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EXECUTIVE SUMMARY

Responding to concerns of the Michigan Dairy Industry in January, 1988, MSU conducted a survey of Michigan dairy farms for the calendar year 1987 to ascertain their current status with respect to technologies utilized, associated management practices, and financial status.

In an effort to assess potential areas of future research to aid Michigan dairy farmers in adapting to the changing face of Michigan's dairy industry in the context of the national industry, an extensive statistical analysis was performed on aspects of the data set produced by the 1987 survey.

Among the major findings of the analysis are that: 1) informal and formal managerial practices relating primarily to health and nutrition, and herd reproduction (A.I.) and performance testing are important determinants of productivity per cow; 2) independence in dairy operations (e.g. purchase by-product feeds) parallels a higher productivity per cow; 3) education is a significant determinant of productivity per cow; and 4) non-farm income is clearly identified as a detrimental element in the determination of productivity per cow. Further research into the dynamics of these relationships could benefit Michigan's dairy producers.

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1. INTRODUCTION

In response to concerns relating to the Michigan Dairy Industry in January, 1988, Michigan State University conducted a survey of Michigan dairy farms to ascertain their current status with respect to technologies utilized, associated management practices, financial status, and demographic characteristics. The time period of the survey was for the calendar year 1987. This report contains a statistical analysis of selected data from that survey incorporating the methodologies of factor analysis extended to regression analysis. Specifically, a statistical analysis is reported herein of the relationships between two indices of productivity and profitability - productivity per cow (MILKPER) and net farm income (NETFINC)- and two broad aspects of Michigan's dairy operations: 1) managerial practices; and 2) demographic characteristics.[1]

The methodology used merges both factor and regression analysis. The two methods of statistical analysis are combined so that 1) the data set can be rewritten in a more compact and telling form, and 2) relationships can be assessed between the chosen indices, MILKPER and NETFINC. The goal of this analysis is to identify areas of research which will provide Michigan dairy farmers with strategies for enhancing their profitability in the decade of the 1990's.

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[1] Though productivity per cow is perhaps the best proxy available, it does have some limitations for representing economic efficiency. It may adequately represent efficiency of capital utilization, but does not necessarily reflect efficiency of the expenses, i.e. of the net farm income variety.

2. DATA

The data source for this study is a sample of Michigan dairy operations responding to the 1987 MSU Survey of Michigan Dairy Farms.[2] The stratified sampling procedure utilized was developed by Michigan Agricultural Statistics Service (MASS) to assure that all regions of the state were sampled in proportion to their number of dairy farms. A focus on long-term viability required the exclusion of farms with five or fewer dairy cows from the sample. Of the 1,500 surveys mailed, 607 farms responded and 508 were still active dairy farms (see Table 1).

A limited portion of the respondents is used in the present analysis. Because all respondents did not answer all of the survey questions, the number of complete observations used in this analysis is 340. Tables 2 and 3 show the relevant statistics of the original and the smaller sample. Appendix A contains a list of the variables and their respective definitions.

Table 1
Current Status of Dairy Farm Respondents, Michigan Dairy Farms
1987

Current Dairy Farming Status	Number of Farms Reporting	Percent of Total Farms Reporting
Active dairy farmers	508	75.8%
No longer in dairying	162	24.2%
Total	607	100.0%

[2] See Connor et al. for a more comprehensive account of the survey's background.

Table 2
A Comparison of USDA Estimates of Michigan Dairy Industry
With Sample From the 1987 MSU Dairy Farm Survey

	Michigan Total	MSU Survey	MSU Survey as a Percent of State
Total pounds of milk produced	5,248,000,000	517,705,173	9.86%
Total cow inventory/1	358,000	35,672	9.96%
Average production per cow	14,537	14,513	-.17%

Table 3
A Comparison of USDA Estimates of Michigan Dairy Industry
With Reduced Sample From the 1987 Dairy Farm Survey

	Michigan Total	MSU Survey	MSU Survey as a Percent of State
Total pounds of milk produced	5,248,000,000	389,056,629	7.4%
Total cow inventory/1	358,000	26,335	7.4%
Average production per cow	14,537	14,773	1.62%

3. MODEL SPECIFICATION

Factor analysis was used to redefine the basic data set in a more compact form. The primary aims of factor analysis are to: 1) identify groups of inter-correlated variables; 2) rewrite the data set in an alternate form.[3] Subsequently, regression analysis was utilized to ascertain relationships among the factors and the dependent variables of MILKPER and NETFINC. The factor analytic model used to redefine the data set is of the form:

$$x_i = G(F_1, F_2, ..., F_k) + u_i \text{ for } i = 1,2,...,n$$

where

x_i = variable i of n variables; F_k = k^{th} factor; and u_i = the unique variance of each variable i. When $u_i = 0$, then $k = i$.

Factor extraction was done by means of the principle components method (Harman 1962; Kaiser 1974; Kim and Mueller 1978; Johnston 1980; Norusis 1988). Because relatively low correlations among the factors, an oblique method of rotation was chosen to obtain better factor/variable correlations.

An ordinary least squares model was used in subsequent regression analysis. The equation estimated was

$$Y = a + B_1F_1 + B_2F_2 + ... + B_kF_k + e,$$

where a = intercept term; B_k = estimated parameters; F_k = respective factors; and e is an error term.

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[3] Methods of analysis other than factor analysis may have proved to be better methods (eg. path analysis). However, it is not the intention of this research to test the validity of theories of managerial organization but to identify natural, purely statistical groupings of practices and demographic characteristics which could affect dairy farm performance. With this analysis, future research could be directed toward the identification of more theoretical managerial constructs.

4. DEFINITIONS OF FACTORS

In order to establish the appropriateness of factor analysis several preliminary statistics were examined. The first statistic was the measure of sampling adequacy or (MSA) of each variable. An examination of the main diagonal of the anti-image correlation matrix (MSA_i's) provides information on the relative worth of keeping individual variables in the factor analysis (Norusis 1988). Table 4 provides a list of MSA's less those of CULL2 and NDHIA, which in the initial analysis had MSA's of .3 and .3, respectively.

A gross measure of sampling adequacy can be found in the Kaiser-Meyer-Olkin (KMO) statistic which compares the magnitude of the observed correlation coefficients and the magnitude of the partial correlation coefficients. If the sum of the squared partial correlation coefficients between all pairs is similar to the sum of squared correlation coefficients, the KMO measure is close to 1. KMO statistics have been included in Table 4 (Kaiser 1974).

One final statistic to be used in determining the utility of factor analysis is Bartlett's test of sphericity (BTS; Norusis 1988). The BTS is used to establish the presence of an adequate level of correlation among the variables to be used in the model. The rejection of the null hypothesis -no significant correlation- signifies the presence of adequate correlation to warrant the use of factor analysis (see Table 4).

