To the Graduate Council:

I am submitting herewith a thesis written by James E. Clark, Jr., entitled "Analysis of Managerial Factors for Dairy Farmers." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

B R McManus

B. R. McManus, Major Professor

We have read this thesis and
recommend its acceptance:

Charles M Cuskaden

Clark F. Garland

Accepted for the Council:

L Evans Roth

Vice Chancellor
Graduate Studies and Research

ANALYSIS OF MANAGERIAL FACTORS FOR DAIRY FARMERS

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

James E. Clark, Jr.

June 1983

ACKNOWLEDGMENTS

The author wishes to express his gratitude to those persons who contributed their encouragement and ideas in the preparation of this thesis.

I wish to express my appreciation in particular to the people who directly contributed to this study, including:

Dr. Ronald E. Tongate, who assisted in making available the data that was used in this study. The data was obtained from the AGRIFAX record division of the Federal Intermediate Credit Bank of Louisville, Kentucky.

Dr. C. M. Cuskaden and Dr. C. D. Garland, for their helpful suggestions and encouragement.

Morgan Gray and Donald Cunningham for their assistance in the computer analysis of the data.

Tim Moore, fellow graduate student, for his helpful suggestions and friendship during the preparation of this thesis.

Special thanks to Dr. B. R. McManus, my committee chairman, for his guidance, advice, and encouragement throughout the entire study.

Finally, I wish to express a very sincere appreciation to my wife, Beth, for her patience, encouragement, and help in this study, and to my parents, Mr. and Mrs. James E. Clark, Sr., for their help in making it possible for me to reach this goal.

ABSTRACT

This study was an analysis of the returns to management to dairy farms in the Fourth Farm Credit District. The data for this study were obtained from the AGRIFAX division of the Federal Intermediate Credit Bank in the Fourth Farm Credit District. These were the records for 70 farms that were on the AGRIFAX program for the years 1976 and 1977. To be classified as dairy farms, at least 50 percent of the total income of each farm was required to have been obtained from the dairy operation, and no more than 15 percent from the sale of livestock.

The principal objective of this study was to develop a management index for classifying managerial quality of individual farms. In order to do this, regression analysis was used to estimate the value of farm production and total cost of the dairying business. The estimated returns to management was compared with the actual figure to develop a management index.

The farms were categorized into three groups based on the management index. Discriminant analysis and selected efficiency factors were used to classify farmers into low, average, and high levels of management ability.

The most important efficiency factor in the discriminant scores was pounds of milk sold per cow for both years.

This study was less than fully successful in consistently quantifying and measuring managerial quality.

Further research is needed to develop techniques for distinguishing the quality of management before using these models in evaluating borrowers for extending credit.

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

CHAPTER I

INTRODUCTION

Of the total number of farms in the United States, the dairy industry made up 15.1 percent of this number in 1969. In recent years the dairy industry has undergone several changes. Some of these changes involve the number of farms reporting milk cows, herd size, and production per cow.[1]

Only 10.5 percent of the number of farms reporting milk cows in 1950 were reporting milk cows in 1978. Between 1970 and 1978, the number of milk cows in the United States fell by 10.3 percent. On the other hand, both herd size and milk production increased. Milk production has increased 1,080 pounds per cow from 1973 to 1978.[2] These statistics are evidence that dairy farms are larger and less numerous than in past years, but produce more milk than formerly.

As the internal structure of the dairying industry has changed, these changes have been paralleled by a increase in the American farmer's reliance on credit in order to obtain the necessary funds for production. In the farming business, as in any business, in order to realize a profit a farmer must possess some operating capital. Most farmers

---

[1] U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, 1976, 97th ed. (Washington, D.C., 1976).

[2] U.S. Department of Agriculture, Crop Reporting Board, Economic, Statistic, and Cooperatives Service, Milk Production, Disposition, Income, 1976-78 (Washington, D.C., May 1979).

today must rely on borrowed capital. The reliance of farmers on borrowed capital can be seen in the total amount of farm real estate debt and farm nonreal estate debt. In the United States in 1978 the farm real estate debt was $63.320 billion in loans outstanding; the total farm non-real estate debt was $55.471 billion in loans outstanding. The amount of total farm real estate debt has increased by 117 percent from 1970 to 1978, and total farm non-real estate debt has gone up 133 percent from 1970 to 1978. In 1977, the amount of interest charges payable on outstanding farm real estate debt was $4.51 billion. This is a 147 percent increase over the same figure for 1970.[3]

At the end of 1978, the Production Credit Associations had $14.601 billion in loans outstanding. This amount was a 147 percent increase over loans outstanding in 1970. The average size of the Production Credit Association loans in 1978 was $42,164. This figure represents a 136 percent increase in the average loan size since 1970. These figures are evidence of a greater use of borrowed capital by the modern farmer.[4]

As reliance on credit has greatly increased in American agriculture in general, the dairy industry has experienced an increased need for credit also. With fewer dairy farms than every producing larger amounts of milk, these larger operations require greater amounts of credit than the dairy farms of the past. With the growing importance of credit in

---

[3]Emanuel Melichar and Marian Sayre, Agricultural Financial Data Book, November 1977 Annual Series and December Monthly Series, Division of Research and Statistics, Board of Governors of the Federal Reserve System, Washington, D.C., pp. 9, 18.

[4]Ibid., p. 4.

the dairy industry, sound agricultural management practices are increasingly vital to a successful operation. Therefore, this study deals with identifying successful management practices in order that both the farmer and the lending institutions may be benefited.

This study was concerned with dairying in the Fourth Farm Credit District, comprised of the states of Indiana, Ohio, Kentucky, and Tennessee. In these states dairy farming accounted for 7.3 percent of the total number of farms.[5]

I. OBJECTIVES

The major objective of this study was to develop workable management indices for dairy farms and to differentiate the farms on this basis. Such management indices could be utilized by farm credit agencies to help identify the better farm managers in screening loan applications.

The specific objectives of this study were:

1. To develop income and cost models that would explain variation between farms.
2. To develop management indices for each farm for returns to management from dairying.
3. To differentiate the dairy farms based on efficiency factors and determine how well the efficiency evaluation would discriminate the farms with respect to classified management groups.

---

[5] U.S. Department of Agriculture, Crop Reporting Board, Economic, Statistic, and Cooperatives Service, Milk Production, Disposition, Income, 1976-78 (Washington, D.C., May 1979).

II. SOURCE OF DATA

Data for this study were obtained from the Federal Intermediate Credit Bank of the Fourth Farm Credit District. These data were taken from the AGRIFAX record division without identification of the farmers.

The farms included in this study were classified as dairy farms. In order to be included in this classification, a farm had to receive a minimum of 50 percent of its total farm income from the dairy operation and no more than 15 percent form the sale of livestock. A total of 70 farms in the AGRIFAX records met these classifications for the years 1976 and 1977.

The farms in this study did not represent a random sample. This is because farms in the AGRIFAX program are larger, faster growing, newer operations with lower equity than a random sample of farms. However, AGRIFAX officials do feel that this group of farms represents a random sample of management ability.[6]

III. PROCEDURE

Data obtained from the Fourth Farm Credit District included over 130 dairy farms for the years 1976 and 1977. For purposes of this analysis, only those farms which had been on the record-keeping system for both years were used. After this initial screening, 70 farms remained which had been on the system both years.

---

[6]Fourth Farm Credit District Production Credit Association, Farm Credit Service, 1977 Agrifax--Comparative Farm Business Analyses (Louisville, Kentucky), p. 4.

The two statistical techniques utilized in this study were regression analysis and multiple discriminant analysis. Regression analysis was used to estimate total value of farm production and total costs for dairying. From these estimating functions obtained through regression, estimated values for total costs, total value of farm production from dairying, and returns to management were obtained. These estimated values and actual values from the records were used in developing management indices as a relative measure of managerial quality as compared to the level of management on the other farms in the study. Discriminant analysis was used to classify each farm into appropriate management groups, based on efficiency factors.

IV. REVIEW OF RELATED STUDIES

In an attempt to provide farmers with information on the most profitable farm enterprises, several agricultural studies were made at the end of the 19th century. These studies became the beginning of the subdiscipline of farm management. One of the first of such studies was by G. W. Curtis and J. W. Carson, who were concerned with the cost and return of growing cotton in Texas.[7] A similar study was accomplished in 1896 by N. A. Weston, dealing with the cost of producing corn and oats in Illinois.[8]

---

[7] G. W. Curtis and J. W. Carson, "Cost of Cotton Production and Profit per Acre," Bulletin No. 26 (Texas Agricultural Experiment Station), 1893.

