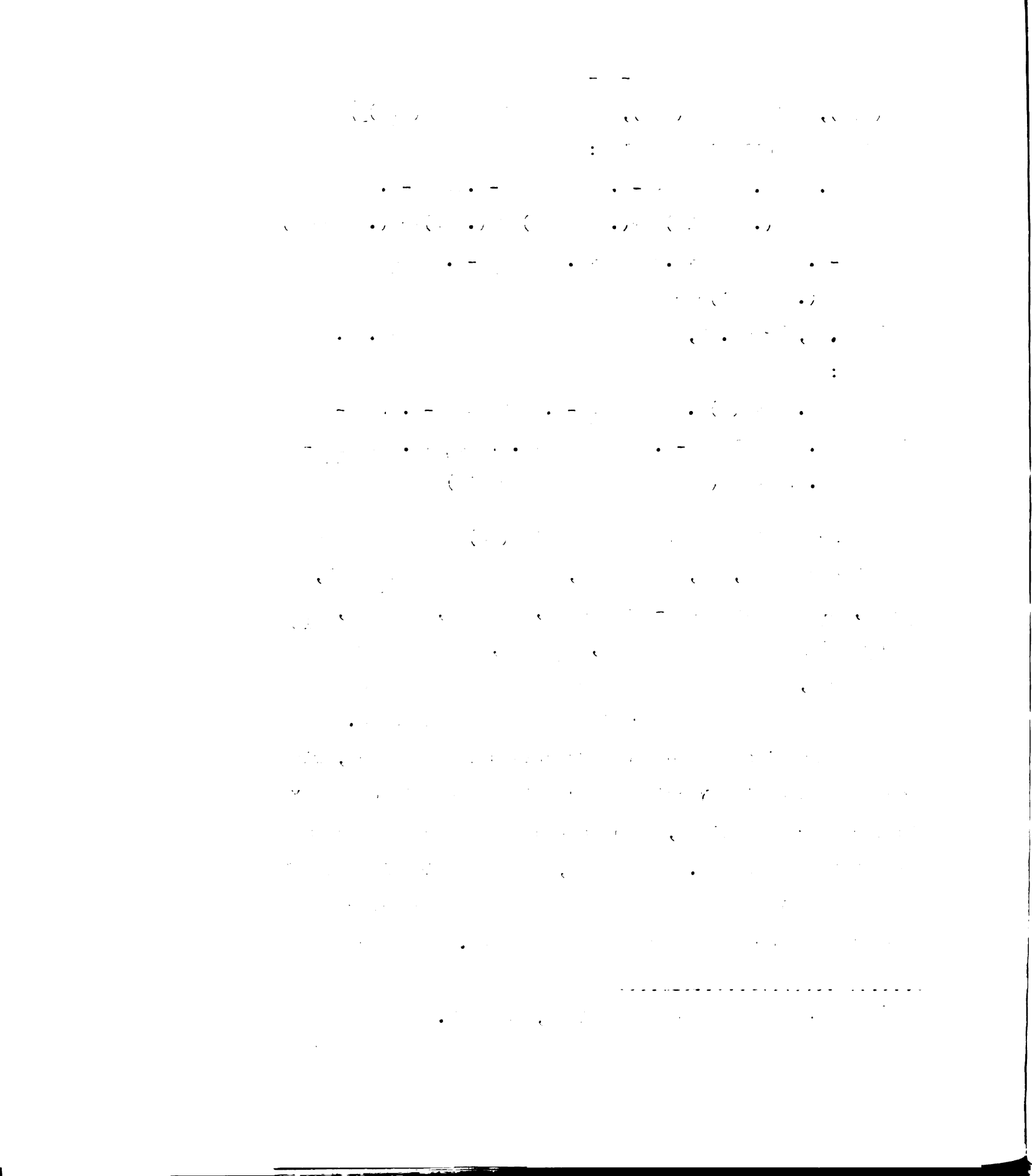
beef cattle farmer, with other things equal, can borrow more money. This was substantiated by the marginal factor cost functions for credit when computed by type of farm.

The values of the type of farm coefficients seemed to be fairly close to expected values. For example: (1) The coefficient of cash-crop farms was -3,757.72, which indicates the cash-crop farmer's credit or available credit on the money market would be $3,757.72 less than the average farmer's. The coefficient for dairy farm was -10,999.35 which indicates his available credit is $10,999.35 less than the average farmer. The coefficient for beef cattle farm was 13,821.12, which indicates the beef cattle farmer could get $13,821.12 more credit, with other things equal, than the average farmer. These values seem to be very reasonable estimates of the actual differences that exist among these types of farmers and quantities of credit they can borrow. (2) The coefficient of net worth was .75, which indicates that as a farmer's net worth increases he can borrow 75 per cent of the increase. This compares favorably with .75 for dairy and .84 for beef cattle farmers from the regression equations for the individual type farms. This value is much higher than .23 for cash-crop farmers on an individual farm basis. It tends to be an average for cash-crop, dairy and beef cattle farmers. The differences in this value for the individual type farms are too great to combine into one value to represent all farmers. (3) The coefficient for credit

rating was 3,437.75 which indicates as a farmer's credit rating changes one classification he can borrow $3,437.75 additional money or purchase this much more on credit. This value seems to be reasonable because a farmer's credit rating greatly affects his ability to borrow and in most instances the amount of credit extended to him. (4) The coefficient of 8,310.01 for interest rate seems to be on the high side of expected value because of policies of lending institutions. They do not increase the size of a farmer's loan just because he is willing to pay a higher interest rate. They loan money at a fixed interest rate and the quantity of the loan is determined by the farmer's assets and other qualities. Farmers can usually get more money by changing the combinations of loans with higher interest payments. However, $8,310.01 seems a high estimate of the average increase due to one per cent change in the interest rate.

The Marginal Factor Cost Functions

The regression equation selected as the best fitting equation was fitted with the quantity of credit as the dependent variable. To facilitate the computing of the marginal factor cost function this equation, using the same variables, was refitted with interest rate as the dependent variable and quantity of credit one of the independent variables. Thus, the equation fitted was interest rate (Y) = f (quantity of credit (X_1), net worth (X_2), credit rating (X_3), gross farm income (X_4), land contract (X_9), cash-crop



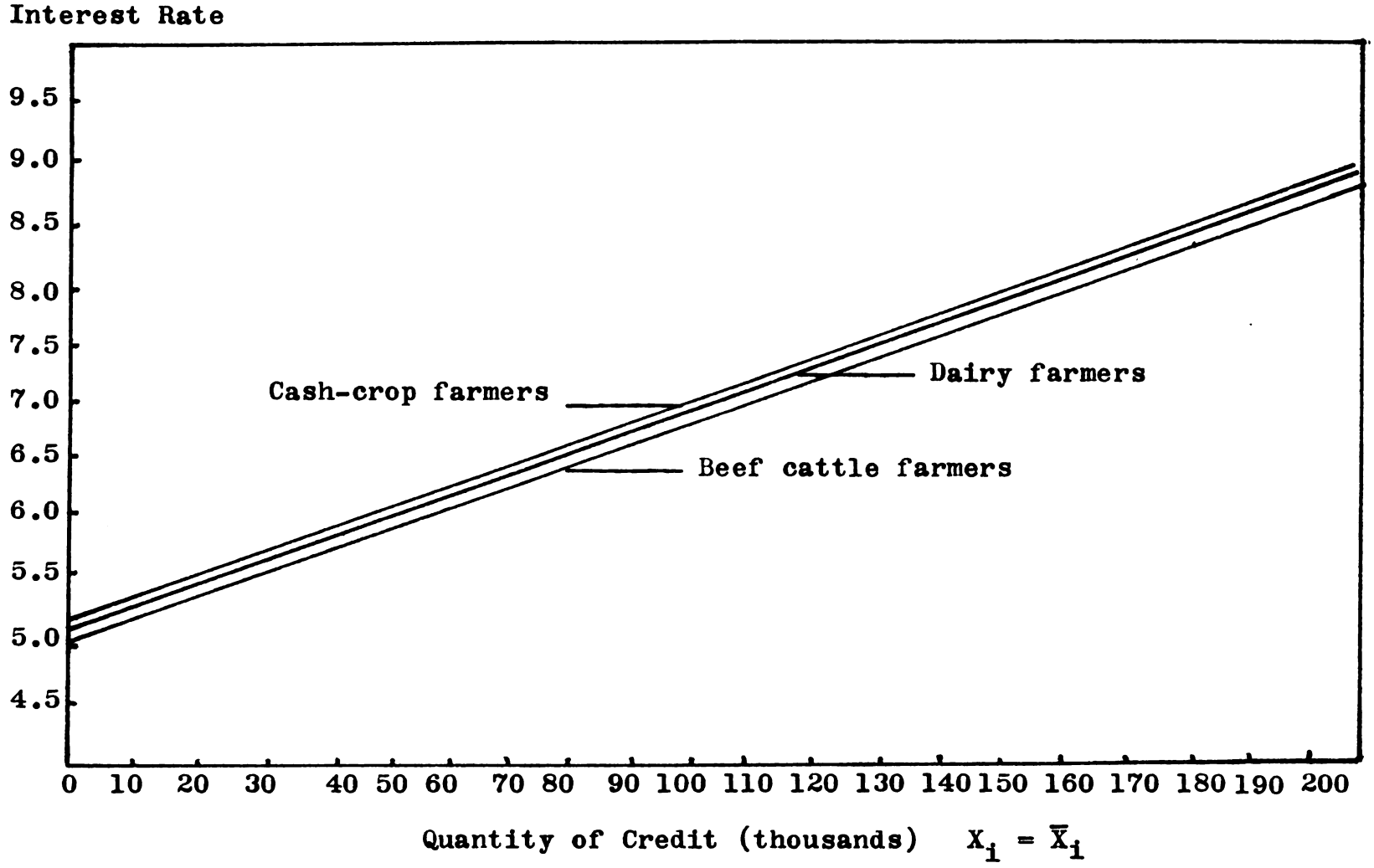


Figure 5. Marginal factor cost functions for cash-crop, dairy, and beef cattle farmers, derived from data for all farms.

were indicated and discussed in the chapter on the individual type farm. After the quantity of credit passes beyond this range the function will likely curve upward until it becomes a vertical (straight) line. This is because of the fact, that after a farmer borrows his limit at the market rates of all lending agencies, open accounts, land contracts, etc., he will reach a point where he cannot borrow any more money regardless of the interest rate he is willing to pay.

There was not much difference in the marginal factor cost functions derived by this method, as can be readily seen in Figure 5, for the different types of farm. The cash-crop function (based on the one derived for only cash-crop farmers) was decreased and the beef cattle function increased. Due to the large degree of difference in the marginal factor cost functions for the type of farm between types of farms, this function does not seem to offer very much.

CHAPTER IV

SUMMARY AND CONCLUSIONS

The primary objective of this study was to estimate and describe the marginal factor cost functions for credit for selected cash-crop, dairy and beef cattle farmers of Michigan. The data necessary to derive these marginal factor cost functions were collected by personal interview from these three types of farms. Therefore, these functions represent the farmers' estimate of the marginal factor cost of credit available to them at various interest rates. The secondary objective was to determine the factors which significantly affect the quantity of credit the different types of farmers estimated they could borrow.

Three counties were selected, one for each type of farm, i.e., Saginaw for cash-crop, St. Clair for dairy and Lenawee for beef cattle. These three counties constituted the sample area. See Chapter I for details.