4.1 FACTOR SELECTION

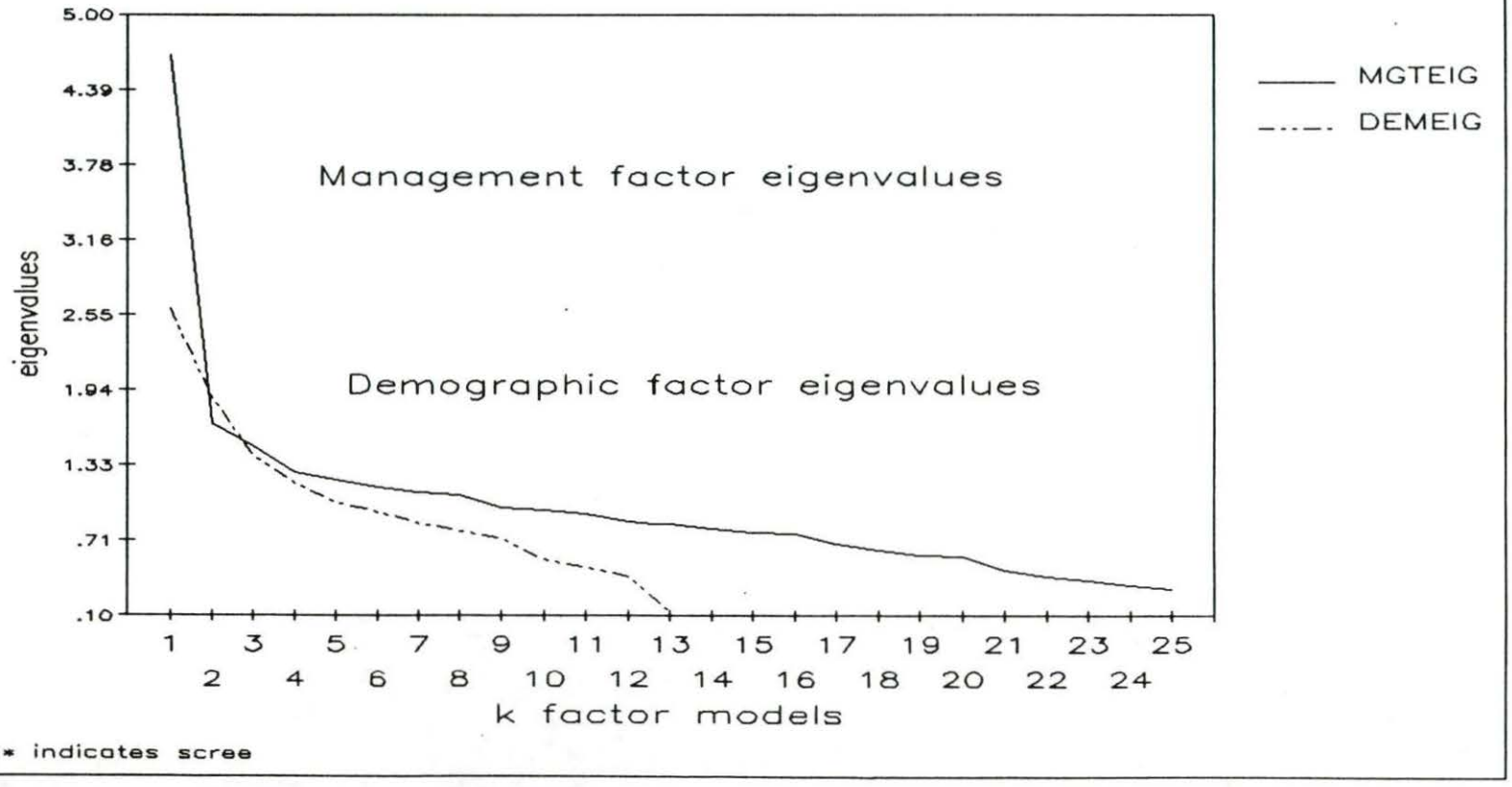
There are a number of methods for selection of the appropriate number of factors to be included in the model. An examination of the eigenplots is used in the present analysis. It is assumed that the *'scree'* or leveling-off begins at the K^{th} factor, where K is the true number of factors (Norusis 1988, B-74). The *scree* defines the

gradual trailing-off of the *eigenvalues* as the number of factors included in the model increases. An examination of Figure 1 indicates that four and five factor models are appropriate in the groupings of managerial practices and demographic characteristic, respectively. Figure 2 shows the percentage of variance in the data sets explained by the two models. Table 5 shows the correlations present among the factors in the two models.

Table 4
Measures of Sampling Adequacy, and Other Statistics

Variable	MSA	Variable	MSA
FORQU	.8646	OWNER1	.6756
HIREPS	.5578	OWNER2	.5418
SOILT	.8494	FAM	.6598
MICROC	.8008	EDU1	.5633
MAILIN	.7971	EDU2	.5747
DHIA	.7967	EDU3	.5617
SOMCC	.7693	BST	.8161
AIHF	.7717	PCHERDS	.6695
AICOW	.6928	CASH	.6013
FRATF	.8321	NETFINC	.7978
GROUP	.8577	NONFINC	.5162
PREGCHK	.8373	DARATIO	.5332
POSTPEX	.8828	COWS	.6133
PURREC	.5524		
HEATSYN	.7716		
VET	.8102		
3X	.7650		
PDIP	.5734		
DIPP	.8149		
1STCALF	.8396		
DRYCMP	.5515		
CULL1	.8287		
REGCAT	.7785		
16PER	.5089		
BYPROD	.6094		
KMO	.7973		.6230
BTS	1537.2367 (0.0000)		928.4293 (0.0000)