[8] N. A. Weston, "The Cost of Producing Corn and Oats in Illinois," Bulletin No. 50 (Illinois Agricultural Experiment Station), 1896.

The objectives of these early farm management studies were to obtain the cost of production. There was no attempt to account for the effects of variations in cost from farm to farm.

In 1903 a farm management study was conducted in order to obtain a business analysis of farm operations. This study, based on factors that affect the yield of apples, was by G. F. Warren of Cornell University.[9]

Warren later made another total farm survey study in an effort to perfect his earlier attempts. This second study was carried out in Livingston County, New York, based on the 1908 crop year. This study resulted in the following significant developments in agricultural research: (1) the use of labor income as a measure of net returns; (2) the use of group sorting and cross tabulation techniques as a means of studying factors associated with labor income; and (3) the analysis of the total farm business rather than one of several enterprises.[10]

Tintner and Brownlee studied Iowa farms, categorizing them into groups based on type of operation. They found that they could explain 74 percent of the total variation in gross profit, and that the significant variables were land, labor, liquid assets, and cash operating expenses. Using the same equation for dairy farms specifically, land

---

[9]G. F. Warren, "An Apple Orchard Survey of Wayne County, New York," Bulletin No. 226, Part I (Cornell, Agricultural Experiment Station), 1905.

[10]G. F. Warren, "An Economic Study of Agriculture in Northern Livingston County, New York, Bulletin No. 529 (Cornell Agricultural Experiment Station), 1932.

and cash operating expenses were found to be the significant variables.[11]

In a study of Iowa dairy farms, Earl Heady used a Cobb-Douglas function to estimate total production. He found that he could explain 90 percent of the variation in total production of dairy farms using the variables of land, equipment, livestock and feed, and miscellaneous expenses.[12]

J. A. Speecher and C. A. Lasseter conducted a study using multiple regression analysis to explain net income from dairying with different farm management factors. They found about 14 of the 38 management factors were significant. Also of importance in determining net income were the size of operation, cropping program, and dairy herd operation.[13]

John E. Kadlec, Luther H. Keller, and Arther K. House tried to determine the factors affecting the cost of producing Grade A milk in the Louisville milkshed area. In their study they used a Cobb-Douglas function to estimate the amount of milk produced. They found building investment, tons of forage, total digestible nutrients from grain, hours of labor, and number of cows to be significant variables which explained

---

[11]Gerhard Tintner and O. H. Brownlee, "Production Function Derived from Farm Records," Journal of Farm Economics 26(1944): 989-1004.

[12]Earl O. Heady, "Production Function from a Random Sample of Farms," Journal of Farm Economics 28(1946): 989-1004.

[13]J. A. Speecher and C. A. Lasseter, "Influence of Specified Farm Management Factors on Dairy Farm Net Income," Journal of Dairy Science 48(1965): 1698-1703.

78 percent of the variation. They used a linear function to estimate the cost per hundredweight of milk produced. The variables used were: technical efficiency index obtained from the production equation, labor hours, building investment per cow, size of herd, quantity of grain fed, quantity of forage fed, and heifers raised in relation to number of cows. In this function there were several interaction terms which were found to be significant variables.[14]

William S. Hamilton, Jr., also used a Cobb-Douglas function to estimate the total gross farm income, marginal productivity of resources, and returns to scale, using Grade A dairy farms in the analysis. The regression analysis explained 88 percent of the variation for the years 1973-75. Investment in dairy cows, man equivalents of hired labor, machinery and equipment expense, operating capital, and acres of open land were the significant variables at the .01 level.[15]

Hamilton estimated a management index for each yearly farm record for each farm in his study by dividing actual gross farm income by a predicted gross farm income. The predicted gross farm income was determined by a regression function using selected variables for the dairy operations. In each case, the quality of managerial ability was a

---

[14]John E. Kadlec, Luther H. Keller, and Arthur K. House, "Factors Affecting Cost of Production of Grade A Milk in the Louisville Milkshed," Bulletin No. 767 (Purdue Agricultural Experiment Station), November 1963.

[15]William S. Hamilton, Jr., "A Production Function Analysis of Grade A Dairy Farms in Middle and East Tennessee" (Unpublished Master's thesis, The University of Tennessee, Knoxville, 1978), p. 29.

relative measure as compared to the level of management on the other farms in the study.[16]

Management factors were related to income over cost in a study by C. A. Brown and J. M. White. In the model for income over cost it was found that five of the 12 variables, milk price, milk produced per cow, concentrate, grain price, and other feed costs, were significant. Those variables accounted for 99 percent of the variation in income over feed cost.[17]

Heady and Dillion stated that assessing management involves subjective elements. Heady used a management index in an unpublished study to measure managerial inputs. The variables he used to predict output were land, labor, capital services, and management. Since management is a difficult factor to measure, sometimes a reverse approach is suggested. In this approach the difference between estimated production levels and actual production levels is credited to management. The differences can then be used as a management index.[18]

Multiple discriminant analysis has been used in several different types of studies including: grouping road sections into cost of right-of-way maintenance, classifying common stock into different groups,

---

[16]Ibid., pp. 68-69.

[17]C. A. Brown and J. M. White, "Management Factors Associated with Herd Average Milk Yield and Income Over Feed Cost in Guernsey, Holstein, and Jersey Herds," Journal of Dairy Science 56, Part 7 (June 1978), 789-804.

[18]Earl O. Heady and John L. Dillion, Agricultural Production Functions (Ames, Iowa: Iowa State University Press, 1961), p. 225.

putting land sales into different categories,[19] and classifying loans as good or bad.[20] One study using this type of analysis was on Grade A dairy farms by E. C. Curring, Jr., W. L. Gibson, and R. K. Reynolds. They placed the farms in that study into different labor income groups and then used different efficiency factors to correctly classify each farm. The most important variable they found was feed cost per hundredweight of milk sold.[21]

Another study by Daniel J. Dunn and Thomas L. Frey used cash grain farms in the analysis. They found four characteristics that would discriminate between the farms. These characteristics were the ratio of total liabilities to total assets (the most important), the amount of credit life insurance, the amount of a loan as a proportion of net cash farm income, and the number of acres owned.[22]

Discriminant analysis was used to classify loans in a study by Larry L. Bauer and John P. Jordan. They used the variables of debts to assets ratio, reasonable farm value, total liabilities, marital status,

---

[19]E. C. Currin, Jr., W. L. Gibson, Jr., and R. K. Reynolds, "Multiple Discriminant Analysis of Grade A Dairy Farm Business," Research Division Bulletin No. 37 (Blacksburg, Virginia: Virginia Polytechnic Institute and State University), January 1971, p. 9.

[20]Larry L. Bauer and John P. Jordan, "A Statistical Technique for Classifying Loan Applications," Bulletin No. 476 (Knoxville, Tennessee: The University of Tennessee Agricultural Experiment Station), March 1971.

[21]Currin, Gibson, and Reynolds, p. 27.

[22]Daniel J. Dunn and Thomas L. Frey, "Discriminant Analysis of Loans for Cash-Grain Farms," Agricultural Finance Review, Economic Research Service, U.S. Department of Agriculture, Vol. 36 (April 1976), p. 6.

percent family expenses to total farm expenses, ratio of current liabilities to assets, number of dependents, and the percent that expected income was of the previous year's income. With these variables they found they could discriminate between two groups, classified as problem loans versus classified as good loans, with a 99 percent probability.[23]

R. B. Johnson used discriminant analysis to classify loans using six important financial ratios. These six ratios were: (1) repayment index, (2) current ratio, (3) total debts as a percent of total assets, (4) net worth as a percent of total debts, (5) ratio of net worth to total PCA commitments for the current year, and (6) ratio of total underlying security to total PCA commitments. Johnson stated in the study that regression analysis answered the question, "What am I best at?" whereas discriminant analysis will reveal the answer to "What group am I most like?"[24]

---

[23]Bauer and Jordan, p. 6.