The questionnaire used to collect these data was designed to collect data on certain factors considered to significantly affect the quantity of available credit. These factors were: (1) interest rate, (2) net worth, (3) farmers' credit rating, (4) gross farm income, (5) net farm income, (6) size of farm, (7) age, (8) education, (9) land contracts, (10) off-farm income and (11) farming experience.

Results and Conclusions

Some of the more important characteristics of the farms will be given and compared, by type of farm to get a clearer picture of the basic characteristics of the farms from which data were collected. These were:

1. The cash-crop farms were smaller in total acres operated than either the dairy or beef cattle farms, averaging only 134.5 acres compared to 214.0 for dairy and 213.5 for beef cattle farms.
2. The cash-crop farmers were slightly younger, with an average age of 43.7 years as compared to 46.5 for dairy farmers and 46.1 years for beef cattle farmers.
3. The cash-crop farmers, although younger, did not have as many years of farming experience, averaging 18.2 years compared to 20.0 for dairy and 20.6 for beef cattle farmers.
4. Within the individual type farms, the younger farmers had more education than older ones. Although the cash-crop farmers were younger they had only an average of 9.4 years of education compared to 9.4 for dairy and 10.6 for beef cattle farmers.
5. The dairy farmers had the lowest average off-farm income with $488 compared to $1,724 for cash-crop and $611 for beef cattle farmers.

6. The beef cattle farmers had the largest average gross farm income per farm and per acre, by a large margin, with $37,513 per farm and $175.70 per acre compared to only $9,119 and $67.80 for cash-crop and $11,748 and $54.90 per farm and per acre respectively for dairy farmers.
7. The beef cattle farmers also had the largest average net farm income with $5,325 per farm and $25.00 per acre compared to only $2,649 and $19.69 for cash-crop farmers and $3,473 and $16.23 per farm and per acre respectively for dairy farmers.
8. There was not as much difference in total income as in other incomes because the cash-crop farmer had more off-farm income and other income, such as wives' salaries, interest payments, dividends, etc., than the dairy or beef cattle farmers. Thus, the cash-crop farmers' average total income was $4,392 per farm and $32.60 per acre compared to $4,181 and $19.56 for dairy and $6,179 and $28.92 per farm and per acre, respectively, for beef cattle farmers.
9. The beef cattle farmers had the highest credit rating with an average of 3.8 (out of a possible 4.0) compared to a 3.4 for cash-crop and 3.5 for dairy farmers.
10. Cash-crop farmers had the lowest net worth, with an average of $46,133 compared to $58,566 for dairy

and $78,713 for beef cattle farmers.

11. Based on their estimates, beef cattle farmers could borrow an average of $111,980 with an average interest rate of 6.1 compared to cash-crop farmers who could borrow an average of $54,203 with an average interest rate of 6.4 or dairy farmers who could borrow an average of $53,374 with an interest rate of 6.1.

12. One of the most significant differences among the types of farms was in the percentage of net worth they estimated they could borrow. These percentages were: beef cattle farmers--142.3 per cent, cash-crop farmers--117.5 per cent and dairy farmers--91.3 per cent.

Selecting the Best Fitting Equations

Several equations were fitted to the data for the individual type farms and to the data of all farms. First, equations were fitted using the quantity of credit as the dependent variable and the other factors, interest rate, net worth, credit rating, gross farm income, net farm income, size of farm, age, and education, in different combinations as the independent variables. Land contracts were not considered in the first and second fits but were added as one of the independent variables in the equations for the third fit.

The "best" equation was selected from the equations

fitted for each type of farm and for all farms. Things considered in selecting the "best" fit were, (1) the adjusted multiple correlation coefficient and multiple determination coefficient, (2) standard error of estimate, (3) number of variables whose coefficients were significant and level of significance, (4) sign and magnitude of coefficients in relation to theoretical consideration and related facts, (5) simple intercorrelations and (6) the distribution of unexplained residuals.

The best fitting equation for cash-crop farms was quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3), gross farm income (X_4), land contract (X_9)]

with the following results:

$$Y = -38{,}796.51 + 4{,}716.54X_1 + .23X_2 + 9{,}319.39X_3 + 1.22X_4 + .31X_9$$
$$(1{,}136.97)^{***}\quad (.07)^{**}\quad (1{,}669.56)^{***}\quad (.29)^{***}\quad (.05)^{***}$$

$\bar{R} = .82$, $\bar{R}^2 = .67$, standard error of estimate $12,685

The best fitting equation for dairy farms was quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), gross farm income (X_4), age (X_7), education (X_8), land contract (X_9)]

with the following results:

$$Y = 15{,}288.64 + 6{,}836.42X_1 + .79X_2 - .14X_4 - 265.18X_7$$
$$(2{,}033.89)^{**}\quad (.04)^{***}\quad (.28)\quad (101.87)^{**}$$

$$+ 4{,}436.02X_8 + .37X_9$$
$$(502.96)^{***} \quad (.10)^{***}$$

$\bar{R} = .93$, $\bar{R}^2 = .86$, standard error of estimate \$11,876

The best fitting equation for beef cattle farms was quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3), net farm income (X_5), land contract (X_9)]

with the following results:

$$Y = -121{,}550.88 + 16{,}747.32X_1 + .84X_2 + 13{,}713.64X_3 +$$
$$(3{,}997.29)^{***} \quad (.05)^{***} \quad (4{,}835.85)^{**}$$
$$.007X_5 + .29X_9$$
$$(.43) \quad (.06)^{***}$$

$\bar{R} = .89$, $\bar{R}^2 = .79$, standard error of estimate \$26,245

The best fitting equation to the data of all farms was quantity of credit (Y) = f [interest rate (X_1), net worth (X_2), credit rating (X_3), gross farm income (X_4), land contract (X_9), cash-crop farm (X_{10}), dairy farm (X_{11}), beef cattle farm (X_{12})]

with the following results:

$$Y = -50{,}191.14 + 8{,}310.01X_1 + .75X_2 + 3{,}437.75X_3 + .24X_4$$
$$(1{,}341.05)^{***} \quad (.03)^{***} \quad (1{,}467.60)^{*} \quad (.07)^{*}$$
$$+ .29X_9 - 3{,}757.72X_{10} - 10{,}999.35X_{11} + 13{,}821.12X_{12}$$
$$(.03)^{***} \quad \text{NC} \quad \text{NC} \quad \text{NC}$$

$\bar{R} = .91$, $\bar{R}^2 = .82$, standard error of estimate \$20,139.

Summary of Factors Affecting Quantity of Credit

As previously pointed out the various regression

equations were fitted with quantity of credit as the dependent variable. This was done to derive a best fitting equation for variables affecting quantity of credit.

The basis for specifying the order of importance of these factors were: (1) the number of final best fitting equations which included this factor, (2) the value of the estimated regression coefficient for this factor, (3) the significance level of this factor as determined by the "t" test used and (4) simple correlations with other factors.

The regression equations selected as the best fitting for individual farm types,(i.e., cash-crop, dairy and beef cattle) indicated the following.

1. Net worth was the most important variable for all types of farmers. The respective coefficients of .23, .79 and .84 for cash-crop, dairy and beef cattle farmers indicated that net worth was more important to dairy and beef cattle farmers than to cash-crop farmers. The "t" test of 3.30, 17.87 and 18.80 indicated that net worth significantly affected the quantity of credit for all three types of farmers.

   One of the probable reasons for the low regression coefficient for net worth for cash-crop farmers was the simple correlation of .73 between net worth and gross farm income for these farmers. Part of the effect of net worth was probably reflected in

the coefficient of gross farm income, which was 1.22. On the other hand, part of the effect of gross farm income (coefficient of -.14) was probably reflected in the coefficient of net worth for dairy farmers. The simple correlation between these two factors for dairy farmers was .71. By the same reasoning, part of the effect of net farm income (coefficient of .007) was probably reflected in the coefficient of net worth for beef cattle farmers although the simple correlation between net worth and net farm income was only .25 for beef cattle farms.

2. Interest rate was second in order of importance as rated on the above basis. The respective "t" test of 4.15, 3.36 and 4.19 for the coefficients of this factor for cash-crop, dairy and beef cattle farmers indicated it was highly significant for all three types of farmers. The coefficients 4,716.54, 6,836.42 and 16,747.32, respectively, for cash-crop, dairy and beef cattle farmers indicated that interest rate has a greater affect on the availability of credit for beef cattle farmers than for either dairy or cash-crop farmers.

There were not any other independent variables highly correlated with interest rate. Land contracts had the highest correlation with -.36, -.31

and -.38 for cash-crop, dairy and beef cattle farmers, respectively.

3. Land contracts or the availability of land contracts rated a very close third in importance. This factor was highly significant as indicated by "t" tests of 6.32, 3.57 and 4.69 for cash-crop, dairy and beef cattle farmers. There was not much difference in the coefficients for the different type farms which were .31 for cash-crop, .37 for dairy and .29 for beef cattle farmers.

   The simple correlation of .49 between net farm income and land contracts for beef cattle farmers indicated a possibility that the regression coefficient for land contract did reflect some of the effects of net farm income, (whose coefficient was .007).

4. Credit rating was included in the best fitting equations for cash-crop and beef cattle farmers. It was significant in both of these equations with "t" test of 5.58 for cash-crop and 2.84 for beef cattle farmers. The respective values of the coefficients of 9,319.39 and 13,713.64 indicated that credit rating had greater influence on the estimated quantity of credit for beef cattle farmers than for cash-crop farmers.

   There was not much indication that the values of

these coefficients were affected by other factors. There were not any very high simple correlations between credit rating and other factors. The highest were .40 and .39 with gross farm income for beef cattle and cash-crop farmers respectively.

After these four factors determining the degree of importance becomes more difficult; therefore, the other factors will not be assigned an order of importance.

Gross farm income was included in two of the final equations, cash-crop and dairy cattle. Its regression coefficient was highly significant for cash-crop farmers ("t" test of 4.19) but was not significant for dairy farmers ("t" test .51). As pointed out above this factor was highly correlated with net worth. Probably the regression coefficient of 1.22 for cash-crop farmers and -.14 for dairy farmers reflected some effects of net worth.

Net farm income, age, and education were the other variables included in at least one final equation. Each was included in only one final equation. Net farm income was in the final equation for beef cattle with a coefficient of .007 and a "t" test of .02. It is readily apparent that it was not statistically significant. The effects of this factor were probably reflected in the coefficients of land contracts (intercorrelation .49) or net worth (intercorrelation of .25).

Age and education were included in the final equation for dairy farmers. Both of these factors were significant as

indicated by "t" test of 2.60 for age and 8.82 for education. The value of their coefficients indicated education had a greater effect on quantity of credit than age. These values were -265.18 for age and -4,436.02 for education. As pointed out in the discussion of the acceptability of this equation, the negative sign for education seems to be contrary to logic. Though the simple correlations between either of these factors and other factors were not large (the highest was a -.32 between age and education), the regression coefficient for education may reflect some of the negative effects of age.

Summary of Factors Affecting Interest Rate

This summary of factors affecting the interest rate is based on equations which treat interest rate as a function of a list of independent variables. The list of variables was secured from the best fitting regression equations treating quantity of credit as the dependent variable. Therefore, some variables which might have had statistically significant effects on interest rate could have been eliminated during the process of revising the equations. The variables considered were: quantity of credit, net worth, credit rating, land contracts, gross farm income, net farm income, age and education.