Figure 1: Eigenplots for management and demographic factors for k factor models



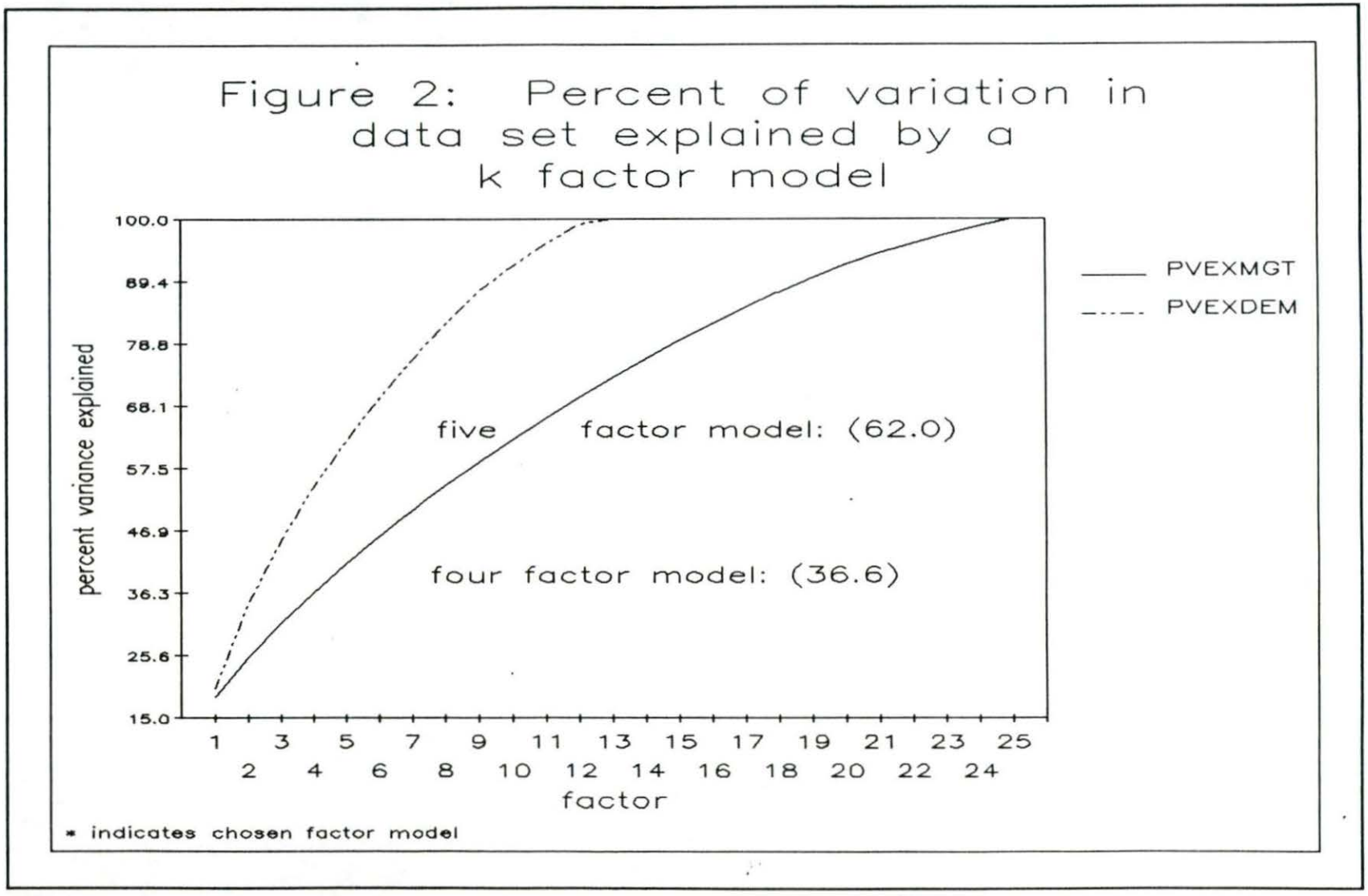


Figure 2: Percent of variation in data set explained by a k factor model
100.0
89.4
78.8
68.1
57.5
46.9
36.3
25.6
15.0
percent variance explained
five factor model: (62.0)
four factor model: (36.6)
PVEXMGT
PVEXDEM
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
factor
* indicates chosen factor model

Table 5
Factor Correlation Matrices

Management Factors

Factors	MGT1	MGT2	MGT3	MGT4
MGT1	1.0			
MGT2	0.1072	1.0		
MGT3	0.0800	-.0051	1.0	
MGT4	0.3102	.0351	.0797	1.0

Demographic Factors

Factors	DEM1	DEM2	DEM3	DEM4	DEM5
DEM1	1.0				
DEM2	-0.0210	1.0			
DEM3	0.1386	-0.0782	1.0		
DEM4	-0.0335	0.0147	-0.0828	1.0	
DEM5	.0001	0.1386	-0.0531	0.0584	1.0

4.1.1 HYPOTHESIZED RATIONALE FOR A FOUR FACTOR MODEL

Table 6 shows an abbreviated structure matrix for the four factor model of management practices. The hypothesized rationale for a four (4) factor model is the following. MGT1 appears to include both herd health (Regularly scheduled vet services [VET], systematic post-partum exams [POSTPEX], pregnancy check within 40 days of breeding [PREGCHK], teat dip cows after milking [DIPP], treat dry cows for mastitis prevention [DRYCMP]) and feed management practices (Soil testing for crops for fertilizer application [SOILT], forage quality testing by cutting [FORQU], FRATF, group cows by production level and feed accordingly [GROUP]). Also included in factor 1 are two reproduction/replacement practices (Cull at a rate greater than 15 percent [CULL1] and heat synchronization check [HEATSYN]). Finally, the presence of Mail-in services for farm records [MAILIN] with regularly scheduled vet services [VET] may indicate specialization of managerial duties. The composition of factor 1 tends to indicate a possible measure of managerial intensity of general dairy farm management, or informal managerial practices. As a measure of informal managerial intensity, MGT1 is hypothesized to have a positive relationship with productivity per cow (MILKPER) and net farm income (NETFINC).

MGT2 is a bit more difficult to explain. The inclusion of a health, a reproductive, and a feed management practice and number of milkings per day could be an indicator of size. According to Dr. Ted Ferris of the Department of Animal Science at MSU, the elements in this factor are management practices which are rarely used by Michigan dairy farmers. Efforts to incorporate heifers into the milking herds earlier (Average age of first calving for heifers is 24-25 months [1STCALF]); milking 3 times a day (3X); hiring pest scouts (HIREPS); and teat dipping cows after milking (PDIP) may

also indicate an attempt to spread fixed costs over more units of production for medium and larger herds with larger yet tenuous relative dependencies on grown feed and forage crops. MGT2 is hypothesized to have a positive relationship with both MILKPER and NETFINC.

MGT3, composed of two feed/protein source variables (Purchase 16 percent plus dairy ration [-16PER] and purchase by-product feeds [BYPROD]), a herd replacement practice (Purchase a majority of replacement cows [-PURREC]) and a general management tool (Micro computer for farm records [MICROC]), appears to indicate the relative independence/capability of the dairy operation with respect to dairy ration formulation and herd replacement. [4] The inclusion of the micro-computer for farm records also tends to indicate a degree of independence with respect to record keeping. It is worth noting that MICROC is somewhat correlated with FORQU and POSTPEX; causality, however, does not necessarily exist. MGT3 is hypothesized to have a positive relationship with both MILKPER and NETFINC.

MGT4 is a tricky factor to interpret. Since an oblique method of rotation was chosen the extracted factors are not orthogonal in their rotated form. Although in most cases the factors are negligibly correlated, the correlation between MGT1 and MGT4 (0.3102) could indicate interpretational problems. Looking at the composition of MGT4 (Artificial insemination in majority of heifer matings [AIHF], artificial insemination in majority of cow matings [AICOW], DHIA performance testing [DHIA], registered cattle account for a majority of herd [REGCAT], subscribe to DHIA somatic cell count [SOMCC]) managerial intensity appears to be a common trait among the variables. The slight correlation of DHIA with AICOW (.3624), AIHF (.3068), SOMCC (.5549), and

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[4] [-] indicates a negative correlation with the respective factor.

REGCAT (.2680) may indicate the presence of a similar yet distinct vector of managerial intensity relating to DHIA herds. 'Formality' in managerial intensity or a tendency to track herd production and genetics effectively might be a good definition of this factor.

To expand upon the above a discussion of probable causality may be in order. Data from the MSU 1987 survey in Table 7 for relative performance of DHIA herds versus NDHIA herds versus both DHIA and NDHIA versus neither shows that DHIA herds perform better on average than non-DHIA herds and usage of either DHIA or NDHIA indicates better herd performance than herds with no performance testing. Data from the USDA's Agricultural Statistics confirms that DHIA herds perform better on average with respect to productivity per cow than non-DHIA herds. This fact, however, may be a function of inherent managerial ability which parallels contracting for DHIA services in which case a causal relationship does not exist. DHIA, considering the above could be a flag denoting general managerial ability. It may follow then that an affirmative response on DHIA implies a high score on MGT1. However, a high score on MGT1 does not necessarily imply a high score on MGT4.