[24]Russell B. Johnson, "Agricultural Loan Evaluation with Discriminant Analysis" (Doctoral dissertation, The University of Missouri, Columbia, 1970; published by University Microfilms International, Ann Arbor, Michigan, 1978), pp. 20-24.

CHAPTER II

CHARACTERISTICS OF FARMS IN STUDY

The dairy farms in this study were taken from the entirety of the Fourth Farm Credit District. Since the farms in this group were considered to be the newer, larger, faster growing, and lower equity operations, it is interesting to observe some of the specific characteristics of these farms. The farms in this study vary widely in size of operation, capital investments, and returns to management and unpaid labor. The total number of dairy cows ranged from 18 to 134 in 1976 and from 18 to 145 in 1977. The total number of man equivalents ranged from 1 to 6.3 in 1976 and from 1 to 7.77 in 1977. Total investments in land, buildings, and improvements per farm ranged from $34,500 to $591,000 in 1976 and $42,450 to $701,740 in 1977. The range of returns to unpaid labor and management was from -$74,587 to $69,468 in 1976 and -$64,019 to $90,819 in 1977.

In order to obtain a better description of the sample of farms used in the study, the farms were classified into three size groupings based on the number of dairy cows. Of the 70 farms in the sample for 1976, 25 had 60 dairy cows or less, 25 had 61 to 90 dairy cows and 20 had 91 or more dairy cows. There was also a total of 70 farms in the sample for the year 1977, categorized as follows: 24 in the 60 or less dairy cow range, 24 in the 61 to 90 dairy cow range, and 22 in the 91 or more dairy cow group.

I. MEASURES OF SIZE OF FARM BUSINESS

A summary of the size of the operations is shown in Tables I and II. From these tables it can be seen that there was only limited difference between the years of 1976 and 1977. The farms in the smallest size range (less than 60 dairy cows) averaged 44 milk cows per farm and used an average of approximately 2 man equivalents of labor per year, or averaged about 22 cows per man equivalent.

On the other end of the scale, the farms in the largest group, according to number of dairy cows (91 or more), averaged 111 cows per farm for 1976 and 116 for 1977. The number of man equivalents per farm in this group averaged 3.6 for 1976 and 3.3 for 1977. These figures resulted in about five more cows per man equivalent in 1977 than in 1976.

Farms with fewer than 60 dairy cows, both years combined, averaged 5.2 acres of tillable land per cow, whereas the largest dairy farms, those with 91 or more dairy cows, averaged 3.4 acres of tillable land per cow, both years combined.

Both the smallest and largest farm groups averaged slightly over a half acre of corn silage per cow, for both years combined. The midsize farm group, those with 61 to 90 dairy cows, had the highest pounds of milk sold per cow, for both years. The largest size group averaged the least amount of pounds of milk sold per cow, for both years.

TABLE I

SIZE OF FARM BUSINESS FACTORS FOR SEVENTY DAIRY FARMS
IN THE FOURTH FARM CREDIT DISTRICT, 1976

Category	Averages per farm[a]			
	All farms	Farms with 60 dairy cows or less	Farms with 61-90 cows	Farms with 91 or more dairy cows
Cows in dairy herd	74	44	75	111
Man equivalents	2.7	2.0	2.6	3.6
Pounds of milk sold per cow	12,186	11,996	13,053	11,338
Tillable acres	311	231	326	392
Acres rented	208 (58)	149 (23)	215 (18)	279 (17)
Acres owned	221	164	244	264
Hay acres	81 (64)	69 (24)	81 (23)	98 (17)
Hay silage acres	79 (38)	40 (8)	60 (16)	123 (14)
Corn acres	93 (68)	75 (25)	103 (24)	103 (19)
Corn silage acres	44 (62)	26 (22)	47 (22)	64 (18)

[a]The number in parentheses indicates the actual number of farms in each group from which that item was calculated. All other categories contained data from the 70, 25, 25 and 20 farms in the respective groupings.

TABLE II

SIZE OF FARM BUSINESS FACTORS FOR SEVENTY DAIRY FARMS
IN THE FOURTH FARM CREDIT DISTRICT, 1977

Category	Averages per farm[a]			
	All farms	Farms with 60 dairy cows or less	Farms with 61-90 cows	Farms with 91 or more dairy cows
Cows in dairy herd	77	44	75	116
Man equivalents	2.6	1.9	2.7	3.3
Pounds of milk sold per cow	11,951	11,972	12,146	11,717
Tillable acres	308	243	314	373
Acres rented	201 (58)	167 (21)	183 (19)	261 (18)
Acres owned	227	172	249	264
Hay acres	84 (65)	66 (23)	97 (23)	89 (19)
Hay silage acres	81 (36)	45 (10)	64 (12)	122 (14)
Corn acres	104 (64)	83 (22)	103 (23)	130 (19)
Corn silage acres	42 (63)	23 (22)	43 (22)	61 (19)

[a]The number in parentheses indicates the actual number of farms in each group from which that item was calculated. All other categories contained data from the 70, 24, 24 and 22 farms in the respective groupings.

II. MAJOR EXPENSES

The farm characteristics summarized in Tables III and IV are the major expense items for the dairy farms for both years. Each expense item, as a percent of the total average cost, exhibited only minor changes from one year to the next. One of the largest expense items was feed cost. Feed cost for both years averaged around 27 to 28 percent of the total average cost for all farms. Miscellaneous cost excepted, the next largest percent of total cost was the interest expense. For all farm groups, the interest expense averaged about 13 percent of total average cost. Fertilizer and chemical cost averaged 12 to 13 percent of the total cost. Repairs, gas, oil, and fuel cost, and labor and custom hire averaged 10 to 11 percent of total cost for all farms.

III. INCOME FACTORS

The major income factors of the farms in the study are summarized in Tables V and VI. Gross milk sales accounted for 70 to 80 percent of total cash farm income. Income from the total dairy operation constituted between 80 and 92 percent of the total average cash farm income.

For 1976 the return to unpaid labor and management was highest for farms with 61 to 90 dairy cows. This figure was twice as high as the corresponding figure for farms with 91 or more dairy cows, and almost three times as large as the same figure for farms with 60 or fewer dairy cows. For 1977, the return to unpaid labor and management was highest

TABLE III

MAJOR EXPENSE ITEMS FOR SEVENTY DAIRY FARMS IN THE FOURTH FARM CREDIT DISTRICT, 1976

Item	Averages per farm[a]							
	All farms		Farms with 60 dairy cows or less		Farms with 61-90 cows		Farms with 91 or more dairy cows	
	Dollars	Percent[b]	Dollars	Percent[b]	Dollars	Percent[b]	Dollars	Percent[b]
Cash rent	3,834 (59)	4	2,329 (19)	3	3,403 (19)	3	5,770 (19)	5
Feed cost	24,239	28	13,880	27	25,520	28	35,587	30
Fertilizer and chemical cost	10,687	13	7,583	15	11,469	13	13,591	11
Labor and custom hire	8,661	10	3,892	7	9,468	11	13,614	11
Interest cost	11,521	13	6,973	13	11,913	13	16,715	14
Seed and plant cost	2,253	3	1,639	3	2,426	3	2,804	2
Repairs, gas, oil and fuel cost	9,545	11	6,440	12	10,307	11	12,472	10
Miscellaneous cost	14,991	18	10,277	20	15,719	18	19,973	17
Weighted total average cost	85,019	100	52,454	100	89,408	100	120,237	100
Unweighted total average cost	85,731		53,013		90,225		120,526	

[a]The number in parentheses indicates the actual number of farms for cash rent. All other categories contained data from the 70, 25, 25 and 20 farms in the respective groupings.

[b]Percentages calculated using weighted total average cost.