When the regression equations were fitted with interest rate as the dependent variable, the results indicated that all the factors did not significantly affect interest rate.

For example: The regression coefficients for age, education, net farm income and gross farm income indicated these factors had very little effect on interest rate. Quantity of credit, net worth and availability of land contracts were the factors that had significant effects on interest rate for all farms. Credit rating had a statistically significant effect on interest rate for cash-crop farmers but not for beef cattle farmers.

Quantity of credit seemed to have the greatest effect of all the factors considered. This factor had a greater effect on the interest rate for cash-crop farmers than for either dairy or for beef cattle farmers. It had a lesser effect upon beef cattle farmers than for dairy farmers. These effects are indicated by their respective marginal factor cost functions.

Marginal Factor Cost Functions

A marginal factor cost schedule of credit was derived for each type of farm in Chapter II by varying the quantity of credit and using mean values[1] (for the individual type of farm) of the other variables in the equation. The equations for marginal factor cost were used in computing these schedules were $MFC = a + 2b_1Q + \sum_{i=2}^{d} b_i X_i$ or $a + 3b_1Q^2 + \sum_{i=2}^{d} b_i X_i$ depending upon type of function fitted.

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[1]For mean values see Appendix B, Table 1.

The marginal factor cost function for cash-crop farmers was $MFC = 8.05 + (3)\ .00000000023X_1^2 - .000018X_2 - .54X_3 + .000023X_4 - .000025X_9$ (X_1 = quantity of credit).

The marginal factor cost function for dairy farmers was $MFC = 5.41 + (2)\ .000010X_1 - .0000086X_2 + .00000012X_4 + .0015X_7 - .000017X_9$ (X_1 = Q - quantity of credit).

The marginal factor cost function for beef cattle farmers was $MFC = 5.86 + (2)\ .000058X_1 - .0000031X_2 - .081X_3 - .0000063X_5 - .0000065X_9$ (X_1 = Q = quantity of credit).

These marginal cost functions were plotted on one chart, Figure 6, to get a better comparison of the functions for the different type farms. It is readily apparent that the average dairy farmer studied thought he had to pay higher interest rates for quantities of credit up to $35,000 than either the average cash-crop or beef cattle farmer. On the other hand, the average beef cattle farmer studied estimated he could get credit at a lower rate of interest than the other two types of farmers after a small quantity has been secured. This may be due to several reasons. (1) The average cattle farmer as pointed out before had a much larger gross farm income than the average dairy or cash-crop farmer studied. (2) Feeder cattle offer a fairly risk free enterprise from the lender's viewpoint. (3) Beef cattle farmers were better credit risk men. A high percentage of the beef cattle farmers had an "excellent" (the highest) credit rating.

Cash-crop farmers estimated they had to pay the same

interest rate as beef cattle farmers up to a quantity of about $20,000. Thereafter the cash-crop farmer's interest rate increased faster than either dairy or beef cattle farmers. This may be due to several reasons. (1) The curvilinear function used permitted the interest rate to increase much faster than a straight line function. (2) Type of assets owned by the cash-crop farmers were different from those owned by other type farmers. A fairly high percentage of the net worth of cash-crop farmers is in the form of machinery and equipment which is not considered as good for security as dairy cows or beef cattle. (3) A greater fluctuation in gross and net farm income for cash-crop farmers as compared to dairy or beef cattle farmers.

These marginal cost functions are reliable only for the range of data for the respective types of farms. The range of data for quantity of credit was up to $115,000 for cash-crop farmers, $156,500 for dairy farmers and $239,500 for beef cattle farmers. Although the range of data for cash-crop was up to $115,000, the curvilinear function is probably unreliable for this amount. The interest rate begins to increase very rapidly after about $50,000 -- probably too fast, even though this function fitted the data better than a linear function over most of the relevant range.

Quantity of credit to be borrowed had the greatest effect upon the interest rate of all the variables considered for all the individual type farms and for all farms combined.

Quantity of credit had a greater effect on the marginal factor cost of credit for cash-crop farmers than either dairy or beef cattle farmers. Net worth and availability of land contracts are the only other variables affecting the interest rate to any significant degree. The regression coefficients for these factors indicated they also affected the cash-crop farmers more than either dairy or beef cattle farmers.

After the marginal factor cost functions for credit were obtained as discussed above another set was derived by using the grand means[2] (mean of data for all farms) of the other variables instead of the means for each type of farm. The functions eliminate differences among types of farms due to different values of the independent variables. These functions were computed and are illustrated in Figure 7. As it can be readily seen there were not any significant differences in the marginal factor cost functions at the higher quantities of credit when computed using the type of farm means for the variables, net worth, credit rating, net farm income, etc., than when computed using the grand mean of these variables.

At the lower quantities (actually the more meaningful quantities) of credit there were some differences. For example, from Figure 7 where marginal factor cost functions were computed with the grand mean values, a loan of $25,000 would cost all types of farmers an interest rate of

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[2]For grand means see Appendix B, Table 1.

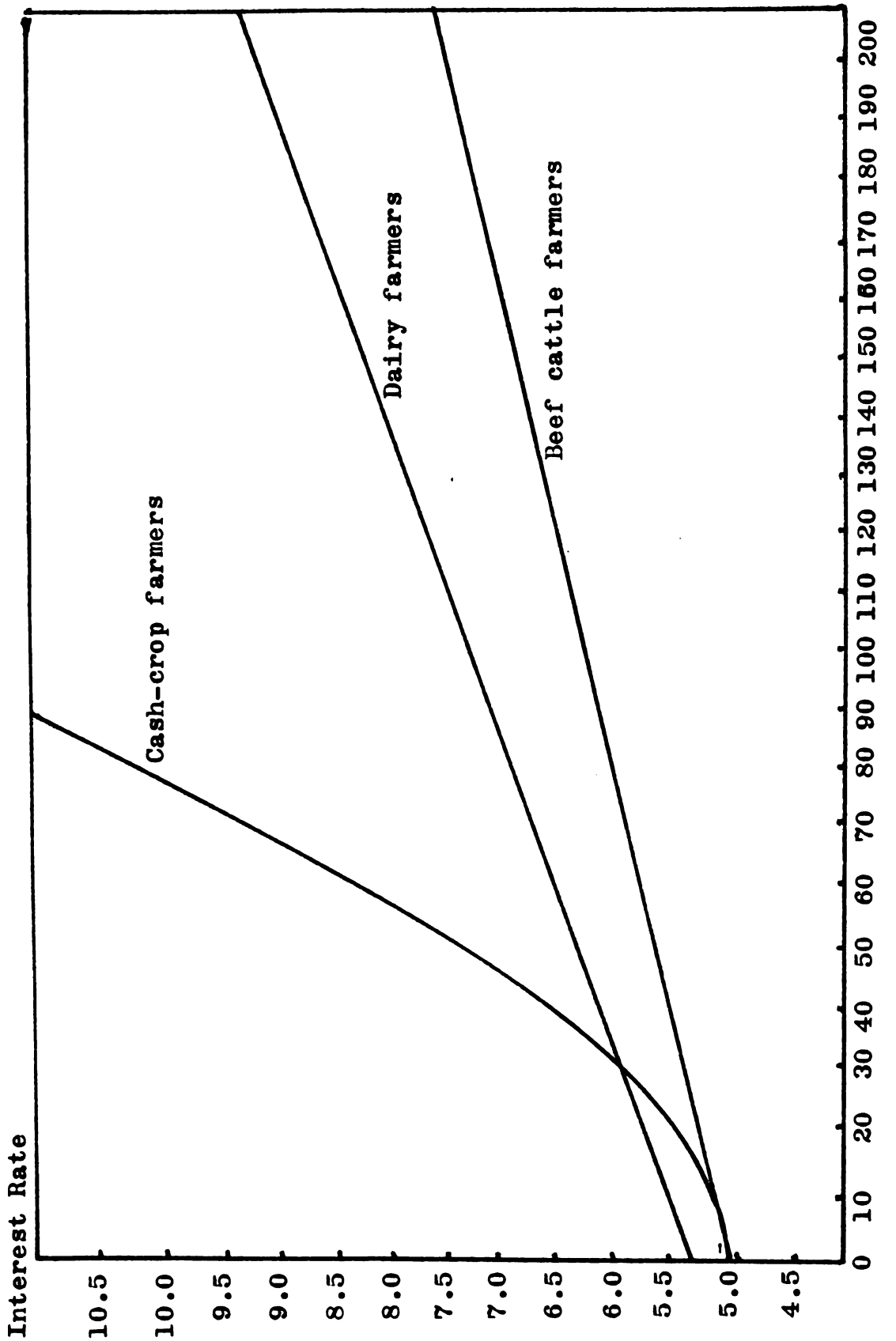


Figure 6. Marginal factor cost functions for cash-crop, dairy and beef cattle farmers, derived from data for individual type farms.

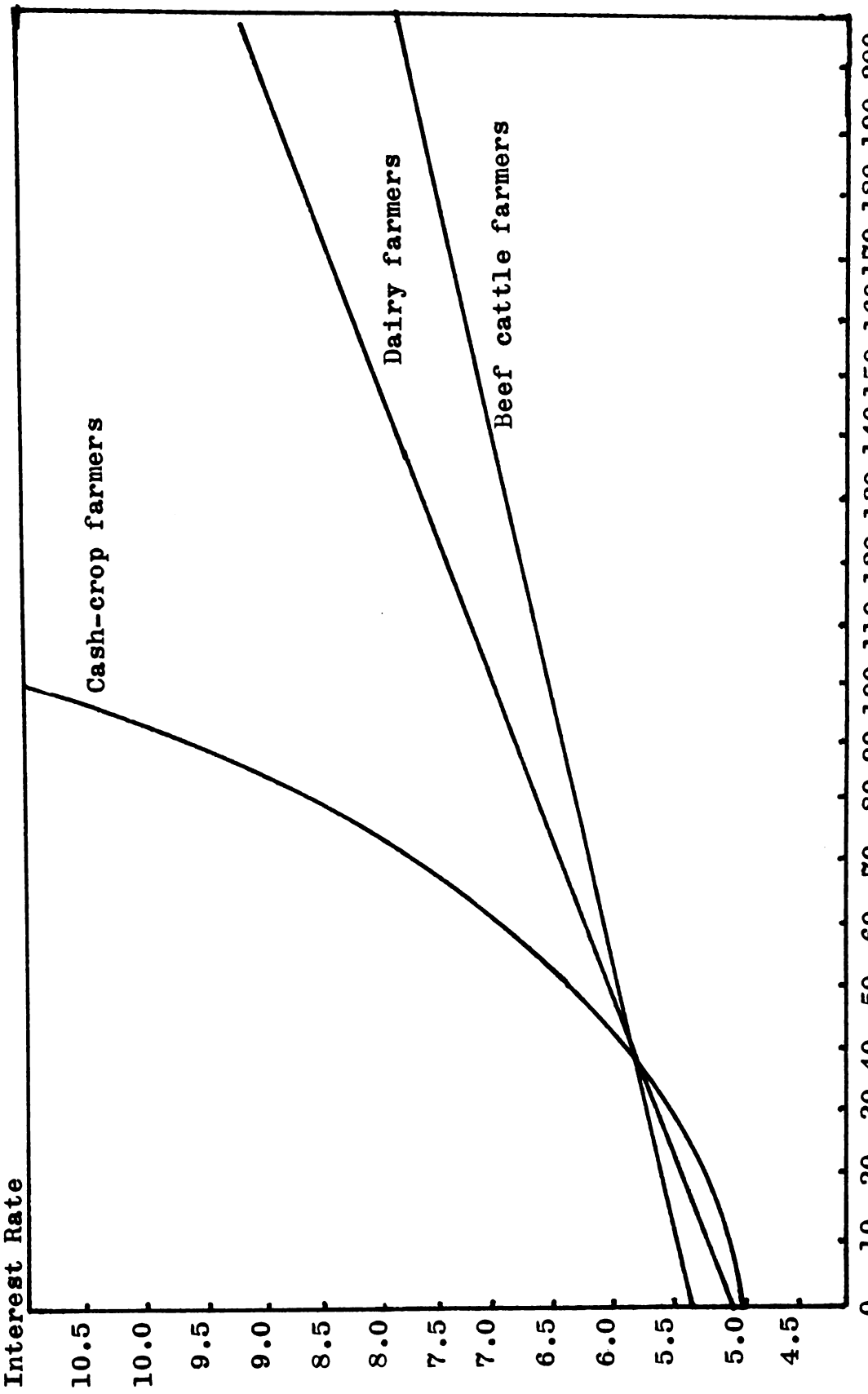


Figure 7. Marginal factor cost functions for cash-crop, dairy and beef cattle farmers, derived from data for individual type farms using grand mean values.