Table 6
Selected Variable-Factor Correlations /1

Factor Variable	Correlation with Factors: MGT1	MGT2	MGT3	MGT4
POSTPEX	.7238			
VET	.7122			
PREGCHK	.6853			
FORQU	.6470		.3464	
FRATF	.5978			
DIPP	.4907			
SOILT	.4639			
DRYCMP	.4536			
GROUP	.4069			
MAILIN	.3639			
CULL1	.3583			
HEATSYN	.3332			
PDIP		.5879		
1STCALF		.5412		
HIREPS		.4589		
3X		.4254		
16PER			-.6161	
PURREC		.3374	-.5089	
BYPROD		.3473	.4849	
MICROC			.4668	
AIHF				.7423
AICOW	.3283			.7319
DHIA	.5316			.6429
REGCAT				.5709
SOMCC	.4561			.5079

/1 No correlations are listed which are below 0.3.

The degree of correlation between MGT1 and MGT4 (0.3102) indicates the diluting effect of NDHIA and no contracted performance testing of managerial intensive dairy farmers. The effect of utilizing both DHIA and NDHIA performance testing -producing a lower herd average comparable to no performance testing- is difficult to explain. In general, however, MGT4 tends to indicate a more formal aspect of the dairy operation. MGT4 is hypothesized to have a positive relationship with both MILKPER and NETFINC.

Table 7
Effects of Performance Testing*

Performance Testing	No. Cases /1	Mean	Standard Deviation
DHIA only	175	15438.15	1876.5
NDHIA only	22	15044.21	2574.9
neither DHIA nor NDHIA	135	14772.96	2858.5
DHIA and NDHIA	8	14786.48	2160.1

/1 340 cases were used to generate these numbers.

4.1.2 HYPOTHESIZED RATIONALE FOR A FIVE FACTOR MODEL

The hypothesized rationale for a five (5) factor model is the following: DEM1 appears to include the three variables distinctly related to the size of the dairy operation (Total cash receipts [CASH], number of cows both dry and milking [COWS], and net farm income [NETFINC]). Though it is apparent that NETFINC is somewhat less correlated with DEM1 than the other two variables this can be explained by the fact that size is only a fair indicator of profitability, only fair. Information on the size of the dairy

operation is contained in DEM1. Size is a distinct advantage in organizing managerial tasks and therefore DEM1 is hypothesized to have a positive relationship with MILKPER. The relationship between DEM1 and NETFINC will not be addressed because of the composition of DEM1.

The implication of DEM2 is fairly obvious, it being composed of the education variables. Although the structure of DEM2 may indicate the likelihood of multicollinearity in the original data set (adding confusion to the present interpretation), correlations among the untransformed education variables is minimal.

Table 8
Selected Variable-Factor Correlations: Demographic Variables

Factor Variable	Correlations with Factors: DEM1	DEM2	DEM3	DEM4	DEM5
CASH	.91361				
COWS	.91007				
NETFINC	.53912				
EDU2		.79957			
EDU1		.72609			
EDU3		.62043		-.3889	
OWNER2			.90659		
OWNER1	.3797		.78276		
FAM		-.3494	.47850		
NONFINC				-.81196	
DARATIO			-.3660		.64374
PCHERDS					.61513
BST		.4151			.53938

* No correlations are listed which are below 0.3. See Appendix A for variable definitions

Education (DEM2) is hypothesized to have a positive relationship with both MILKPER and NETFINC.

Factor 3 is similarly easy to explain; composed of OWNER1 (other than individual ownership), OWNER2 (limited partnership or corporate family farm), and FAM (number of families), Factor 3 relates information as to the complexity of the ownership structure. Correlations between FAM and OWNER1 (0.2838), and OWNER2 (0.1309) in the original data set tend to indicate that complexity of ownership patterns increase somewhat with the number of families involved in the dairy operation. Complexity of ownership structure (DEM3) is hypothesized to have a positive effect on both MILKPER and NETFINC.

Factor 4 is somewhat strange in that it is composed of only one variable, NONFINC which is negatively correlated (-0.8120) with its factor.[5] Interpretation of Factor 4 is simply the relative absence of non-farm income. The presence of non-farm income, (-)DEM4, is hypothesized to have a positive relationship with MILKPER yet a negative relationship with NETFINC.

Factor 5 presents some problems. Containing the variables DARATIO, PCHERDS and BST, Factor 5 appears to demand a rather intuitive interpretation. It is hypothesized that PCHERDS is a weak proxy for a dairy farmer's optimism for future economic/political trends. That all three variables are positively correlated with Factor 5 would may imply that given the present financial condition (DARATIO) of a dairy farm, there may be a propensity to adopt BST and/or a plan to expand herd size. In sum, plans to expand production are positively associated with financial stress. Optimism

[5] Although some statisticians contend that each factor requires at least three variables, a more general criterion of twice the number of variables as factors is used in the present case.

despite present financial status is hypothesized to have a negative relationship with both MILKPER and NETFINC.

5. MANAGEMENT FACTORS AS INDEPENDENT VARIABLES [6]

In an attempt to ascertain the relative importance of the defined managerial and demographic factors (independent variables) in the determination of MILKPER and NETFINC (dependent variables) OLS regressions as defined in Section 3 were performed. At times relationships are somewhat tautological due to a characteristic of a factor and its inherent identification with a dependent variable (eg., DEM1 -composed of CASH, COWS, and NETFINC- and COWS). To partially alleviate the biasing effect of these respective factors on the regression statistics, certain appropriate factors will be dropped. While comparability between regressions will be hampered, interpretation within regressions will be enhanced. Because the number of independent variables is greatly reduced the relative size of the coefficients between regressions will be examined at times in addition to the explanatory value of variables within regressions.

5.1 MANAGEMENT FACTORS ON PRODUCTIVITY PER COW

The regression of the management factors on productivity per cow (MILKPER) while controlling for certain dairy farm characteristics resulted in a fairly wide range of adjusted-R^2's. The percent of variation in MILKPER explained by the management factors ranged from a low of 0.0 to a high of 0.5657. The majority of the adjusted-R^2's were in the 0.1000 to 0.2500 range. Three regressions demonstrated relatively high adjusted-R^2's: 1) non-specialized dairy operations (0.4164); 2) low net farm income and low debt-asset ratio (0.3695); and 3) high net farm income and high debt-asset ratio (0.5657).

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[6] See Appendix B for further details concerning regression results.

The management factors were fairly consistent in their significance between regressions. MGT1, the factor denoting informal managerial intensity, was significant in all regressions with the exception of that which controlled for large dairy herds (>120 cows). The consistent significance of MGT1 demonstrates that additional research on health and nutrition practices and specific combinations of those practices would prove useful to Michigan dairy farmers.

MGT2, the factor composed of infrequently used management practices, is significant in the regression controlling for non-specialized dairy operations, but has a negative coefficient. It would appear that non-specialization, no matter the absolute size of the dairy operation, implies that the use of certain/many of the infrequently used management practices is detrimental to productivity per cow.[7] The management practice which most surely accounts for the majority of this effect is 1STCALF. MGT3 and MGT4 are both significant in the regressions controlling for: 1) small herds (<60 cows); and 2) specialized dairy operations. MGT3 is also significant when controlling for low net farm income and high debt-asset ratio. Furthermore, MGT4 is significant when controlling for low net farm income and low debt-asset ratio.