TABLE IV

MAJOR EXPENSE ITEMS FOR SEVENTY DAIRY FARMS IN THE FOURTH FARM CREDIT DISTRICT, 1977

Item	Averages per farm[a]							
	All farms		Farms with 60 dairy cows or less		Farms with 61-90 cows		Farms with 91 or more dairy cows	
	Dollars	Percent[b]	Dollars	Percent[b]	Dollars	Percent[b]	Dollars	Percent[b]
Cash rent	4,447 (58)	4	2,806 (19)	4	3,176 (18)	3	7,021 (21)	5
Feed cost	24,104	27	13,272	23	23,052	27	37,069	29
Fertilizer and chemical cost	10,517	12	7,245	13	10,223	12	14,406	11
Labor and custom hire	9,773	11	4,541	8	8,677	10	16,678	13
Interest cost	11,828	13	9,108	16	11,558	13	15,091	12
Seed and plant cost	2,473	3	1,621	3	2,702	3	3,152	2
Repairs, gas, oil and fuel cost	10,144	11	6,781	12	10,646	12	13,265	10
Miscellaneous cost	17,071	19	11,814	21	17,024	20	22,858	18
Weighted total average cost	89,595	100	56,603	100	86,264	100	129,221	100
Unweighted total average cost	90,357		57,188		87,058		129,540	

[a]The number in parentheses indicates the actual number of farms for cash rent. All other categories contained data from the 70, 24, 24 and 22 farms in the respective groupings.

[b]Percentages calculated using weighted total average cost.

TABLE V

INCOME FACTORS FOR SEVENTY DAIRY FARMS IN THE FOURTH FARM CREDIT DISTRICT, 1976

Income item	Averages per farm[a]			
	All farms	Farms with 60 dairy cows or less	Farms with 61-90 cows	Farms with 91 or more dairy cows
	dollars			
Income from dairy products	90,458	53,315	95,613	130,444
Income from dairy[b]	7,094	5,180	7,279	9,255
Return to unpaid labor and management	12,331	6,774	19,882	9,839
Total cash farm income	111,578	72,580	118,807	151,290
Nonfarm cash income	1,587	1,729	1,186	1,911

[a]All categories contained data from the 70, 25, 25, and 20 farms in the respective groupings.

[b]Includes sales from the dairy operation except dairy products.

TABLE VI

INCOME FACTORS FOR SEVENTY DAIRY FARMS IN THE FOURTH FARM CREDIT DISTRICT, 1977

Income item	Averages per farm[a]			
	All farms	Farms with 60 dairy cows or less	Farms with 61-90 cows	Farms with 91 or more dairy cows
	dollars			
Income from dairy products	92,289	50,889	90,893	138,974
Income from dairy[b]	9,650	8,669	9,807	10,549
Return to unpaid labor and management	5,181	3,186	7,950	11,288
Total cash farm income	116,542	73,590	117,972	161,840
Nonfarm cash income	2,851	2,953	1,830	3,854

[a]All categories contained data from the 70, 24, 24, and 22 farms in the respective groupings.

[b]Includes sales from the dairy operation except dairy products.

for the largest group of dairy farms. However, in 1977, this figure varied directly with the size of the farms. Hence, for the year 1977, the largest operations had the greatest return to unpaid labor and management, while the smallest operations had the lowest figures. In 1977 the group average return to unpaid labor and management ranged from a low of $3,186 for the farms with 60 or fewer cows, to a high of $11,288 for those farms with 91 or more dairy cows.

IV. AVERAGE INVESTMENT

The size and type of investments of the study farms are shown in Tables VII and VIII. The investment per cow ranged from $3,749 to $6,268 for the three different size groupings over both years. The investment per cow was lower for the largest dairies, possibly indicating a more efficient use of nondivisible resources. The largest increase in investment per cow was from 1976 to 1977 for farms with 60 or fewer dairy cows.

The largest increase in investment resulted from land, building, and improvements. For all three groups the investment in dairy cows for both years ranged from 16 to 19 percent of the total average farm investment. The total average farm investments increased for each group from 1976 to 1977, but the percentage of increase varied greatly among groups. Total average investments rose proportionately higher for the smallest farm group (60 or fewer dairy cows), with an increase of 30.5 percent. The investments for the largest dairy farm group (90 or more cows) showed an increase of 18.1 percent, while the average

TABLE VII

INVESTMENT FACTORS FOR SEVENTY DAIRY FARMS IN THE FOURTH FARM CREDIT DISTRICT, 1976

Investment item	Averages per farm[a]			
	All farms	Farms with 60 dairy cows or less	Farms with 61-90 cows	Farms with 91 or more dairy cows
	dollars			
Dairy cows	56,491	35,201	61,065	77,384
Machinery and equipment	52,893	33,217	64,293	63,238
Land, buildings, and improvements	171,401	114,536	196,143	211,554
Feed and crops	28,564	18,109	29,913	39,948
Other	16,171	10,240	15,840	23,999
Total	325,520	211,303	367,254	416,123
Investment per cow	4,399	4,802	4,897	3,749

[a]All categories contained data from the 70, 25, 25, and 20 farms in the respective groupings.

TABLE VIII

INVESTMENT FACTORS FOR SEVENTY DAIRY FARMS IN THE FOURTH FARM CREDIT DISTRICT, 1977

Investment item	Averages per farm[a]			
	All farms	Farms with 60 dairy cows or less	Farms with 61-90 cows	Farms with 91 or more dairy cows
	dollars			
Dairy cows	62,121	38,562	61,609	88,380
Machinery and equipment	63,196	46,227	64,977	79,765
Land, buildings, and improvements	200,147	156,415	194,543	253,967
Feed and crops	33,344	23,065	34,215	43,608
Other	17,812	11,545	16,665	25,900
Total	376,620	275,814	372,009	491,620
Investment per cow	4,891	6,268	4,960	4,238

[a]All categories contained data from the 70, 24, 24, and 22 farms in the respective groupings.

investment of the midsize group (61 to 90 dairy cows) increased only 1.3 percent.

CHAPTER III

ESTIMATION OF DAIRYING INCOME AND COST FACTORS

Management indices for returns to the management were derived to differentiate the farms based on efficiency factors. To obtain the management indices, farm records of 70 farms which were on the AGRIFAX program for both the years 1976 and 1977 were used. The development of such indices would allow the farms to be placed into management groups to determine if the efficiency factors could be used as effective indicators of the management level.

In order to derive management indices, functions were fitted to the value of farm production from dairying and total cost of dairying. Estimates from the functions were made for income and cost. The estimated total dairying income (value of farm production from dairying), less the estimated total cost of dairying, resulted in an estimated returns to management from dairying. Such an estimate was derived separately for the years 1976 and 1977. Actual returns to management were computed directly from the data for both years. The actual returns to management was divided by the estimated returns to management to derive the management indices for each respective year and respective farm. The management indices were developed as a quantified estimate of management quality. Also, the management index is a relative rather than absolute measure of management as compared to the level of management on the other farms for the respective sets of farm resources.

I. HYPOTHESIZED ESTIMATING FUNCTIONS

In deciding what type of analysis to use in a study, there are several factors to consider. Economic theory is considered for gaining insights into the relationships being studied. Consideration is given to the causal relationships in the economic process to be estimated. In choosing a model which best fits the data, major consideration is given to the goodness of fit as can be measured by the F test and by the R^2.

In pure competition when a farmer sells his products he is a price taker and does not influence prices received for his products; when he buys inputs he is unable to influence the prices paid for the inputs. Once a production function, price of output, and prices of inputs are known, then income and cost functions can be determined and can be derived one from the other. Shephard shows that the cost function and production function are equivalent statements of production alternatives, assuming that the process is organized for minimum costs.[1] The production function for this study was assumed to be homogenous of degree one.[2] The value of farm production was also assumed to be homogenous of degree one. "A production function of degree one generates a linear long-run total cost function."[3]

---

[1]Ronald W. Shephard, Cost and Production Functions (New York: Princeton University Press, reprint of the 1953 edition, 1981), p. 17.

[2]James M. Henderson and Richard E. Quandt, Microeconomic Theory: A Mathematical Approach (New York: McGraw-Hill, 1958), p. 62.

[3]Ibid., p. 66.

In this study the Cobb-Douglas type equation was selected because of the convenience in interpreting elasticities, minimal requirements for degrees of freedom, simplicity of computation, and because its functional shape is of the same general shape of the hypothesized value of farm production and cost functions.[4,5]

The Cobb-Douglas type function was used when fitting functions to the value of production data and the total cost data. This type function was fitted to the value of farm production from dairying and selected inputs so an expected value of farm production could be ascertained for the set of resources of each respective farm. A Cobb-Douglas type total cost function was fitted to the total cost and selected input data for the dairy farms so an expected cost estimate could be ascertained for the set of resources of each respective farm. The purpose of fitting functions to the value of farm production data and cost data was to derive expected values for each farm for income and cost; then expected returns to management could be obtained for relating actual returns to management in estimating the managerial quality for each respective farm.