approximately 5.5 per cent. Whereas, the marginal factor cost functions of Figure 6 indicate a loan of $25,000 would cost cash-crop farmers 5.5 per cent, dairy farmers 5.8 per cent and beef cattle farmers 5.4 per cent. By using the grand means, the beef cattle farmers' interest rates were decreased and dairy farmers' interest rates were increased. The marginal factor cost curves that would best represent the average cash-crop, dairy or beef cattle farm studied are in Figure 6 where the means of each particular farm type were used. The mathematical marginal factor cost functions can be used with individual quantities for the variables, net worth, gross farm income, etc., to fit a particular farm, to compute either the quantity of credit forthcoming at a certain price or the interest rate payable for a certain quantity of credit.

One other marginal factor cost function was computed. This was from the data for all farms to obtain a general function with the types of farm included as independent variables. The marginal factor cost function based on the data for all farms was $MFC = 6.64 + (2)\ .0000090X_1 - .0000063X_2 - .27X_3 - .00000014X_4 - .0000098X_9 + .070X_{10} + .0079X_{11} - .071X_{12}$. ($X_1$ = Q = quantity of credit). The marginal factor cost schedules were computed by varying the quantity of credit (X_1), using the grand means for X_2 through X_9 while using $X_{10} = 1$; $X_{11} = 0$; $X_{12} = 0$ for cash-crop farmers, $X_{10} = 0$; $X_{11} = 1$; $X_{12} = 0$ for dairy farmers and $X_{10} = 0$; $X_{11} = 0$; $X_{12} = 1$ for beef cattle farmers. These

were computed and are illustrated in Figure 5, Chapter III. Based on these results as indicated by Figure 5, there was only a small degree of difference in the marginal factor cost function for the three different types of farmers. For example, for a $15,000 loan the cash-crop farmer's cost would be 5.5 per cent, dairy farmer's cost 5.4 per cent and 5.3 per cent for beef cattle farmers. Of course, the biggest objection to the use of this function to represent a particular type of farm is that this difference of approximately .1 per cent remains constant throughout the function. This is very different to what was indicated by the marginal factor cost functions for the particular types of farms, Figure 6 and Figure 7. Therefore, this function would not be useful to represent the individual types of farms.

Based on the various marginal factor cost functions computed and schedules plotted the marginal factor cost functions of credit computed by using individual type farm data and mean values for the particular type farm represent the cash-crop farmer's, dairy farmer's and beef cattle farmer's marginal factor cost functions of credit better than any other function computed. These marginal factor cost schedules are illustrated in Figure 6.

Possible Implications of Results

As pointed out in the introduction, this study was not designed as a problem solving type study but as a descriptive study. The primary objective was to derive and describe the

marginal factor cost function for credit for Michigan's cash-crop, dairy and beef cattle farmers. Though the results do not solve any problem there are several areas in which they may be used. The two primary uses of the results are in the areas of:

1. (a) Research work, especially in budgeting and programming where the quantity of credit available to a farmer to carry out certain projects or adjustments on the farm is required.

   (b) Supply response work where there is a need to know the quantity of credit farmers think they have available to use in estimating their production of farm commodities.

2. Extension work with farmers in the field of credit.

There have been numerous studies made in the past, a few of these were mentioned briefly in the introduction, which have required some kind of estimate as to the quantity of credit available to a farm or a farmer under a specified set of circumstances. In the past, almost all of the researchers carrying out these types of studies had to assume a set of rules or guides which would determine the quantity of credit available to the farm or farmer. The mathematical marginal factor cost functions derived in this study can be used to estimate the quantity of credit available, with the researcher having to estimate or know only the interest rate the farmer

can pay or is willing to pay for credit. The value of the other variables such as net worth, gross farm income, net farm income, etc., will probably be known by the researcher. If not, then the marginal factor cost function with the mean of the particular type farm that he is working with can be used to estimate the quantity of credit such a farm could regard as available on the capital market.

These results can be used by extension economists working with farmers in the field of credit. For example, it could be pointed out that farmers think credit is available at a cheaper rate for use in dairying than for use in cash-crop farming or at an even cheaper rate for use in buying feeder cattle and feeding them out to market weights. Also that it might be easier for the cash-crop farmer to expand by adding livestock to his program rather than expanding through more acres of cash-crops based on the cost of credit available for these additional enterprises. The variables used in making estimates have to be adjusted to fit a particular farmer; even then the functions should not be expected to estimate the exact amount of credit a farmer could borrow on the capital market. In addition to substantial standard errors of estimate, it must be stressed that the estimate is of what farmers think they can borrow not of what they can actually borrow. These marginal factor cost functions should serve, however, as broad outlines as to the quantity of credit a particular type farmer or a particular farmer can borrow.

The results of this study should benefit extension economists by giving them a clearer picture of the credit market the different types of farmers think they face. The knowledge of the type of marginal factor cost function the different types of farmers think they face should be of use to extension personnel working in the field of farm credit. These functions can be applied to the situation of a beginning farmer or a person wanting to start farming (with modifications) to get an estimate of the quantity of credit he could borrow to commence farming based on his present thinking, net worth, credit rating, estimated gross farm income and other factors.

Another important way these results can be used by extension economists is to give farmers an indication of the importance of their credit rating. The results of this study indicated that a farmer's credit rating is very important not only in aiding the farmer in getting a loan but also in determining the size of that loan. Based on the estimated coefficients of $9,319.39 for cash-crop farmers and $13,713.64 for beef cattle farmers, the value of the farmer's credit rating is very high. These coefficients indicate that as a farmer's credit rating changes from one classification to another, i.e., from "fair" to "good" or from "good" to "excellent", it increases the quantity of credit available by approximately $10,000. This information should be very useful in stressing to farmers the

importance of keeping an unblemished credit rating.

Some secondary uses of these marginal factor cost functions might be:

1. In the teaching field

2. As an aid to the various lending agencies.

These marginal factor cost functions and the method used to derive them could be used in the classroom to illustrate how marginal factor cost functions can be derived from farm data and also to make realistic comparisons among the three different types of farms.

Various lending agencies probably would be interested in what farmers think concerning the quantity of credit available to them under the present policies of these lending agencies. If these marginal factor cost functions based on farmers' estimates of the quantity of credit available to them varies to a significant degree from what the lenders are willing to loan, this would indicate the farmers are not well informed as to the policies of the lending agencies. Of course these functions include farmers' estimates of the value of land contracts available to them on a credit basis over which established lending agencies have little control; therefore, these would not be expected to coincide too closely with marginal factor cost functions derived from the lender's viewpoint.

Another study of marginal factor cost functions for credit, with the data collected from lending agencies might

be worthwhile. As mentioned above some allowances would have to be made for land contracts and other sources that are not controlled by the regular established lending agencies. A study of this kind should be valuable for two reasons:

1. The marginal factor cost function derived from the lender's viewpoint would serve as a check on the functions derived in this study.
2. If there was much difference in the two methods, this would indicate that farmers are not well informed concerning their credit possibilities and that more information should be extended to farmers, through the various organizations, on the policies of the different lending agencies.

Other studies should give more attention to different kinds of collateral (closely related to net worth). At least three categories of collateral are important, (1) land and buildings, (2) livestock (dairy cows, feeder cattle, etc.), and (3) machinery and equipment. It is likely that these could be used in a general marginal factor cost function for a combination of different types of farms, probably without a type of farm variable, to produce improved results for individual type farms.

BIBLIOGRAPHY

BIBLIOGRAPHY

Bell, Sidney C., Financing Dairy Production Adjustments in the Tennessee Valley Area of Alabama, unpublished M.S. Thesis, Auburn University, 1957.

Bolger, Ross, A Partial Evaluation of the Michigan Township Extension Program in Denmark Township Over the Period 1953 to 1958, Using Cobb-Douglas Analysis, unpublished M.S. Thesis, Department of Agricultural Economics, Michigan State University, 1959.

Bradford, Lawrence A. and Johnson, Glenn L., Farm Management Analysis, John Wiley and Sons, New York, 1953.

Brake, John R., Financial Seasonality of Dairy Farming and its Relation to Risk and Uncertainty, unpublished M.S. Thesis, Department of Agricultural Economics, Michigan State University, 1956.

Brake, John R., Prediction of Fertilizer Consumption in Two Regions of the United States, Ph.D. Thesis, North Carolina State College, 1959.

Dvorak, Frank E., Programming the Organization and Capital Use for a Cash-crop Farm in the Saginaw Valley and Thumb Area of Michigan, unpublished M.S. Thesis, Michigan State University, 1959.