5.2 MANAGEMENT FACTORS ON NET FARM INCOME

An attempt to explain net farm income using the management factors resulted in relatively low adjusted-R^2's. Though the adjusted-R^2's range from 0.0 up to 0.2734, the majority are around 0.1000. Only in the regression controlling for high net farm income and high debt-asset ratio did a relatively noteworthy adjusted-R^2 result (0.2734).

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[7] This may be somewhat disturbing since milking three times a day is widely believed to increase productivity per cow. However, if the factor MGT2 is understood to mean infrequently used practices in general and not 3X in particular, some amount of rationale is present in the results.

As in the regression using the management factors to explain productivity per cow, MGT1 dominates the other factors in overall significance across all categories.

MGT2 presents some interpretational problems. Though MGT2 displays the expected positive sign in the categories of small herds and high net farm income and high debt-asset ratio, it possesses a negative coefficient in the category of low net farm income and low debt-asset ratio. Despite the fact that the categories in which MGT2 is significant is not consistent between the regressions using MILKPER and NETFINC as dependent variables, the effect of MGT2 and its components is in need of further research.

The next management factor demonstrates a relatively consistent significance. In the categories of small herds, low net farm income and low/high debt-asset ratio, and specialized dairy operations, MGT3 is significant and possesses the expected positive coefficient. Three of the four categories mentioned -all but low net farm income and low debt-asset ratio- are consistent between the MILKPER and NETFINC regressions. MGT3 and its component variable are therefore good areas for further research.

MGT4 is significant in only one category, that of high net farm income and high debt-asset ratio,and possesses an unexpected negative coefficient. Further research could identify what is occurring on these farms to affect such a relationship.

6. DEMOGRAPHIC FACTORS AS INDEPENDENT VARIABLES

6.1 DEMOGRAPHIC FACTORS ON PRODUCTIVITY PER COW

The regression of the demographic factors on MILKPER performed acceptably well. Although there are many and consistently significant factors in these regressions none of the adjusted-R^2's are very large; the category of low net farm income and low

debt-asset ratio possessed the largest (0.2295). While most of the remaining statistics were above 0.1500, some were around 0.0500.

DEM1, an indicator of economic size, was significant in 5 of the nine categories. The categories in which it was not significant may be of interest: 1) herds with 60 cows or more; and 2) farms with high net farm incomes. Both of these categories may indicate the diminishing effect of size on relative efficiency as measured by productivity per cow. Among relatively smaller herds, however, the potential benefits to accrue to the operators with increased size are most likely to be highly correlated with managerial ability. The value of size in relation to managerial ability is a topic to be addressed by further research.

The value of DEM2, the education factor, appears to be similar to that of DEM1. larger herds (> 60 cows) and high net farm income farms are categories in which DEM2 is not significant. Additionally, DEM2 is not significant in the category of low net farm income and high debt-asset ratio. As with DEM1, the value of managerial ability needs further study. It is likely that the age of the principle operator in combination with the age of the operation are key components in the determination of the value of education and therefore the degree of managerial capability.

DEM3 is significant in none of the categories.

DEM4, the factor demonstrating the relative absence of non-farm income, is significant in the categories of medium sized herds, dairy operations with low debt-asset ratios and those that are specialized. The positive coefficient indicates that for increases in non-farm income, productivity per cow tends to fall off. The value of non-farm income in the enterprise mix is therefore a topic for further research which has the potential of aiding Michigan dairy operations in the process of reconfiguration.

Lastly, DEM5, the factor denoting the presence of optimism despite present financial status, is significant only in the category of specialized dairy operations. The negative coefficient of DEM5 indicates that productivity per cow increases somewhat as a function of the degree of optimism. This result can be expected given the commitment of capital commitment and income streams characteristic of specialized dairy production.

6.2 DEMOGRAPHIC FACTORS ON NET FARM INCOME

The regression of the demographic factors on NETFINC performed somewhat better than that using MILKPER. The statistics for the adjusted-R^2 ranged from a low of 0.0300 to a high of 0.4246. The regressions that performed rather well on the basis of the size of the adjusted-R^2 are: 1) high net farm income and low debt-asset ratio (0.4246); 2) medium sized herds (0.2949); and 3) non-specialized dairy operations (0.2457). In this set of regressions, DEM1 is left out because of its implicit identification with the dependent variable, NETFINC.

DEM2 is difficult to interpret in this set of regressions. For herds of less than 120 cows and high net farm income and low debt-asset ratio operations, DEM2 possesses a negative coefficient. When controlling for specialized dairy operations, DEM2 possesses a positive coefficient. The effect of older -less education- yet better managers -more experience- is difficult to identify in the data set. It is also difficult to determine the effect of ownership patterns and number of families involved in the operation. Further research may be able to uncover the relative value of these components.

DEM3 is again not significant in any of the regressions.

A problem of changing signs is evident when examining the results of DEM4. It should be remembered that the sign of the coefficient is the opposite sign of the actual effect (see Table 6). DEM4 takes on a negative sign in the following categories: 1) herds

with more than 59 cows; 2) operations with high net farm income and low debt-asset ratio; and 3) non-specialized dairy operations. DEM4 takes on a positive sign in the categories for low net farm income and low debt-asset ratio, and specialized dairy operations. This would tend to indicate the relatively greater importance of family labor on smaller, specialized dairy operations. Further research is necessary to identify the true costs and benefits of non-farm income.

DEM5 is only significant in the categories of: 1) herds with more than 59 cows; and 2) low net farm income and high debt-asset ratio. The coefficient of DEM5 is consistently negative signifying that for increases in optimism there are statistically significant decreases in net farm income. This is a relationship which is difficult to understand. It would appear that for the more optimistic dairy operations, their position as identified by their net farm income is worse than their less optimistic -more rational- counter-parts

7. SUMMARY RESULTS

The use of factor analysis on the data set leads to the identification of several areas in which further research could be potentially profitable. Tables 9, 10, 11, and 12 provide summary results for the factor regression analysis. Attempts to explain the variation of productivity per cow and net farm income with the management and demographic factors are rather successful.

The management factors performed relatively well. MGT1, the factor representing informal managerial practices -primarily POSTPEX, VET, PREGCHK, FORQU, and FRATF- [8] is extremely consistent. Those dairy farmers that score highly on MGT1 are generally more successful in terms of productivity per cow and have higher

[8] These variables have a correlation of 0.5 or greater with MGT1.

net farm incomes than those that do not. MGT1 demonstrates that additional research on health and nutrition practices and specific combinations of those practices would prove useful to Michigan dairy farmers. More information on MGT2, composed of infrequently used managerial practices, may prove to be beneficial to non-specialized dairy operations and low net farm income/low debt-asset ratio operations or for those farms that should not be using such practices. The value of MGT3, the factor indicating the degree of independence of the dairy operation, parallels that of MGT1. Finally, MGT4 or the factor of formal managerial practices appears to be important in determining productivity per cow but not net farm income. This last point may also indicate the potential benefit of an in-depth financial analysis comparing DHIA herds with no performance testing.