Value of Farm Production from Dairying

Products produced on a farm are the result of using inputs in a production process and can be expressed as:

---

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

[5]John P. Dell and Frank Orazem, Production Economics Theory with Applications (Columbus, Ohio: Grid, Inc., 1978), pp. 40-42.

$$Y = f(X_i)$$

where:

Y = value of farm production from dairying

X_i = respective inputs

In this case, the following function was selected:

$$Y = aX_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6}$$

where:

Y = value of farm production from dairying

a = some constant

X_1 = investment in land, buildings, and improvements

X_2 = man equivalents

X_3 = machinery and equipment investment

X_4 = number of dairy cows

X_5 = total feed cost

X_6 = major farm expense items[6]

b = regression coefficient.

Value of farm production from dairying, the dependent variable, is hypothesized to be positively related to selected independent variables. As the specific independent variable increases, value of farm production would increase also. The independent variables selected for this estimating function were: investment in land, buildings, and

---

[6]Major farm expense items included rent, seed, fertilizer and lime, miscellaneous expenses, custom hire, and breeding and veterinary expenses.

improvements; man equivalents; machinery and equipment investment; number of dairy cows; total feed cost; and major farm expense items.[7]

The annual flow of services from land, buildings and improvements should generate an income through the dairy herd. As the magnitude of the investment changes, income would be expected to change in the same direction. Man equivalents serves as a measure for the labor contribution. As the stream of services from the machinery and equipment are used, an associated income should be generated. The machinery and equipment investment should reflect the quantity and quality of this resource that is used in the operation. Number of dairy cows serves as the converting unit of transforming resources into milk which was the major source of income in value of farm production from dairying. Feed is an important input in producing milk; so, total feed cost was the variable used to represent feed. Major farm expense items was used to represent several other contributory factors in the production of milk in the dairy operation.

Total Cost of Dairying

The cost function hypothesized in this study is total cost for the diary business. Cost is a function of inputs used in the production process and can be expressed as:

$$C = f(X_i)$$

where:

C = total cost for the dairy business

---

[7] Ibid.

X_i = respective inputs.

In this case, the following function was selected:

$$C = aX_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5}$$

where:

C = total cost for the dairy business

a = some constant

X_1 = investment in land, buildings, and improvements

X_2 = man equivalents

X_3 = machinery and equipment investment

X_4 = number of dairy cows

X_5 = major farm expense items[8]

b = regression coefficient.

Total cost from the dairy portion of the farm, the dependent variable, is hypothesized to be positively related to: investment in land, buildings and equipment; man equivalents; machinery and equipment investment; number of dairy cows; and major farm expense items.[9]

Variables were included to represent land, labor, and capital. Number of dairy cows was used as the basic unit for converting resources into salable products. The major farm expense items variable was included to represent contributions not represented in the other variables except management.

---

[8]Included rent, seed, fertilizer and lime, miscellaneous expenses, custom hire, and breeding and veterinary expenses.

[9]Ibid.

A model was estimated for 1976 and for 1977. All the observations did not contain all of the data needed; 61 out of 70 observations were used in 1976 and 67 out of 70 observations were used in 1977.

II. EMPIRICAL MODELS

Adjustments to Data

This study was concerned with the dairy operation of the business for making comparisons between farms. Since the farms used in the study were classified as dairy farms, adjustments in the data were needed to reflect the dairy operation. All adjustments were made on the basis that cost, man equivalents, and investments of the dairying business were the same percent of the total farm figures for each as dairying was of the total value of farm production. For example, if total dairying income on Farm X was computed to be 90 percent of the total value of farm production, then costs for dairying were estimated to be 90 percent of the total farm costs. The values of the other variables were adjusted, where appropriate, in this same manner for each farm and then used in the final models. In addition charges were made for equity capital, operator labor, and unpaid family labor.[10,11] The amount charged for equity capital was 7 percent. This percent was chosen

---

[10] Fourth Farm Credit District Production Credit Association, Farm Credit Service, 1976 Agrifax--Comparative Farm Business Analyses (Louisville, Kentucky), pp. 7 and 49.

[11] Fourth Farm Credit District Production Credit Association, Farm Credit Service, 1977 Agrifax--Comparative Farm Business Analyses (Louisville, Kentucky), pp. 11 and 51.

because it was used in the AGRIFAX record summary and because it seemed to be a reasonable value to use for 1976 and 1977. Operator labor and unpaid family labor were charged at a rate of $750 per month so that the management index would reflect a return to management and not a return to unpaid labor.

In the equations for value of farm production from dairying, adjustments were made to the data as explained above, in order to limit these figures to the dairy portion of each farm business. The figures that were used to represent the value of farm production accounted for total cash income from the dairy operation and included any change in the inventories adjusted to account for only the dairy portion of the farm. This adjustment was made in the same way that the variables used in the equations were adjusted.

The two years of data were analyzed as separate models. A management index for each specific year for each farm was estimated.

Estimating Value of Farm Production from Dairying

The Cobb-Douglas equation used for fitting the value of farm production from dairying for each year is as follows:

$$Y = aX_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6}$$

where:

Y = value of farm production from dairying

a = some constant

X_1 = investment in land, buildings, and improvements

X_2 = man equivalents

X_3 = machinery and equipment investment

X_4 = number of dairy cows

X_5 = total feed cost

X_6 = major farm expense items[12]

b = regression coefficients.

The equations were estimated as follows:[13]

Equation I (Estimated Value of Farm Production from Dairying for 1976):

$$Y = 4.1149 \; X_1^{.0700} \; X_2^{-.0992} \; X_3^{.0574} \; X_4^{.4719} \; X_5^{.0786} \; X_6^{.3326}$$

$R^2 = .89$

Equation II (Estimated Value of Farm Production from Dairying for 1977):

$$Y = 1.5462 \; X_1^{.2788} \; X_2^{-.0757} \; X_3^{.0756} \; X_4^{.2987} \; X_5^{.1548} \; X_6^{.3112}$$

$R^2 = .87$

The t test was used to test if the sum of the elasticities differed significantly from one at the .10 level;[14] the results did not differ significantly from one in either Equation I or II. The sum of the elasticities for Equation 1 was .9124 and for Equation II 1.0434.

---

[12]Included rent, seed, fertilizer and lime, miscellaneous expenses, custom hire, and breeding and veterinary expenses.

[13]The Cobb-Douglass type function was converted to logarithmetic form to allow estimation by the least squares method.

[14]Jan Kmenta, Elements of Econometrics (New York: The Macmillan Company, 1971), pp. 372-374.

Comparison of Equations I and II

The regression coefficients and coefficients of determination for the two equations are compared in Table IX. The coefficients of determination show that 89 and 87 percent of the variability in the value of farm production from dairying could be explained for 1976 and 1977, respectively. The coefficient of determination was significant at the .01 level for both years.

In the equation for value of farm production from dairying for 1976, Equation I, the five variables, investment of land, buildings, and improvements; machinery and equipment investment; number of dairy cows; total feed cost; and major farm expenses all demonstrated the expected sign of positive association. Three variables were significant at the .10 level, with those being number of dairy cows, total feed cost, and major farm expenses.

In Equation II the same five variables had the hypothesized positive sign. Three variables in Equation II were significant at the .10 level. Two of these, total feed cost and major farm expenses, were the same as in Equation I. The other significant variable was investment in land, buildings, and improvements.

The three variables not significant at the .10 level in Equation I were: investments in land, buildings, and improvements, man equivalents; and machinery and equipment investment. Those variables not significant at the .10 level in Equation II were: man equivalents; machinery and equipment investment; and number of dairy cows. In addition, the variable, man equivalents, had a negative coefficient in

TABLE IX

COMPARISON OF REGRESSION COEFFICIENTS AND COEFFICIENTS OF DETERMINATION FOR ESTIMATED EQUATIONS FOR VALUE OF FARM PRODUCTION FROM DAIRYING FOR 1976 AND 1977

Input	Equation I (1976)			Equation II (1977)		
	Regression coefficient	Standard error of the estimate	Significance level	Regression coefficient	standard error of the estimate	Significance level
Investment in land, buildings, and improvements	0.0711	0.0443	0.1178	0.2788	0.0839	0.0020
Man equivalents	-0.0992	0.0684	0.1558	-0.0757	0.1230	0.5422
Machinery and equipment investment	0.0574	0.0611	0.3536	0.0756	0.0825	0.3656
Number of dairy cows	0.4719	0.1084	0.0001	0.2987	0.1832	0.1118
Total feed cost	0.0786	0.0397	0.0556	0.1548	0.0704	0.0343
Major farm expenses	0.3326	0.0629	0.0001	0.3112	0.0884	0.0012
Coefficients of determination		.8933			.8659	

both equations. This negative coefficient, if significant, would indicate a negative return to the additional use of this input, leading to the conclusion that the farmer could somewhat reduce the amount of labor and still maintain the same level of production. This negative figure could also be a result of a failure to accurately determine the correct amount of labor used in the production process or of some extra labor being held in reserve because of the labor demands in a dairy business for 365 days of the year.