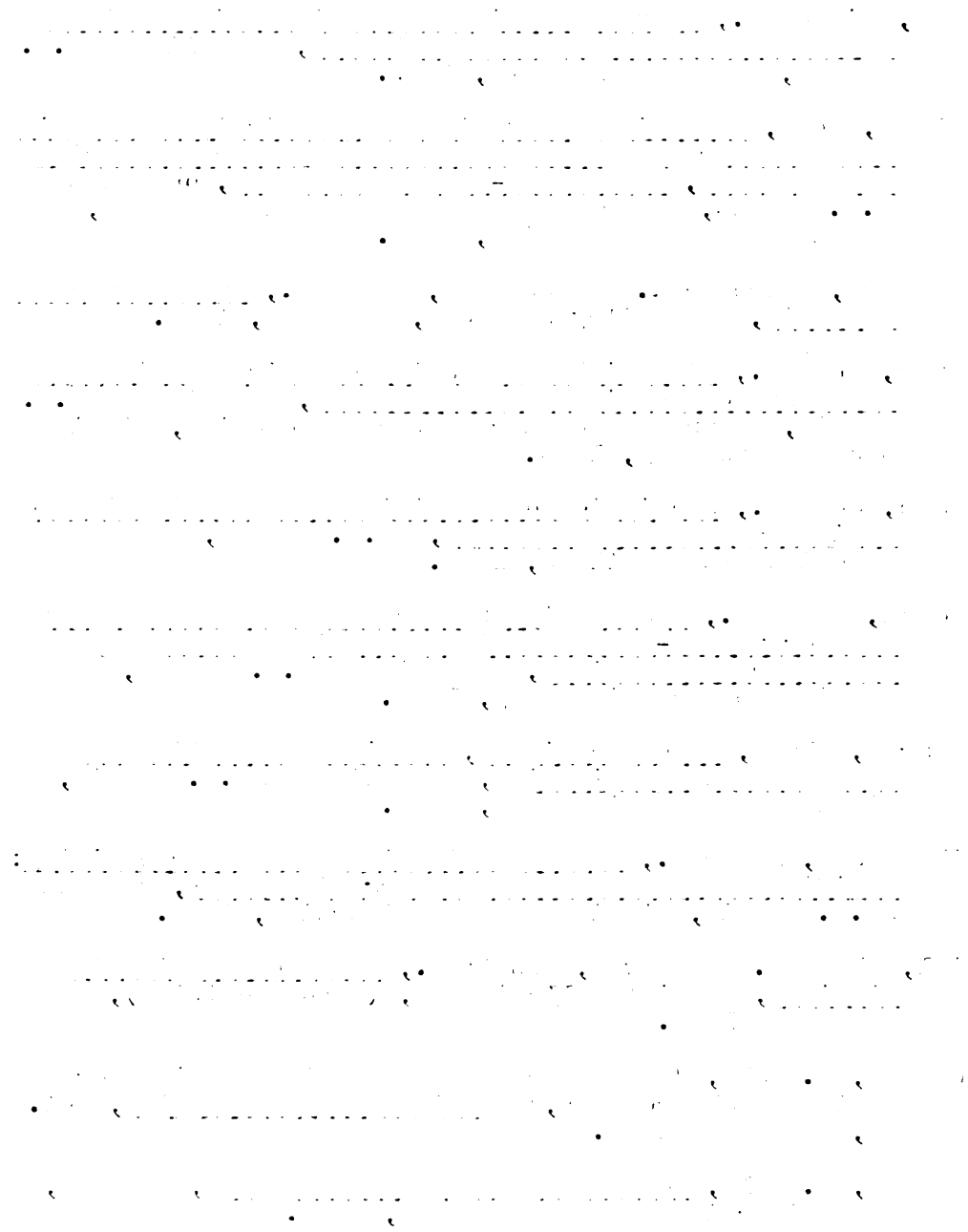
Edwards, Clark, Resource Fixity, Credit Availability and Agricultural Organization, unpublished Ph.D. Thesis, Michigan State University, 1958.

Hildebrand, Peter E., Farm Organization and Resource Fixity: Modification of the Linear Programming Model, unpublished Ph.D. Thesis, Michigan State University, 1959.

Hill, Elton B. and Mawby, Russell G., Types of Farming in Michigan, Special Bulletin 206, (second edition), September 1954.

Johnson, D. Gale, "The Nature of the Supply Function for Agricultural Products," American Economic Review, Vol. 40, September 1950.

Johnson, D. Gale, Forward Prices for Agriculture, Chicago, The University of Chicago Press, 1947.



McKee, Dean E., Economic Appraisal of Adjustments in Dairying in Michigan to Meet Changing Conditions, work in current progress at Michigan State University.

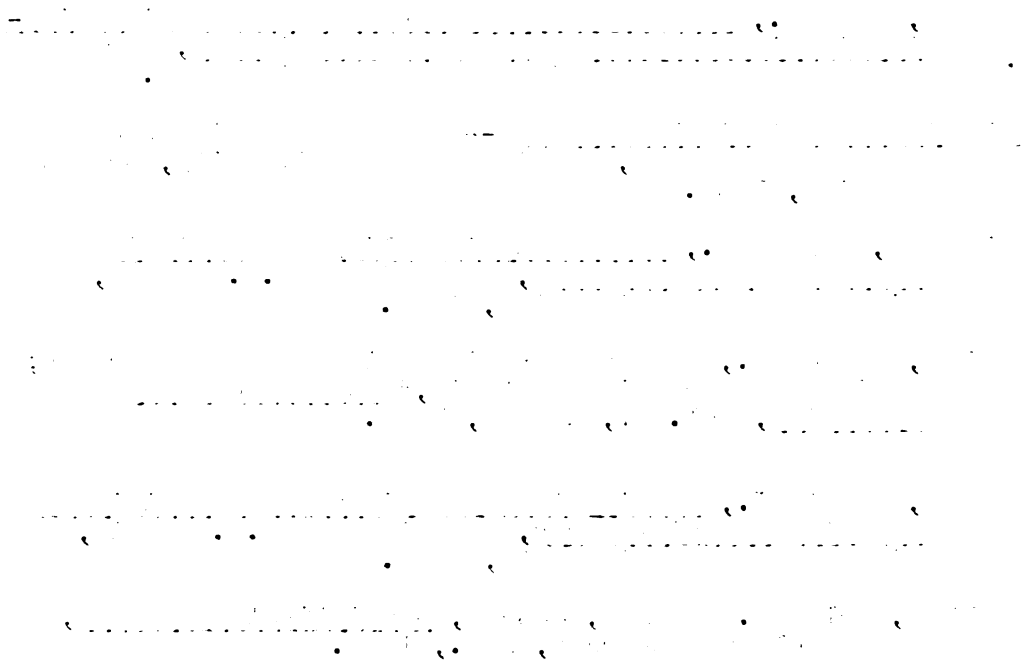
Michigan Statistical Abstract -- Bureau of Business and Economic Research, Michigan State University, Second Edition, 1958.

Pickler, Eugene B., Use and Availability of Credit in Northern Michigan Farms, unpublished M.S. Thesis, Michigan State University, 1959.

Smith, Victor E., "Perfect vs Discontinuous Input Markets; A Linear Programming Analysis," Journal of Farm Economics, Vol. 37, August, 1955.

Trant, Gerald I., Institutional Credit and The Efficiency of Selected Dairy Farms, unpublished Ph.D. Thesis, Michigan State University, 1959.

Walker, Helen M. and Lev, Joseph, Statistical Inference, Henry Holt and Company, Inc., 1953.



APPENDIX

APPENDIX A

Procedure[1] for securing regression coefficients for the three dummy variables in the regression equation fitted to data from all farms. (See pp. 83 to 84). Estimated values for $b_i : i = 1, \ldots, 9$ were secured by the method of least squares; b_{10} and b_{11} were also estimated by least squares with X_{12} omitted. The problem is to obtain b_{12} and to modify the estimates of b_{10} and b_{11} accordingly. The dummy variables in this instance are X_{10}, X_{11}, and X_{12}, which are identified as X_1, X_2 and X_3 in the following:

Type 1 farms (cash-crop farms)

$$Y_1 = B_{01} + \sum_{i=4}^{d} B_i X_i + u_1$$

Type 2 farms (dairy farms)

$$Y_2 = B_{02} + \sum_{i=4}^{d} B_i X_i + u_2$$

Type 3 farms (beef cattle farms)

$$Y_3 = B_{03} + \sum_{i=4}^{d} B_i X_i + u_3$$

For estimating, combine into one equation

$$Y = b_{03} + (B_{01} - B_{03})X_1 + (B_{02} - B_{03})X_2 + \sum_{i=4}^{d} B_i X_i + u$$

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[1]This procedure was formulated by Professor R. L. Gustafson, at the suggestions of John Brake and Glenn L. Johnson, Department of Agricultural Economics, Michigan State University.

where X_1 = 1 if farm is type 1
0 otherwise

X_2 = 1 if farm is type 2
0 otherwise

Estimate of $B_{03} = b_0$	Estimate of $B_{03} = b_0$
" " $(B_{01} - B_{03}) = b_1$	" " $B_{01} = b_0 + b_1$
" " $(B_{02} - B_{03}) = b_2$	" " $B_{02} = b_0 + b_2$

Define a new parameter, namely

$$B_0^* = \frac{N_1 B_{01} + N_2 B_{02} + N_3 B_{03}}{N} \qquad (N_1 + N_2 + N_3 = N)$$

$$\text{Estimate of } B_0^* = \frac{N_1(\text{Est. } B_{01}) + N_2(\text{Est. } B_{02}) + N_3(\text{Est. } B_{03})}{N}$$

$$= \frac{N_1(b_0 + b_1) + N_2(b_0 + b_2) + N_3 b_0}{N}$$

$$= \frac{(N_1 + N_2 + N_3)b_0 + N_1 b_1 + N_2 b_2}{N}$$

$$= b_0 + \frac{N_1}{N} b_1 + \frac{N_2}{N} b_2$$

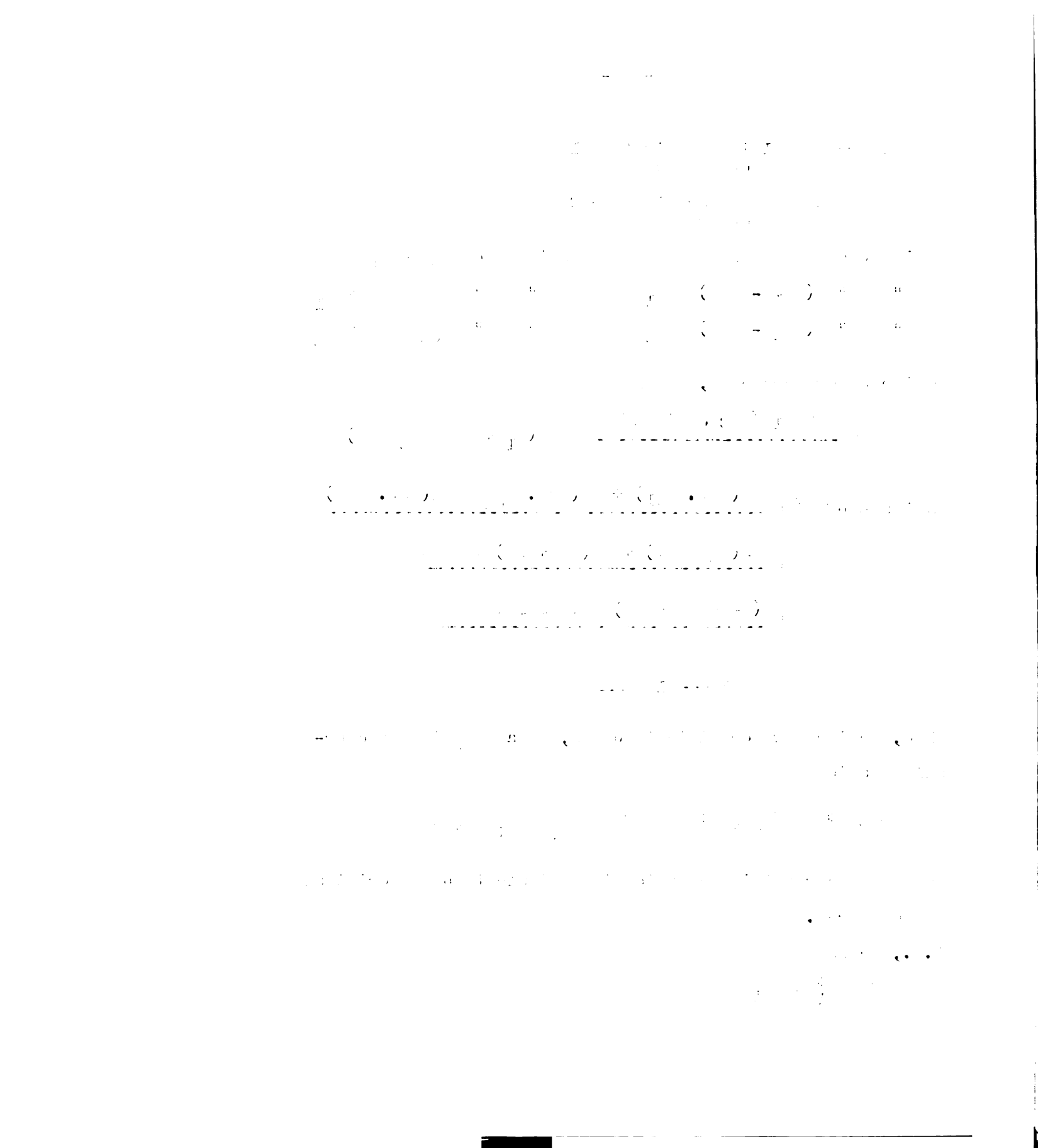
Also, define new coefficients of X_1, X_2 and X_3 in the overall equation

$$Y = B_0^* + B_1^* X_1 + B_2^* X_2 + B_3^* X_3 + \sum_{i=4}^{d} B_i X_4 + u$$

so that the resulting equation is equivalent to the original set of three.