With respect to the demographic factors, many interesting relationships are apparent. Education (DEM2) while having a positive relationship with productivity per cow, sometimes makes a negative contribution to net farm income (see also section 5.3). The relative absence of non-farm income, DEM4, again is indicated as having a negative effect on productivity per cow and net farm income. An exception lies in specialized dairy operations. DEM5, the factor defining a relative optimism despite of present financial status, demonstrates an interesting, negative relationship with net farm income in many categories. By this last relationship Michigan dairy farmers, i.e., medium to large herds with relatively low debt-asset ratios appear to be fairly committed to dairy production. However, specialized operations and those with low net farm income and low debt-asset ratios seem more likely to cash in on that optimism.

Table 9
Summary Results: Regressions of Management Factors on Productivity Per Cow

Variables Categories		MGT1	MGT2	MGT3	MGT4
Herd size:					
less than 60 cows	H:	+	+	+	+
	A:	+	-	+	+
	S:	***	0	**	***
60 to 119 cows	H:	+	+	+	+
	A:	+	-	+	+
	S:	**	0	0	0
more than 119 cows	H:	+	+	+	+
	A:	+	-	+	+
	S:	0	0	0	0
Net income/debt-to-asset ratio:					
low net farm income/ low debt-to-asset ratio	H:	+	+	+	+
	A:	+	-	+	+
	S:	***	0	0	***
high net farm income/ low debt-to-asset ratio	H:	+	+	+	+
	A:	+	-	+	+
	S:	*	0	0	0
low net farm income/ high debt-to-asset ratio	H:	+	+	+	+
	A:	+	-	+	+
	S:	*	0	*	0
high net farm income/ high debt-to-asset ratio	H:	+	+	+	+
	A:	+	-	+	+
	S:	***	0	0	0
Specialization:					
specialized	H:	+	+	+	+
	A:	+	-	+	+
	S:	***	0	**	***
non-specialized	H:	+	+	+	+
	A:	+	-	+	+
	S:	***	***	0	**

Key:
1) H= hypothesized sign;
2) A= actual sign;
3) S= significance (0=non-significance; *=0.05; **=0.01; ***=0.001);
4) Bold lettered variable and categories indicate the presence of interesting results
5) Factor definitions:
   a) MGT1= the informal managerial factor, primarily composed of health and nutrition variables;
   b) MGT2= the factor that represents infrequently used managerial practices, characterized by the spreading of costs over more units of production;
   c) MGT3= the factor which indicates a degree of independence of a dairy operation, i.e., dairy ration tends to be formulated no bought and a majority of the replacement cows are not bought;
   d) MGT4= the formal managerial factor, primarily composed of contracted performance testing and A.I. in cows and heifers.

Table 10
Summary Results: Regressions of Management Factors on Net Farm Income

Variables Categories		MGT1	MGT2	MGT3	MGT4
Herd size:					
less than 60 cows	H:	+	+	+	+
	A:	+	+	+	+
	S:	***	*	**	0
60 to 119 cows	H:	+	+	+	+
	A:	-	-	+	-
	S:	0	0	0	0
more than 119 cows	H:	+	+	+	+
	A:	-	+	+	-
	S:	0	*	0	0
Net income/debt-to-asset ratio:					
low net farm income/ low debt-to-asset ratio	H:	+	+	+	+
	A:	+	-	+	-
	S:	*	*	*	0
high net farm income/ low debt-to-asset ratio	H:	+	+	+	+
	A:	+	+	-	+
	S:	0	0	0	0
low net farm income/ high debt-to-asset ratio	H:	+	+	+	+
	A:	+	+	+	-
	S:	0	0	***	0
high net farm income/ high debt-to-asset ratio	H:	+	+	+	+
	A:	-	+	+	-
	S:	*	*	0	0
Specialization:					
specialized	H:	+	+	+	+
	A:	+	+	+	+
	S:	**	0	*	0
non-specialized	H:	+	+	+	+
	A:	+	-	+	+
	S:	0	0	0	0

Key:
1) H= hypothesized sign;
2) A= actual sign;
3) S= significance (0=non-significance; *=.05; **=.01; ***=.001);
4) Bold lettered variable and categories indicate the presence of interesting results
5) Factor definitions:
   a) MGT1= the informal managerial factor, primarily composed of health and nutrition variables;
   b) MGT2= the factor that represents infrequently used managerial practices, characterized by the spreading of costs over more units of production;
   c) MGT3= the factor which indicates a degree of independence of a dairy operation, i.e., dairy ration tends to be formulated no bought and a majority of the replacement cows are not bought;
   d) MGT4= the formal managerial factor, primarily composed of contracted performance testing and A.I. in cows and heifers.

Table 11
Summary Results: Regressions of Demographic Factors on Productivity Per Cow

Variables Categories		DEM1	DEM2	DEM3	DEM4	DEM5
Herd size:						
less than 60 cows	H:	+	+	+	+	-
	A:	+	+	+	+	-
	S:	***	***	0	0	0
60 to 119 cows	H:	+	+	+	-	-
	A:	+	+	-	+	-
	S:	0	0	0	*	0
more than 119 cows	H:	+	+	+	-	-
	A:	+	-	-	+	-
	S:	0	0	0	0	0
Net income/debt-to-asset ratio:						
low net farm income/ low debt-to-asset ratio	H:	+	+	+	-	-
	A:	+	-	+	+	-
	S:	***	**	0	*	0
high net farm income/ low debt-to-asset ratio	H:	+	+	+	-	-
	A:	+	-	+	+	-
	S:	0	0	0	**	0
low net farm income/ high debt-to-asset ratio	H:	+	+	+	-	-
	A:	+	+	-	+	-
	S:	**	0	0	0	0
high net farm income/ high debt-to-asset ratio	H:	+	+	+	-	-
	A:	+	+	-	-	+
	S:	0	0	0	0	0
Specialization:						
specialized	H:	+	+	+	-	-
	A:	+	+	-	+	-
	S:	**	***	***	**	*
non-specialized	H:	+	+	+	-	-
	A:	+	+	+	+	-
	S:	*	0	0	0	0

Key:
1) H= hypothesized sign;
2) A= actual sign;
3) S= significance (0=non-significance; *=.05; **=.01; ***=.001);
4) Bold lettered variable and categories indicate the presence of interesting results
5) Factor definitions:
   a) DEM1= the factor indicating the economic size of the operation;
   b) DEM2= the education factor;
   c) DEM3= the factor indicating ownership patterns as they correlate with the number of families involved in the dairy operation;
   d) DEM4= the factor indicating the absence of non-farm income;
   e) DEM5= the factor that represents a weak proxy for optimism despite present financial status.