Estimating Costs of Production from Dairying

The Cobb-Douglas type equation used for estimation of total cost from dairying for both years was the following:

$$C = aX_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5}$$

where:

C = total cost from dairying

a = some constant

X_1 = investment in land, buildings, and improvements

X_2 = man equivalents

X_3 = machinery and equipment investment

X_4 = number of dairy cows

X_5 = major farm expense items[15]

b = regression coefficients.

---

[15] Included rent, seed, fertilizer and lime, miscellaneous expenses, custom hire, and breeding and veterinary expenses.

The estimates for the equations for total cost from dairying were developed as follows:[16]

Equation III (Estimated Total Cost Equation for 1976):

$$C = 4.9933 \; X_1^{.1199} \; X_2^{.1201} \; X_3^{.0407} \; X_4^{.3479} \; X_5^{.3110}$$

$$R^2 = .88$$

Equation IV (Estimated Total Cost Equation for 1977):

$$C = 4.7264 \; X_1^{.0967} \; X_2^{.1618} \; X_3^{.1069} \; X_4^{.2737} \; X_5^{.4110}$$

$$R^2 = .93$$

The t test was used to test if the sum of the elasticities differed significantly from one at the .10 level;[17] the results did not differ significantly from one in either Equation III or IV. The sum of the elasticities in Equation III was .9396, and .9601 for Equation IV.

Comparison of Equations III and IV

The regression coefficients and coefficients of determination for the two equations are compared in Table X. The coefficient of determination (R^2) was .88 for 1976 and .93 for 1977. This shows that the models explained 88 percent and 93 percent of the variability of the dependent variable for the respective years. The coefficient of determination for each equation was significant at the .01 level as

---

[16]The Cobb-Douglas type function was converted to logarithmetic form to allow estimation by the least squares method.

[17]Kmenta.

TABLE X

COMPARISON OF REGRESSION COEFFICIENTS AND COEFFICIENTS OF DETERMINATION FOR ESTIMATED TOTAL COST EQUATIONS FOR 1976 AND 1977

Input	Equation III (1976)			Equation IV (1977)		
	Regression coefficient	Standard error of the estimate	Significance level	Regression coefficient	Standard error of the estimate	Significance level
Investment in land, buildings, and improvements	0.1199	0.0447	0.0109	0.0967	0.0456	0.0408
Man equivalents	0.1201	0.0685	0.0878	0.1618	0.0620	0.0130
Machinery and equipment investment	0.0407	0.0618	0.5141	0.0169	0.0462	0.7164
Number of dairy cows	0.3479	0.0880	0.0003	0.2737	0.0743	0.0007
Major farm expenses	0.3110	0.0753	0.0002	0.4110	0.0587	0.0001
Coefficients of determination		.8767			.9345	

determined by the F test. All of the variables for 1976 and 1977 exhibited the hypothesized sign.

In 1976 there were four variables: major farm expenses;[18] number of dairy dows in the herd; investment in land, buildings, and improvements and man equivalents which were significant at the .10 level. In the cost equation for 1977, the same four variables were significant at the .10 level.

---

[18] Included rent, seed, fertilizer and lime, miscellaneous expenses, custom hire, and breeding and veterinary expenses.

CHAPTER IV

MANAGEMENT INDEX AND DISCRIMINANT ANALYSIS FOR MANAGEMENT CLASSIFICATION

One objective of this study was to develop management indices for purposes of classifying the farms into management levels. After the farms were classified according to the management indices, seven efficiency factors were selected to ascertain if they could be used in separating the farms into management categories. Discriminant analysis was utilized to statistically classify the farms into management levels.

I. DEVELOPMENT OF MANAGEMENT INDICES

Most of the farms in the study had negative imputed returns to management. In order to place the returns to management on a positive basis, a constant value of $90,000 was added to the difference between the actual and estimated value of farm production and to the difference between the actual and estimated costs for both years. This was done to remove all of the negative values, the lowest of which was -$88,715. The addition of a constant makes the actual and estimated values all positive. This enables them to be placed in the first quadrant of a graph so that a relevant distance can be observed. For example, if Farm A had an income from dairying of $10,000, while dairying costs were $15,000, then the return to management would be -$5,000. However, for use in the calculation of the management index, the chosen constant figure would be added to the -$5,000.

The management indices were computed for each farm in the study as a means of comparing each manager's actual returns to his estimated returns to management. The management index is a means of determining whether or not a farm manager's returns were what they were expected to have been, based on his given set of available resources.

Actual returns to management were calculated directly from the data. Estimated returns to management were the differences between the estimated value of farm production and the estimated cost of production from the dairying operation for each respective farm. The estimated returns to management ranged from -$88,715 to $26,629 for 1976 and from -$86,410 to $59,463 for 1977. The actual calculated range of returns to management in 1976 was from -$65,802 to $38,497 and from -$53,301 to $85,196 in 1977.

The management index for both years was calculated as follows:

$$\text{Management Index for Returns to Management} = \frac{Y}{\hat{Y}} \times 100$$

where:

Y = actual returns to management

$\hat{Y}$ = estimated returns to management.

This method of calculating the index expresses the actual returns to management as a percentage of the estimated returns to management, as determined by the income and cost equations developed earlier. If it is assumed that a farmer's actual returns should equal or exceed his estimated returns, then the management index should be equal to or greater than 100. This would indicate that a farmer's actual returns

were equal to or greater than the returns estimated for him, based on his available resources. Therefore, a management index of below 100 would indicate below average management performance, and indices of greater than 100 would indicate above average management levels.

The values computed for the management indices of 1976 ranged from 3.296 to 150.434. The mean value of these indices was 99.922, and the standard deviation was 27.408. The management indices for 1977 ranged from a low value of 22.379 to a high of 211.269. The mean index for 1977 was 101.704 and the standard deviation was 33.077.

II. SELECTION OF EFFICIENCY FACTORS

The value derived for a management index could be affected by several factors. Some of the efficiency factors could be used as an additional means of classifying the management level. In this study efficiency factors used in the discriminant analysis were from the following groups: production efficiency, cost efficiency, labor efficiency, and investment efficiency. The production efficiency factors used were pounds of milk sold per cow and corn yield per acre. The cost efficiency factors selected for use were machinery and equipment costs per tillable acre and feed cost per hundredweight of milk sold. Cows per man equivalent was used to represent labor efficiency. The investment factor used was investment in land, buildings and improvements per cow. In addition to the selected variables discussed above, one other factor was selected as a measure of overall efficiency. This variable was milk sales per dollar of total investment in dairying.

III. DISCRIMINANT ANALYSIS

Discriminant analysis classifies by computing a set of linear functions on the basis of variables common to each observation.[1] This technique can be used to establish groups, explain their differences, and classify future observations into one of the group. By analysis of variance, the discriminant analysis determines a set of linear functions which best discriminates among the groups. This is achieved by combining a set of variables so that their means are the maximum distance apart.[2] One of the major limitations of this analysis technique is that only quantifiable characteristics can be used in the function.

There were two major purposes in utilizing discriminant analysis in the study. First, it was used to determine whether or not selected variables could discriminate between different levels of management ability. Secondly, it was used in order to develop from the discriminant function some critical values for the variables used in the analysis.

The use of discriminant analysis requires a preclassification of the observations into groups. The observations in this study were classified based on the management index for each farm. The farms were grouped into below average, average, and above average management

---

[1] E. C. Currin, Jr., W. L. Gibson, Jr., and R. K. Reynolds, "Multiple Discriminant Analysis of Grade A Dairy Farm Businesses," Research Division Bulletin No. 37 (Blacksburg, Virginia: Virginia Polytechnic Institute and State University), January 1971.