i.e., we want

$$B_0^* + B_1^* = B_{01}$$



$$B_0^* + B_2^* = B_{02}$$

$$B_0^* + B_3^* = B_{03}$$

From this, we have

$$\text{Estimate of } B_1^* = \text{est. } B_{01} - \text{est. } B_0^*$$

$$= b_0 + b_1 - (b_0 + \frac{N_1}{N} b_1 + \frac{N_2}{N} b_2)$$

$$= (1 - \frac{N_1}{N}) b_1 - \frac{N_2}{N} b_2$$

$$\text{Estimate of } B_2^* = \text{est. } B_{02} - \text{est. } B_0^*$$

$$= b_0 + b_2 - (b_0 + \frac{N_1}{N} b_1 + \frac{N_2}{N} b_2)$$

$$= - \frac{N_1}{N} b_1 + (1 - \frac{N_2}{N}) b_2$$

$$\text{Estimate of } B_3^* = \text{est. } B_{03} - \text{est. } B_0^*$$

$$= b_0 - (b_0 + \frac{N_1}{N} b_1 + \frac{N_2}{N} b_2)$$

$$= - \frac{N_1}{N} b_1 - \frac{N_2}{N} b_2$$

b_0 = computed a in original equation

b_1 = computed coefficient of X_1 in original equation

b_2 = computed coefficient of X_2 in original equation

B_0^* = derived a value

B_1^* = modified coefficient of X_1

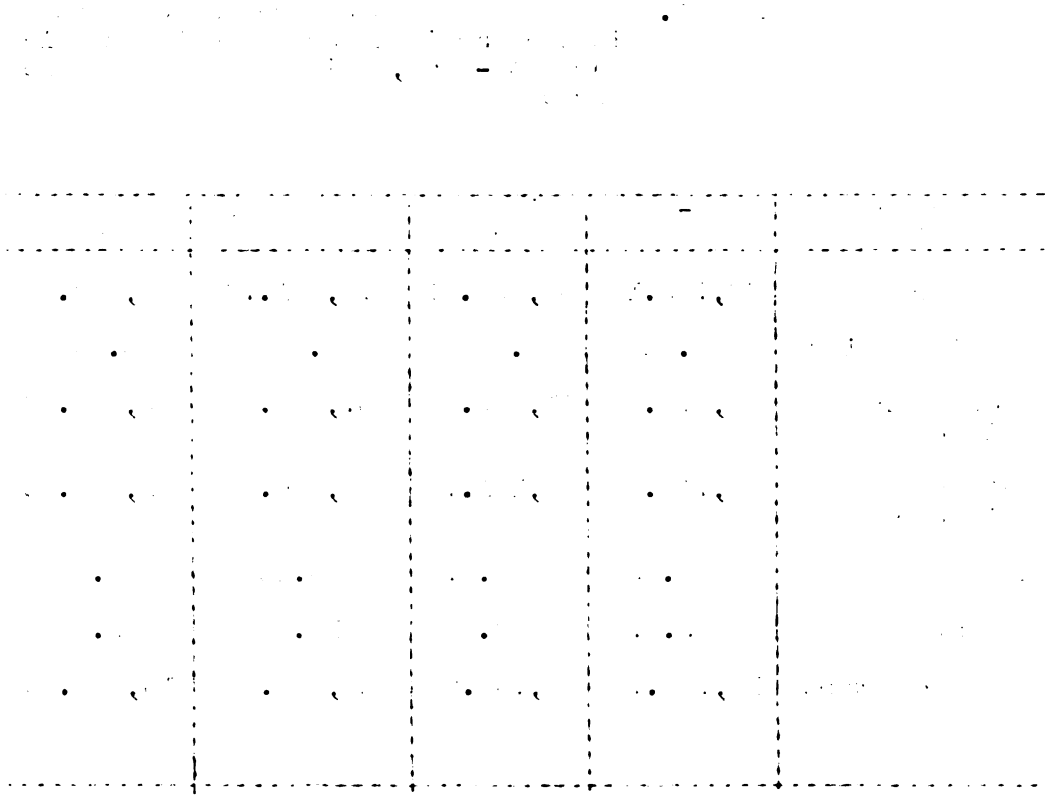
B_2^* = modified coefficient of X_2

B_3^* = derived coefficient of X_3

APPENDIX B

APPENDIX TABLE 1. The Mean Values of the Factors Used in the Marginal Factor Cost Schedules for Cash-crop, Dairy and Beef Cattle Farmers

Independent Variable	Cash-crop farms	Dairy farms	Beef Cattle farms	Grand mean
Net Worth	46,759.18	58,592.01	79,661.76	62,220.06
Credit rating	3.42	3.50	3.81	3.59
Gross farm income	9,278.48	11,959.46	37,922.36	20,208.58
Net farm income	2,713.92	4,161.74	5,380.61	2,844.02
Age	43.99	46.87	46.12	45.69
Education	9.37	9.48	10.56	9.82
Land contracts	18,746.75	4,795.03	26,088.24	16,688.66



APPENDIX C

CONFIDENTIAL

Schedule No. _____

Telephone No. _____

Name _____

Address _____

1. Farm Size

	Owned	Rented	Total
Tillable			
Non-tillable open			
Woodland and other			
Total			

Tillable acreage leased out _____ Net tillable acres _____

2. How many years have you operated a farm? _____ years.

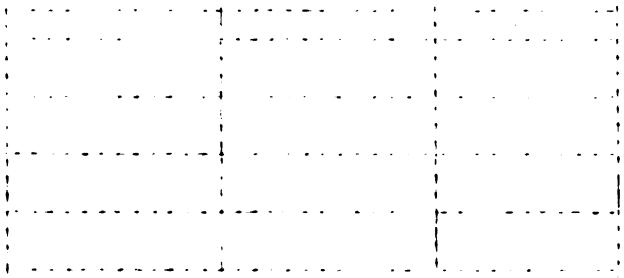
3. Family Characteristics

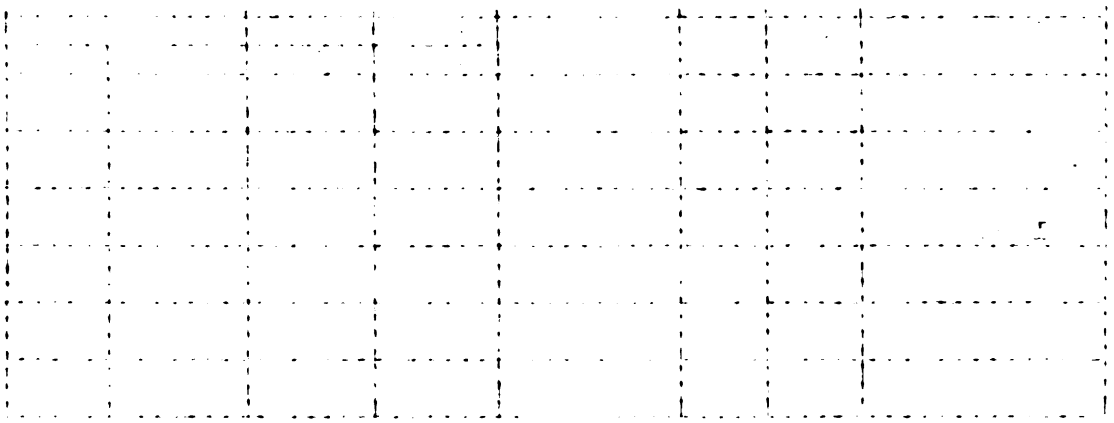
Family member	Age	Sex	Education grade	Months worked		Off farm Work	
				months	value	months	Value
Husband							
Wife							
Children							

Value of farm labor other than operators _____

4. Did you and your family have any income last year from non-farm source such as: Sale of products from land rented out, cash rent, boarders, old age assistance, pensions, veteran's allowances, unemployment compensation, interest, dividends, or help from non-resident members of the family?

Yes _____ No _____ Total annual amount _____





5. To determine your estimated farm income

a. CASH FARM RECEIPTS	1958 Price	1958 Value	1959 Price	1959 Value
Cattle: Dairy (culls, calves, breeding stock, etc.)				
Beef				
Swine				
Poultry				
Sheep, wool and wool payments				
Other livestock				
Dairy products				
Eggs				
Other produce raised:				
Grain, hay, other crops				
Fruits and vegetables				
Forest products				
Soy beans, beans, etc.				
Machine work off farm				
Agricultural payments				
Machinery Sales				
Other cash farm receipts				
Total cash farm receipts				

(To enumerater: get totals only if you cannot get individual items for each year.)

b. CASH EXPENSES:	1958 Price	1958 Value	1959 Price	1959 Value
Hired labor				
Feed purchased				
Seeds, plants, spray materials				
Machine hire				
Supplies purchased				
Repair and Maintenance:				
Machinery (overhauls, tires, etc.)				
Improvements				
Livestock expense except poultry				
Poultry purchased				
Fertilizer including lime				
Gasoline, fuel oil, grease				
Taxes on farm property				
Insurance on farm property				
Electricity and phone (farm share)				
Other cash farm expenses				
Capital investments:				
Dairy cattle purchased				
Beef cattle purchased				
Hogs purchased				
Sheep purchased				
Other livestock purchased				
Machinery purchased				
Farm improvement pur.				
Total Cash Farm Expenses				
Interest and debt payments				
Rent				
Totals				

c. FARM EARNINGS SUMMARY (to be completed in office)

	1958	1959
Cash farm receipts	_____	_____
Less cash farm expenses	_____	_____
Net cash farm income	_____	_____
Net inventory change (plus or minus)	_____	_____
Net farm family income	_____	_____
Less family labor (other than operators)	_____	_____
NET FARM INCOME	_____	_____