Table 12
Summary Results: Regressions of Demographic Factors on Net Farm Income

Variables Categories	DEM1	DEM2	DEM3	DEM4	DEM5
Herd size:					
less than 60 cows	H:X	+	+	+	-
	A:X	-	-	-	-
	S:X	*	0	0	0
60 to 119 cows	H:X	+	+	+	-
	A:X	-	+	-	-
	S:X	***	0	***	***
more than 119 cows	H:X	+	+	+	-
	A:X	-	+	-	-
	S:X	0	0	**	*
Net income/debt-to-asset ratio:					
low net farm income/ low debt-to-asset ratio	H:X	+	+	+	-
	A:X	+	+	+	-
	S:X	0	0	*	0
high net farm income/ low debt-to-asset ratio	H:X	+	+	+	-
	A:X	-	+	-	-
	S:X	**	0	**	0
low net farm income/ high debt-to-asset ratio	H:X	+	+	+	-
	A:X	+	+	+	-
	S:X	0	0	0	0
high net farm income/ high debt-to-asset ratio	H:X	+	+	+	-
	A:X	-	+	+	-
	S:X	0	0	0	0
Specialization:					
specialized	H:X	+	+	+	-
	A:X	+	+	+	-
	S:X	0	0	**	0
non-specialized	H:X	+	+	+	-
	A:X	-	+	-	-
	S:X	0	0	**	0

Key:
1) H= hypothesized sign;
2) A= actual sign;
3) S= significance (0=non-significance; *=.05; **=.01; ***=.001);
4) Bold lettered variable and categories indicate the presence of interesting results
5) Factor definitions:
   a) DEM1= the factor indicating the economic size of the operation;
   b) DEM2= the education factor;
   c) DEM3= the factor indicating ownership patterns as they correlate with the number of families involved in the dairy operation;
   d) DEM4= the factor indicating the absence of non-farm income;
   e) DEM5= the factor that represents a weak proxy for optimism despite present financial status.
6) X indicates a factor left out of the regression be cause of an inherent identification with the dependent variable.

8. CONCLUSIONS

Michigan dairy producers who have survived the turmoil of the 1980's may have some difficulty in undergoing major operational restructuring. Major operational restructuring will be necessary, however, if Michigan dairy producers, as an integral part of Michigan's dairy industry, are to move into the 1990's in good form. Such restructuring will no doubt help in avoiding the OTA projections of a down-sized production traditional region production region and maintain an industry vital to Michigan's rural and general economies.

This analysis attempted to identify areas within typical dairy operations where such restructuring might prove beneficial. It is not the intention of this analysis to conclude that the areas identified are the method of restructuring needed. Rather, the areas identified have a relatively greater potential of leading to research that will be both beneficial and profitable to Michigan's dairy farmers.

This data set was designed to provide a descriptive overview of the Michigan dairy industry. As a result the questions were designed to give discrete observations on very specific management practices and demographic characteristics. Therefore applying the sophisticated statistical techniques used in this analysis presented some problems.

It is clear, however, that many of the factors analyzed did have an influence on the productivity and financial performance of Michigan dairy farms. It also appears from this analysis that it is combinations of demographic and management practices that are associated with improved dairy farm performance. This suggests that some additional research should focus on determining the appropriate mix of management strategies that are better suited to dairy farms with different dairy farming systems. This analysis establishes that 1) there is great potential pay-off from targeting the industry

with a farm and management systems applied research and extension program; and 2) that determining the composition of these efforts and measuring their impacts is extremely difficult.

8.1 RESEARCH METHODS

Given the preceding, both regression analysis and factor analysis in combination with further regression analysis of the defined factors was used to identify relationships among the managerial and demographic characteristics of Michigan dairy farms and indices of profitability and efficiency in the form of net farm income and productivity per cow. In examining these relationships, the isolation of the effects of one variable from those of another is desirable and thus some rationale exists for the utilization of regression analysis. But since a dairy operation can be thought of as a firm or a composite of both managerial and demographic characteristics, a redefinition of the characteristics using factor analysis also has a certain rationale. Using the factors in further regression analysis allows for an understanding of the relationships between the composites of managerial activities and demographic characteristics and the indices of profitability and efficiency.

An important consideration relates to the statistics produced by the methodologies utilized. While the methodologies do not produce statistics comparable to those one would expect from the analysis of time series data, it must be remembered that cross-section data was the basis of this analysis of Michigan dairy farms and farmer characteristics. Moreover, the relationships implicit in the equations estimated are necessarily incomplete. None-the-less, even the explanation of a modest proportion of the variance in net farm income or productivity per cow is worthy of further investigation.

8.2 MAJOR FINDINGS

The major findings of the above analysis are the following:

1) The significance of MGT1, the factor of informal managerial practices, provides crucial information for researchers and Michigan dairy farmers. Further study of the importance of health and nutrition practices individually and as components of the dairy farm managerial regime will lead to a better understanding of their contribution to productivity per cow and profitability.

2) The factor indicating a degree of independence in dairy operations (MGT3) parallels MGT1 in importance.

3) Further study of infrequently used managerial practices as identified by MGT2 only show a slight potential adding to the knowledge base as to the configuration of Michigan dairy operations. However, a solid documentation and characterization of their deleterious effects *would* benefit those producers currently expending resources in these areas.

4) The formal aspect of a Michigan dairy operation as defined by MGT4 is of secondary interest relative to informal practices. Although the two factors (MGT1 and MGT4) are correlated (0.3102), the magnitude of MGT1's coefficient is consistently larger and is more frequently significant than that of MGT4. Properly utilized performance testing and A.I. can be critical tools in raising productivity per cow. However, when combined with generally poor managerial efforts, formal systems are essentially useless.

5) The factor defining economic size (DEM1) demonstrates that research on the effect of size may be of very important for smaller dairy herds and operations. The potential benefits to accrue to these smaller operations are likely to be highly correlated

with managerial ability. Further research could identify effective combinations of size and managerial ability/practices for smaller farms.

6) Education is a significant factor in determining productivity per cow. With occasional negative relationships with net farm income, further research into the changing dynamics of the life-cycle of Michigan dairy operations (i.e., with respect to the education level of not only the principle operator but secondary operators/partners as well) may prove useful.[9]

7) Ownership patterns in combination with the number of families involved in a dairy operation do not indicate any potential for further research. This area of the dairy operation, however, can not be ignored as this area is critical to the "utility" that an individual producers achieve from dairy farming where "utility" is some function of income, job satisfaction, and other non-monetary measures of psychological well-being.

8) The presence of non-farm income is clearly identified as a detrimental element in the determination of productivity per cow. Further study could prove fruitful in determining why this is so. The value of diversification of income sources should also be addressed.

9) Lastly, DEM5, an indicator of optimism despite present financial status, and/or productivity per cow, most Michigan dairy farmers are committed to dairy production. Whether this commitment to dairy farming in Michigan is logical and rational will depend upon the ability of Michigan dairy operators to successfully adapt their operations to the economic and political environment of the dairy industry in the

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[9] Interpretation of the apparent contribution of the education-based factor is potentially dangerous. Education and experience *per se* are <u>not</u> important. However, what the manager does with the knowledge is critical. Education can therefore be seen as an important source of knowledge, but the management behavior is more important.

US as a whole and within Michigan in particular. Without a reconfiguration of management, labor, capital, and perhaps enterprise mix, a commitment to dairy production could well be folly.

8.3 FUTURE RESEARCH EFFORTS

The formulation of a strategic plan to safe-guard Michigan's dairy industry is a necessary given the rapidity of change in today's economic and political environment and the crucial role that the dairy industry plays in Michigan's economy. The present study has attempted to identify areas which have the potential, given further research, of guiding Michigan dairy farmers through a process of enterprise reconfiguration. The ultimate goal of the reconfiguration is to maintain the position of Michigan's dairy industry within the traditional dairy region and nationally as well. Only through a commitment to further research concerning the managerial and demographic make-up of Michigan's dairy farms will the development of an adequate strategic plan to carry Michigan's dairy industry into the 1990's and beyond.