[2] William S. Peters and George W. Summers, Statistical Analysis for Business Decisions (New York: Prentice-Hall, 1968), p. 401.

ability levels with management indices of less than 90, 90 to 110 and more than 110 for the groups, respectively.

The discriminant function takes the form of:

$$Y = a_1X_1 + a_2X_2 + \ldots a_kX_k$$

where:

Y = discriminant value

$X_1 \ldots X_k$ = quantifiable characteristics of the observations

$a_1 \ldots a_k$ = estimated discriminant coefficients.

The six efficiency factors which were chosen by efficiency groups were utilized in the discriminant analysis. In addition to these six variables, one overall efficiency factor was used. These seven variables used in the analysis are listed as follows:

X_1 = pounds of milk sold per cow

X_2 = corn yield per acre

X_3 = machinery and equipment costs per tillable acre

X_4 = investment in land, buildings, and improvements per cow

X_5 = feed cost per hundredweight of milk sold

X_6 = cows per man equivalent

X_7 = value of milk sold per dollar of investment.

Results of Discriminant Analysis

Discriminant analysis was conducted on both years of data to determine whether or not it would correctly classify the observations

into the three management groups.[3] The coefficients of the discriminant functions are given in Tables XI and XII.

There are four factors which help to determine the importance of a variable in the function. These factors are the absolute value of the variable in the observations, the value of the difference between the coefficients between groups, the absolute size of the coefficient in the discriminant function, and the discriminant score.

In the analysis of the 1976 data, two variables had a discriminant function coefficient greater than one as shown in Table XI. Feed cost per hundredweight of milk sold ranged from 3.1317 in group 3 to 3.3542 in group 2 and value of milk sold per dollar of investments ranged from -1.5326 in group 2 to 14.5355 in group 1.

In the 1977 analysis, only one variable in the discriminant function had a coefficient greater than one as shown in Table XII. This variable was value of milk sold per dollar of investment. The coefficient of this variable ranged from 10.5008 in group 1 to 35.5422 in group 3.

A discriminant score can be computed for each variable, and can be compared with discriminant scores of variables in the same group and in other groups. The discriminant score is obtained by multiplying the mean value of a variable in a certain management index group by the discriminant coefficient of the same variable in that same management

---

[3]The chi square test was significant at the .10 level; therefore, the analysis was forced to use the pooled covariance matrix in order to obtain the discriminant function.

TABLE XI

FACTOR MEAN VALUES, ESTIMATED DISCRIMINANT FUNCTION COEFFICIENTS, AND DISCRIMINANT SCORES FOR SELECTED VARIABLES BY MANAGEMENT GROUPS FOR 1976

Factor	Mean values	Management index groups					
		Less than 90		90-110		Greater than 110	
		Discriminant coefficient	Discriminant score[a]	Discriminant coefficient	Discriminant score[a]	Discriminant coefficient	Discriminant score[a]
Pounds of milk sold per cow	12,338.25	0.0068	83.90	0.0079	97.47	0.0072	88.84
Corn yield per acre	99.547	-0.0454	-4.52	-0.0376	-3.74	-0.0233	-2.32
Machinery and equipment costs per tillable acre	70.325	0.1643	11.55	0.1572	11.06	0.1043	7.33
Investment in land, buildings, and improvements per cow	1950.217	0.0025	4.88	-0.0010	1.95	-0.0006	-1.17
Feed cost per hundredweight of milk sold	6.334	3.1411	19.90	3.3542	21.25	3.1317	19.84
Cows per man equivalent	36.051	0.3355	12.08	0.4050	14.60	0.4038	14.56
Value of milk sold per dollar of investment	0.420	14.5355	6.10	-1.5326	-0.64	2.4840	1.04
CONSTANT TERM		-67.3984	-67.40	-71.2553	-71.26	-62.1175	-62.12
Total Discrimant Score			66.49		66.79		66.00

[a]The discriminant score was obtained by multiplying each factor mean value by the discriminant coefficient, respectively.

TABLE XII

FACTOR MEAN VALUES, ESTIMATED DISCRIMINANT FUNCTION COEFFICIENTS, AND DISCRIMINANT SCORES FOR SELECTED VARIABLES BY MANAGEMENT GROUPS FOR 1977

Factor	Mean values	Management index groups					
		Less than 90		90-110		Greater than 110	
		Discriminant coefficient	Discriminant score[a]	Discriminant coefficient	Discriminant score[a]	Discriminant coefficient	Discriminant score[a]
Pounds of milk sold per cow	12,106.15	0.0026	31.48	0.0028	33.90	0.0023	27.84
Corn yield per acre	106.751	0.1543	16.50	0.2117	22.64	0.1819	19.45
Machinery and equipment costs per tillable acre	69.825	0.0307	2.14	0.0046	0.32	0.0035	0.24
Investment in land, buildings, and improvements per cow	2163.774	0.0013	2.81	0.0014	3.03	0.0024	5.19
Feed cost per hundredweight of milk sold	7.548	0.5163	3.90	0.3761	2.84	0.3466	2.62
Cows per man equivalent	35.524	0.3084	10.96	0.3519	12.50	0.2752	9.78
Value of milk sold per dollar of investment	0.358	10.5008	3.76	23.6627	8.47	35.5422	12.72
CONSTANT TERM		-33.5691	-33.57	-43.7206	-43.72	-38.8421	-38.84
Total Discrimant Score			37.98		39.98		39.00

[a]The discriminant score was obtained by multiplying each factor mean value by the discriminant coefficient, respectively.

group. The efficiency factor which contributed most to the discriminant scores was pounds of milk sold per cow, Tables XI and XII.

Classification Matrix

A classification matrix for each year is shown in Tables XIII and XIV. These tables illustrate the manner in which the discriminant function classified the observations into the three management groups. If the discriminant function had classified all the observations perfectly, all the figures not shown in parenthesis would have been zeroes. The figures on the diagonal, which are shown in parentheses, are those observations which were correctly classified.

From the 1976 data, 10 observations were in group 1, according to the management index of each. The discriminant analysis correctly classified seven of these. Of those incorrectly assigned, two were assigned to group 2 and one was placed in group 3. Therefore, 70 percent of the observations in group 1 was correctly classified for 1976. Sixteen observations were in group 2. The discriminant analysis correctly classified eight of these. Therefore, 50 percent of the observations in group 2 was correctly classified for 1976. Group 3 demonstrated the highest percentage correctly classified for 1976, with 75 percent correct. The overall correct classification for the model, using the 1976 data, was 63 percent.

In the 1977 data, group 1 contained eight observations, five of which were correctly classified. Therefore, 62.5 percent of the observations in group 1 was correctly classified. Group 2 contained 17 observations, 10 of which were correctly classified, resulting in a

TABLE XIII

CLASSIFICATION MATRIX FOR ESTIMATED DISCRIMINANT FUNCTIONS OF MANAGEMENT GROUPS FOR SEVEN SELECTED VARIABLES FOR 1976[a]

A prior management index classification groups	Group assignment according to discriminant functions				
	Management index groups			Total	Percent correctly classified
	Less than 90	90-110	Greater than 110		
Group 1	(7)	2	1	10	70.00
Group 2	3	(8)	5	16	50.00
Group 3	2	1	(9)	12	75.00
Total				38	63.16

[a]There was information for computing the management index on 38 of the study farms.

TABLE XIV

CLASSIFICATION MATRIX FOR ESTIMATED DISCRIMINANT FUNCTIONS OF MANAGEMENT GROUPS FOR SEVEN SELECTED VARIABLES FOR 1977[a]

A prior management index classification groups	Group assignment according to discriminant anaylsis				
	Management index groups			Total	Percent correctly classified
	Less than 90	90-110	Greater than 110		
Group 1	(5)	1	2	8	62.50
Group 2	1	(10)	6	17	58.82
Group 3	2	3	(5)	10	50.00
Total				35	57.14

[a]There was information for computing the management index on 35 of the study farms.

58.82 percent correct classification. Fifty percent of the observations in group 3 was correctly classified. The overall percentage of correct classifications for the discriminant analysis of the 1977 data was 57 percent.