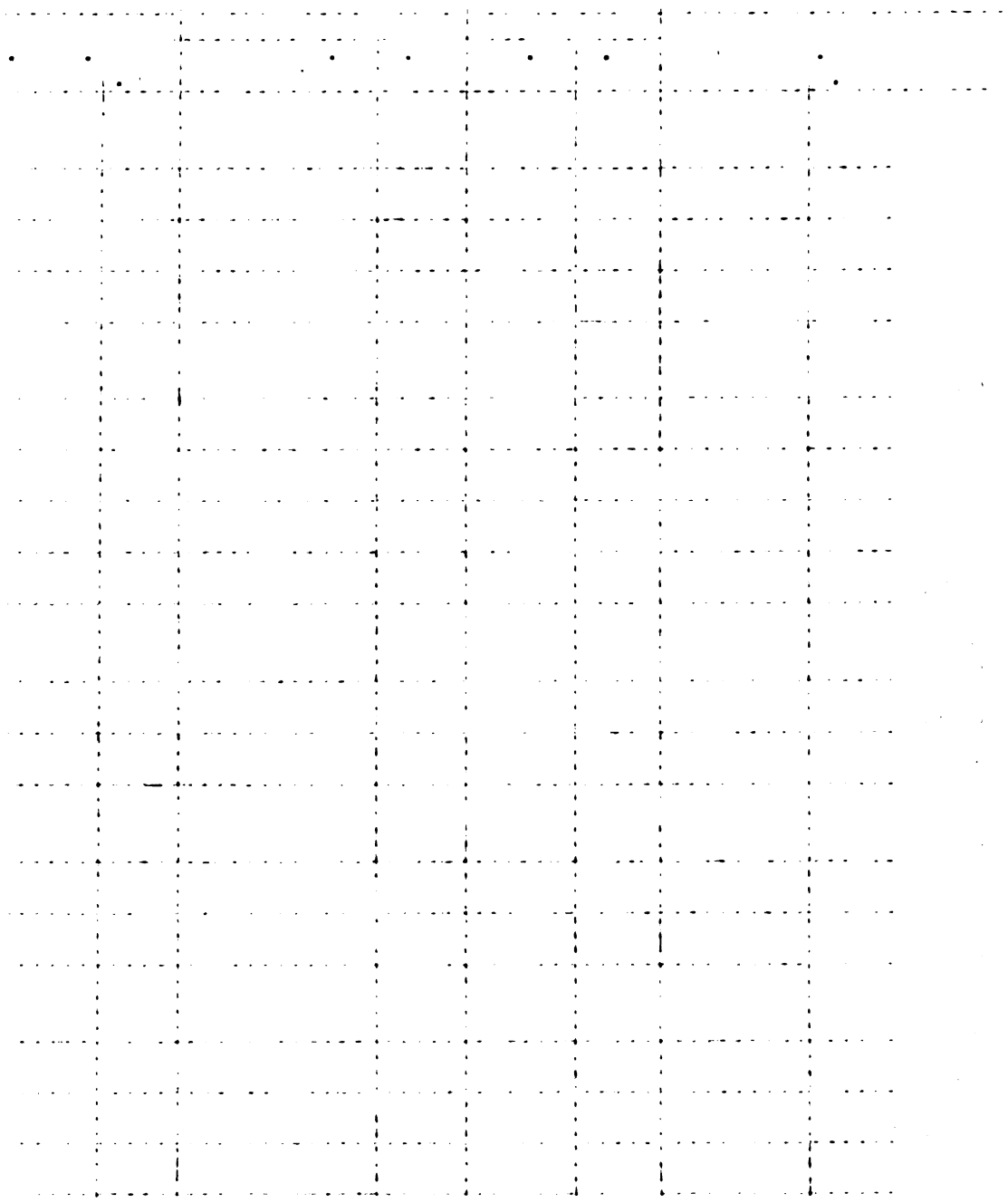
6. Inventory information

		Increase	Decrease
Livestock (all livestock, dairy and beef cattle, swine, etc. page 5 & 6)	1958	_____	_____
	1959	_____	_____
Machinery equipment (page 8)	1958	_____	_____
	1959	_____	_____
Feed, seed and fertilizer	1958	_____	_____
	1959	_____	_____
Totals		_____	_____
Net	1958	_____	_____
	1959	_____	_____

7. Livestock Inventory 1959

Kind	Beg. Inventory No.	Beg. Inventory Value	Add: No. born	Add: No. bought	Subtract: No. Sold	Subtract: No. butchered or died	End. Inv. No.	End. Inv. Value
DAIRY								
Cows								
Heifers								
Calves								
Bulls								
BEEF								
Cows								
Heifers								
Feeders								
Calves								
Bulls								
HOGS								
Sows								
Boars								
Pigs								
SHEEP								
Ewes								
Rams								
Lambs								
POULTRY								
Hens								
Roosters								
Broilers								
Totals								

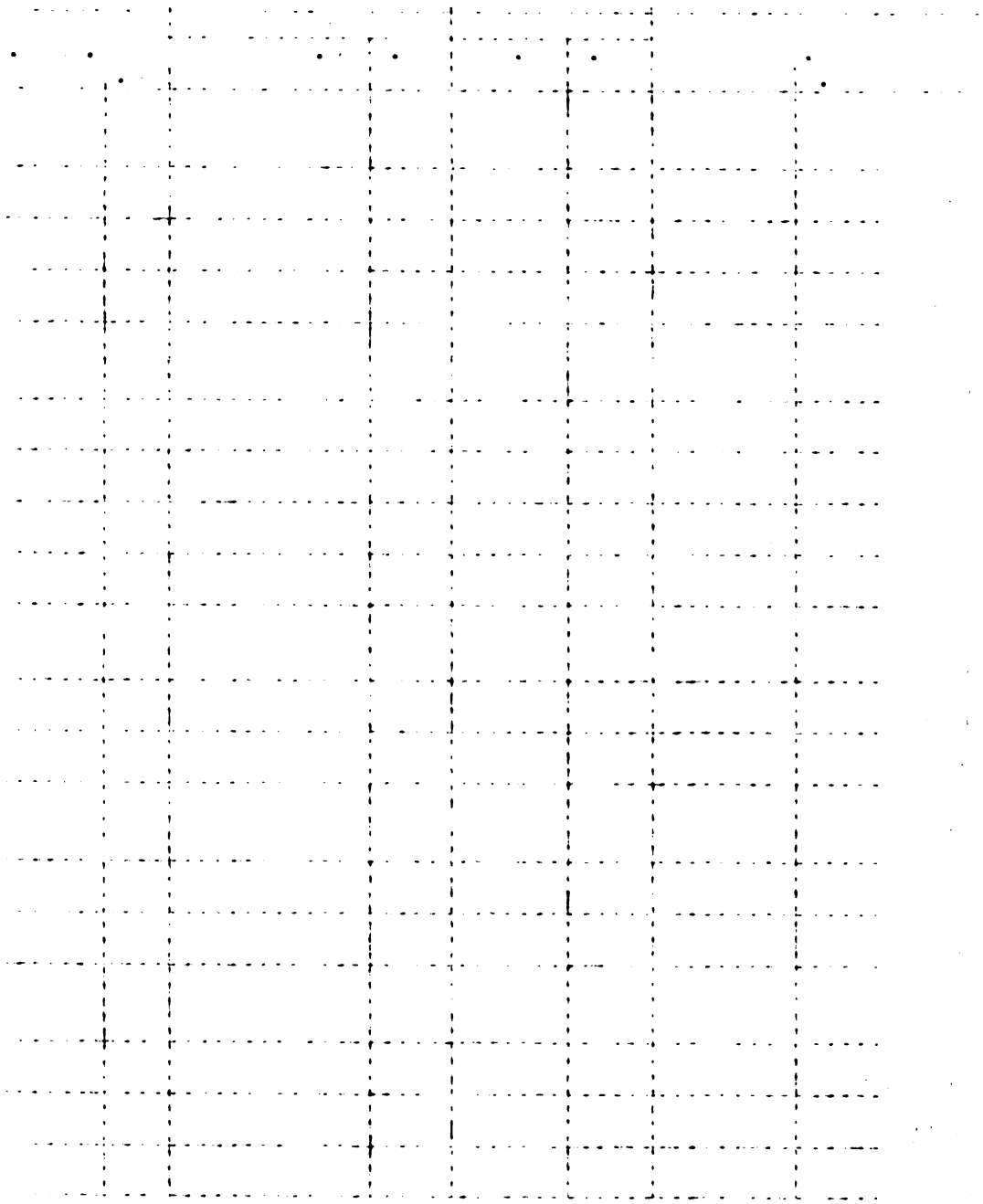
Inventory Increase _____ or Decrease _____



8. Livestock Inventory 1958

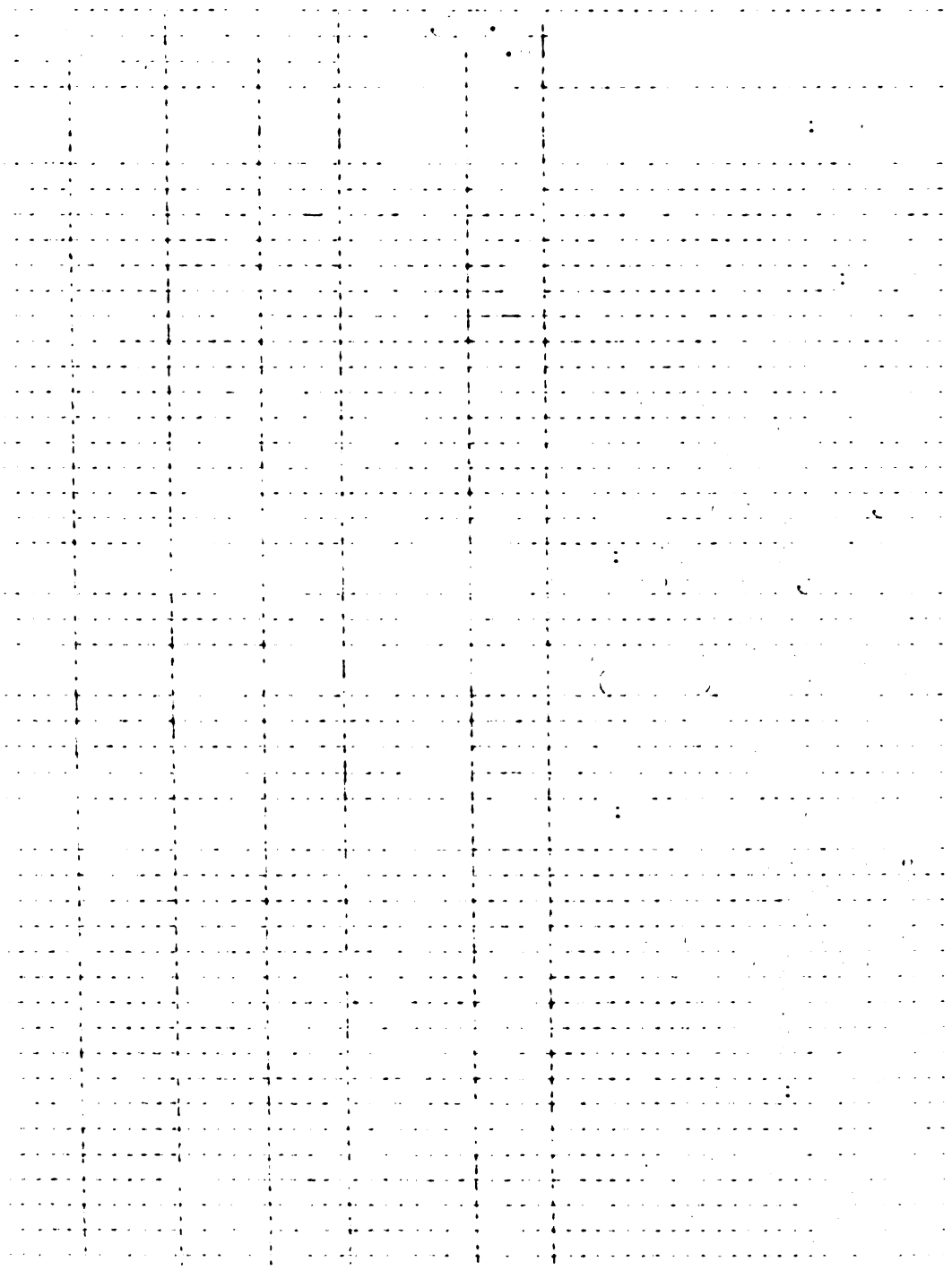
Kind	Beg. Inventory No.	Beg. Inventory Value	Add: No. born	Add: No. bought	Subtract: No. Sold	Subtract: No. butchered or died	End. Inv. No.	End. Inv. Value
DAIRY								
Cows								
Heifers								
Calves								
Bulls								
BEEF								
Cows								
Heifers								
Feeders								
Calves								
Bulls								
HOGS								
Sows								
Boars								
Pigs								
SHEEP								
Ewes								
Rams								
Lambs								
POULTRY								
Hens								
Roosters								
Broilers								
Totals								