These results illustrate that the model performed similarly for both years of data. The results reveal that there is roughly a 60 percent probability of the discriminant function assigning an observation into the correct group.

CHAPTER V

SUMMARY AND CONCLUSIONS

I. SUMMARY

Objectives

There were two major objectives of this study. These objectives were to quantify a value for the management ability on each farm in the study, and then to categorize the farms into three management groups based on selected efficiency factors.

Data

The data used were obtained from the AGRIFAX record keeping program of the Federal Intermediate Credit Bank in the Fourth Farm Credit District. The records that were obtained were for dairy farms. All of the farms received at least 50 percent of their total income from dairy operations, and no more than 15 percent from the sale of livestock. Data were obtained for two years, 1976 and 1977, and both years were analyzed separately to determine if any type of relationship could be found to exist between specific variables and income and cost. Two analysis techniques were utilized, regression analysis and discriminant analysis.

Regression Analysis

Four empirical models, or functions, were fitted to the data. The functions for the value of farm production from dairying for 1976 and

1977 used the following independent variables: investment in land, buildings, and improvements; man equivalents; machinery and equipment investment; number of dairy cows; total feed cost; and major farm expense items. The functions for total cost for 1976 and 1977 used the following independent variables: investment in land, buildings, and improvements; man equivalents; machinery and equipment investment; number of dairy cows; and major farm expense items.

The variables that were significant at the .10 level in the equation for value of farm production from dairying in 1976 were number of dairy cows, total feed cost, and major farm expense items. In the value of production equation for 1977, the variables of investment in land, buildings, and improvements, total feed cost, and major farm expense items were significant at the .10 level. The R^2 values for these production equations were 89 percent and 87 percent for 1976 and 1977, respectively.

Significant at the .10 level in both years for the cost equation were: investment in land; buildings and improvements; man equivalents; number of dairy cows; and major farm expense items. These equations had R^2 values of 88 percent and 93 percent for the years of 1976 and 1977, respectively.

The Management Index

A figure for returns to management was computed by subtracting the total cost from dairying from the value of farm production from dairying. This value was calculated for both actual and predicted

values, to obtain both the actual value of returns to management and the predicted value of returns to management.

From these figures a management index for the returns to management was developed. Such an index was developed for each farm in the study and for each of the two years separately. The management indices ranged from 3.296 to 150.434 for 1976 and from 22.379 to 211.269 for 1977.

The farms were classified into three management groups based on the management index of each. Group 1 consisted of the below average managers with an index of less than 90. The second group was composed of the average managers whose indices ranged from 90 to 110, and group 3 included the above average managers whose indices were higher than 110.

Discriminant Analysis

Discriminant analysis was used to classify the observation into the three management groups. This classification by discriminant analysis was then compared to the previous classification based on management indices. It was found that the discriminant function correctly classified 63 percent of the 1976 observations and 57 percent of the 1977 observations.

A discriminant score was calculated for each variable in each management group. The efficiency factor which contributed most to the discriminant scores was pounds of milk sold per cow.

II. CONCLUSIONS

This study was less than fully successful in consistently quantifying and measuring managerial quality.

Further research is needed to develop techniques for distinguishing the quality of management before using these models in evaluating borrowers for extending credit.

LIST OF REFERENCES

LIST OF REFERENCES

Bauer, Larry L., and John P. Jordan. "A Statistical Technique for Classifying Loan Applications." Bulletin No. 476, The University of Tennessee Agricultural Experiment Station, March 1971.

Brown, C. A., and J. M. White. "Management Factors Associated with Herd Average Milk Yield and Income Over Feed Cost in Guernsey, Holstein, and Jersey Herds." Journal of Dairy Science, 56, Part 7 (June 1973): 789-804.

Currin, E. C., Jr., W. L. Gibson, and R. K. Reynolds. "Multiple Discriminant Analysis of Grade A Dairy Farm Businesses." Research Division Bulletin No. 37, Blacksburg, Virginia: Virginia Polytechnic Institute and State University, January 1971.

Curtis, G. W., and J. W. Carson. "Cost of Cotton Production and Profit per Acre." Bulletin No. 26, Texas Agricultural Experiment Station, 1893.

Dell, John P., and Frank Orazem. Production Economics Theory with Applications. Columbia, Ohio: Grid, Inc., 1978.

Dunn, Daniel J., and Thomas L. Frey. "Discriminant Analysis of Loans for Cash-Grain Farms." Agriculture Finance Review, Economic Research Service, U.S. Department of Agriculture, Vol. 36, April 1976.

Fourth Farm Credit District Production Credit Association, Farm Credit Service. 1976 Agrifax--Comparative Farm Business Analyses. Louisville, Kentucky.

Fourth Farm Credit District Production Credit Association, Farm Credit Service. 1977 Agrifax--Comparative Farm Business Analyses. Louisville, Kentucky.

Hamilton, William S., Jr. "A Production Function Analysis of Grade A Dairy Farms in Middle and East Tennessee." Unpublished Master's thesis, The University of Tennessee, Knoxville, 1978.

Heady, Earl O., and John L. Dillon. Agricultural Production Functions. Ames, Iowa: Iowa State University Press, 1961.

Heady, Earl O. "Production Function from a Random Sample of Farms." Journal of Farm Economics, 28(1946): 989-1004.

Henderson, James M., and Richard E. Quandt. Microeconomic Theory: A Mathematical Approach. New York: McGraw-Hill, 1958.

Johnson, Russell B. "Agricultural Loan Evaluation with Discriminant Analysis." Doctoral dissertation, The University of Missouri, Columbia, 1970; published by University Microfilms International, Ann Arbor, Michigan, 1978.

Kadlec, John E., Luther H. Keller, and Arthur K. House. "Factors Affecting Cost of Production of Grade A Milk in the Louisville Milkshed." Bulletin No. 767, Purdue Agricultural Experiment Station, November 1963.

Kmenta, Jan. Elements of Econometrics. New York: The Macmillan Co., 1971.

Melichar, Emanuel, and Marian Sayre. Agricultural Financial Data Book. November 1977 Annual Series and December Monthly Series. Division of Research and Statistics, Board of Governors of the Federal Reserve System. Washington, D.C.

Peters, William S., and George W. Summers. Statistical Analysis for Business Decisions. New York: Prentice-Hall, 1968.

Shephard, Ronald W. Cost and Production Functions. New York: Princeton University Press, reprint of the 1953 ed., 1981.

Speecher, J. A., and C. A. Lasseter. "Influence of Specified Farm Management Factors on Dairy Farm Net Income." Journal of Dairy Science, 48(1965): 1698-1703.

Tintner, Gerhard, and O. H. Brownlee. "Production Function Derived from Farm Records." Journal of Farm Economics, 26(1944): 566-571.

U.S. Department of Agriculture, Crop Reporting Board, Economic, Statistic and Cooperatives Service. Milk Production, Disposition, Income, 1976-78. Washington, D.C., May 1979.

U.S. Department of Commerce, Bureau of the Census. Statistical Abstract of the United States, 1976, 97th ed. Washington, D.C., 1976.

Warren, G. F. "An Apple Orchard Survey of Wayne County, New York." Bulletin No. 226, Part I, Cornell Agricultural Experiment Station, 1905.

Warren, G. F. "An Economic Study of Agriculture in Northern Livingston County, New York." Bulletin No. 539, Cornell Agricultural Experiment Station, 1932.

Weston, N. A. "The Cost of Producing Corn and Oats in Illinois." Bulletin No. 50, Illinois Agricultural Experiment Station, 1896.

VITA

James Edward Clark, Jr., was born in Lebanon, Kentucky on June 3, 1955, the son of Mr. and Mrs. James E. Clark, Sr. In June of 1973 he was graduated from Bowling Green High School in Bowling Green, Kentucky.

In August 1973, he entered Mississippi State University as a student in the College of Agriculture. He majored in Agricultural Economics and was awarded the Bachelor of Science degree in July 1977.

From July 1977-July 1979, he was employed as a graduate research assistant in the Department of Agricultural Economics and Rural Sociology of The University of Tennessee, Knoxville.

He is presently employed with the Federal Land Bank of Louisville, Kentucky, and is completing the requirements for the Master of Science degree in Agricultural Economics.

He is married to the former Beth Ammons of Inverness, Mississippi.