Inventory Increase _____ or Decrease _____



9. Machinery & Equipment Investment

Item	Dec. 31, 1959		Bought		Sold	
	No.	Value	Value		Value	
			1958	1959	1958	1959
Tractors:						
Trucks:						
Combine						
Bean Harvester						
Corn picker						
Sugar beet harvester						
Beet Loader						
Bean winrower or rake						
Baler						
Bean, beet or corn planter						
Grain drill						
Corn & grain handling: Elevator, Blower or Auger						
Drier						
Cleaning equipment						
Fertilizer distributor or lime spreader (Manine)						
Seeder						
Spraying equipment						
Wagons & trailers						
Mower						
Cultivation equipment: Bottom plow						
Bottom plow						
Planters						
Disc harrows						
Spring tooth harrows						
Drag or spike harrows						
Clod buster						
Cultipacker						
Field cultivator						
Roller						
Cultivator: rows						
Rotary hoe						
Leveller						
Down the row thinner						
Leveller						
Grader or scraper						
Bulldozer						



Item	Dec. 31, 1959		Bought		Sold	
	No.	Value	Value		Value	
			1958	1959	1958	1959
Other Crop machinery						
Workshop equipment:						
Welder						
Engines, motors						
Water pump						
General farm tools						
(forks, shovels, etc.)						
Mower						
Rake						
Forage harvester						
Blower						
Feed grinder						
Manure spreader						
Manure loader						
Dairy equipment						
Other livestock equipment						
Automobile (farm share)						

Totals -- Ending 1959 inventory _____

Minus items bought in 1959 _____

plus item sold in 1959 _____

total _____

Plus 10% of this total _____ = _____ **ending 1958 inventory.**

Ending 1958 inventory _____

Minus item bought in 1958 _____

Plus item sold in 1958 _____

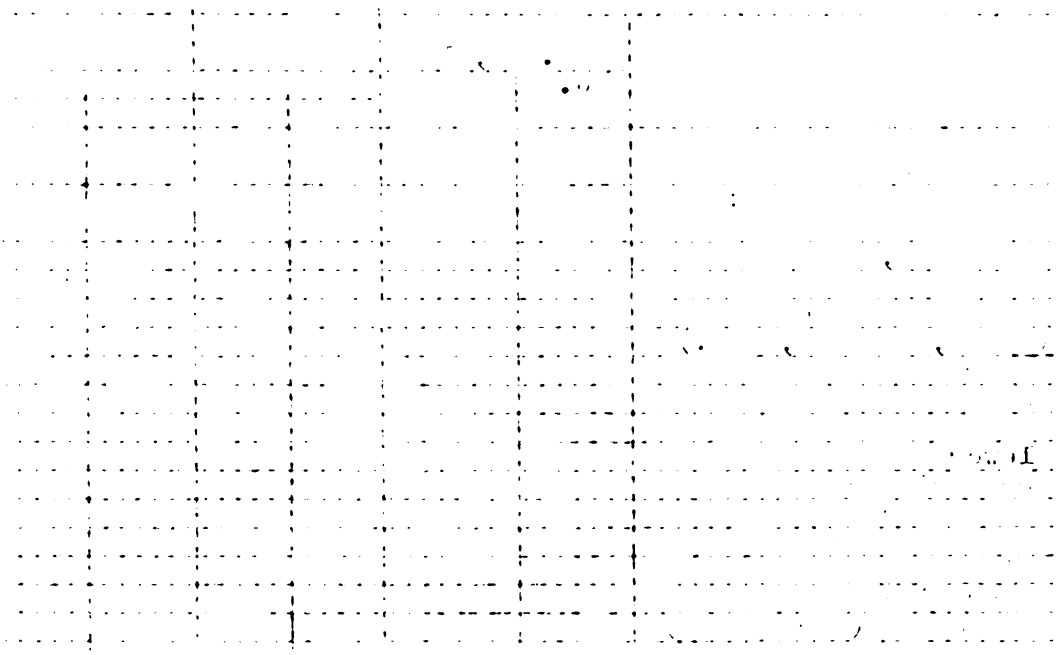
Total _____

Plus 10% of this total _____ = _____ **beginning 1958 inventory**

Inventory Increase **Decrease**

1959_____ **1959**_____

1958_____ **1958**_____



10. Major changes in farm organization for 1960 relative to 1959

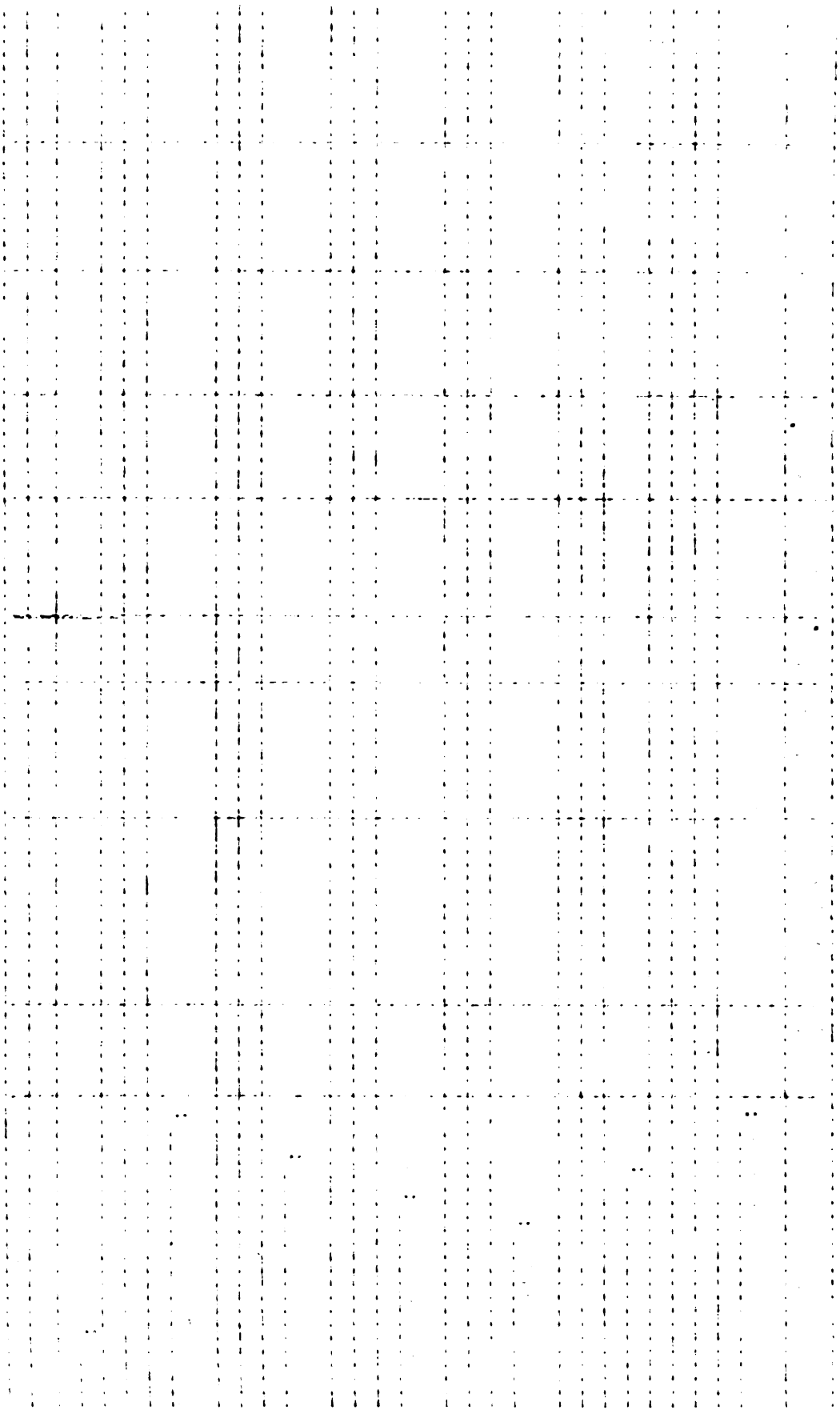
Crops	Changes

Livestock	Changes

Prices	Changes

11. RECORD OF LIABILITIES AT END OF 1959

Type	Year Made	Source of funds	amount	Int. rate	Repay method	Annual payt.	Balance due	Purpose	Security
al estate mortgages:									
attel mortgages:									
Secured notes:									
Unsecured notes:									
Open book accounts:									
Installment purchases:									
Other:									
Taxes due									
Insurance due									
Rent due									



12. Under your present situation, considering your equity in your land and other assets, what is the maximum amount of money that you think you could borrow from the following sources?

	Amt.	Interest rate	Terms (length of loan, etc.)	Conditions (security, other farm etc.)
a. Federal Land Bank				
b. Farmer's Home Admin.				
c. Commercial Banks				
d. Insurance Companies				
e. Individuals (Land contracts, etc.)				
f. Production Credit Assoc.				
g. Machinery dealers				
h. Livestock dealers				
i. Fertilizer dealers				
j. Open accounts (time payments, etc.)				
k. Others				

13. Consider for a few minutes that you are going to borrow all the money that you can possibly get. Now tell me the details of these loans.

14. Does the price of land purchased on land contract depend on interest rates?

_____yes _____no

15. Is there another combination of loans that would give you more than this amount of money if you were willing to pay higher interest rates? Details?

16. NET WORTH STATEMENT
(As of December 31, 1957)

Assets		Liabilities	
Land, per acre	$_____	Farm mortgage (page 10)	$_____
Buildings	_____	Other mortgages (p. 10)	_____
Machinery (page 8)	_____	Bank notes (page 10)	_____
Livestock (page 5)	_____	Personal notes	_____
Feed, seed, supplies	_____	Other notes	_____
Household equipment	_____	Accounts payable	_____
Stocks, bonds	_____	Taxes, rent, ins. due	_____
Cash on hand	_____	Other debts	_____
Cash in bank	_____		
		TOTAL	$_____
Accounts receivable	_____		
	_____	Net worth	_____
			_____
TOTAL	$_____		
		TOTAL	$_____

17. THREE CREDIT REFERENCES
(Business reference)

	Name	Type of Business	Business Address
1.	_____	_____	_____
2.	_____	_____	_____
3.	_____	_____	_____