APPENDIX A

DEFINITIONS OF VARIABLES AND ABBREVIATIONS

N= Number of observations in category

R-barsqrd= R^2 adjusted for the degrees of freedom

F= F-statistic

DEMOGRAPHIC CHARACTERISTICS OF DAIRY FARMS

BST= No intention of using bST (0), else (1)

CASH= Total cash receipts *
- 1=Less than 10,000
- 2=10,000 to 19,999
- 3=20,000 to 39,999
- 4=40,000 to 99,999
- 5=100,000 to 174,999
- 6=175,000 to 249,999
- 7=250,000 to 499,999
- 8=Over 500,000

COWS= Number of cows, both dry and milking

DARATIO= Debt-asset ratio *
- 0=0
- 1=1 to 19 Percent
- 2=20 to 39 Percent
- 3=40 to 69 Percent
- 4=70 to 100 Percent
- 5=100 Percent and over

EDU#= Education level of the principle operator

EDU1= At least high school education (1), else (0)

EDU2= Greater than high school education (1), else (0)

EDU3= At least college graduate (1), else (0)

FAM= Number of families involved in the dairy operation

APPENDIX A (cont'd.)

HERDSIZE= Size of herd
1=Less than 30
2=30 to 44
3=45 to 59
4=60 to 89
5=90 to 119
6=120 to 149
7=150 to 209
8=210 to 269
9=270 and up

MILKPER= Productivity per cow

NETFINC= Net farm income *
1=Less than 10,000
2=10,000 to 19,999
3=20,000 to 39,999
4=40,000 to 99,999
5=100,000 to 174,999
6=175,000 to 249,999
7=250,000 to 499,999
8=Over 500,000

NONFINC= Non-farm income *
0=None
1=Under 5,000
2=5,000 to 9,999
3=10,000 to 14,999
4=15,000 to 19,999
5=20,000 to 39,999
6=40,000 And up

OWNER1= Other than individual ownership (1), else (0)

OWNER2= Limited partnership or corporate family farm (1), else (0)

PCHERDS= Planned percent change in herd size for 1993

SPECDAIR= Specialized dairy operations, i.e., with greater than 75 percent of total cash receipts stemming from sales related to the dairy operation

MANAGEMENT PRACTICES

16PER= Purchase 16% plus dairy ration

1STCALF= Average age at first calving for heifers is 24-25 months

3X= Milk 3 time a day

APPENDIX A (cont'd.)

AICOW= A.I. in majority of cow matings

AIHF= A.I. in majority of heifer matings

BYPROD= Purchase by-product feeds(brewer's grain, cottonseed, etc.)

CULL1= Culling rate greater than or equal to 15 percent

CULL2= Culling rate greater than or equal to 30 percent

DHIA= DHIA performance testing

DIPP= Teat dip all cows after milking

DRYCMP= Treat dry cows for mastitis

FORQU= Forage quality testing by cutting

FRATF= Feed ration formulation on a regular basis

GROUP= Group cows by production and feed accordingly

HEATSYN= Heat synchronization check

HIREPS= Hire pest scouts

MAILIN= Mail-in service for farm records

MICROC= Micro computer for farm records

NDHIA= Other than DHIA performance testing

PDIP= Predip all cows

POSTPEX= Systematic post-partum exams

PREGCHK= Pregnancy check within 40 days after breeding

PURREC= Purchase majority of replacement cows

REGCAT= Registered cattle account for a majority of the herd

SOILT= Soil testing for crops for fertilizer application

SOMCC= Subscribe to DHIA somatic cell count

VET= Use regularly scheduled vet services

* All categorical financial data is redefined as the mean of each range.

APPENDIX B

Appendix B contains the results of the regressions run using complex variables, i.e., those managerial and demographic variables which are defined by means of factor analysis. The data are laid out as follows:

1234.00**
(350.00)

The top number is the estimated coefficient as to the relationship of that variable with the dependent variable. The stars to the right of the coefficient estimate signify the degree of significance of the estimate (eg. *=.05; **=.01; ***=.001). The bottom number represents the standard error of the coefficient estimate. The statistics for R^2 and an F -test and its significance are shown at the bottom of each category. Where the category is indicated, i.e., at the top, the relevant dependent variable and the number of observations used are also indicated.

APPENDIX B (cont'd.)
Factor Regression Results: No Controls

D.V.:	MILKPER	NETFINC
Controls:	none	none
Factors	N=340	N=340
MGT1	1163.8171***	8649.0000***
	(162.3138)	(3008.2952)
MGT2	-344.2980**	4590.5027
	(163.5111)	(2856.8892)
MGT3	428.5542***	6864.7660**
	(163.3660)	(2854.3547)
MGT4	738.5443***	315.5707
	(171.2741)	(2992.5265)
R-barsqrd	0.2288	0.0456
F	26.1453	5.0499
Significance	0.0000	0.0006
DEM1	1167.0259***	X
	(171.6322)	
DEM2	627.3451***	-11824.00***
	(172.0229)	(2683.34)
DEM3	-55.0013	5954.26*
	(172.3713)	(2669.69)
DEM4	517.9215***	-13834.46***
	(170.7946)	(2663.67)
DEM5	-341.4363	-10029.40***
	(171.9843)	(2682.76)
R-barsqrd	0.1600	0.1817
F	13.7964	19.6459
Significance	0.0000	0.0000

APPENDIX B (cont'd.)
Factor Regression Results: Controlling for Herd Size

D.V.:	MILKPER	NETFINC	MILKPER	NETFINC
Controls:				
	HERDSIZE<60	HERDSIZE<60	60<HERDSIZE<120	60<HERDSIZE<120
Factors	N=168	N=168	N=107	N=107
MGT1	1487.9681***	10717.3931***	925.5266**	-850.2792
	(293.2694)	(2873.8043)	(305.4419)	(5938.6177)
MGT2	-297.0995	3953.4326*	-328.1873	-8292.8254
	(236.2495)	(2315.0550)	(232.3412)	(6294.4586)
MGT3	722.1618**	5322.8529**	233.2412	1438.3824
	(245.6338)	(2407.0140)	(329.4272)	(6404.9581)
MGT4	1116.3442***	3.8811	125.0902	-1542.7747
	(244.0741)	(2391.7295)	(317.8237)	(6179.3536)
R-barsqrd	0.2833	0.0996	0.0785	-0.0200
F	17.5025	5.6157	3.2563	0.4807
Significance	0.0000	0.0003	0.5722	0.7499
DEM1	2511.4971***	X	1153.6856	X
	(636.3636)		(594.0904)	
DEM2	1007.0095***	-5867.7988*	606.0904	-15512.3370***
	(286.0203)	(2597.8565)	(277.6451)	(4573.5227)
DEM3	313.0976	-1076.0644	-77.5187	6671.0793
	(303.2886)	(2597.9513)	(297.3111)	(4836.6087)
DEM4	418.9694	-7138.5352	664.6235*	-15660.5213***
	(295.5479)	(2672.6694)	(264.5427)	(4243.4967)
DEM5	-188.0489	-4696.4152	-340.1281	-19068.9179***
	(249.8914)	(2240.9024)	(345.9425)	(5672.1041)
R-barsqrd	0.1413	0.0731	0.0653	0.2949
F	6.4966	4.2930	2.4529	11.8721
Significance	0.0000	0.0025	0.0386	0.0000

APPENDIX B (cont'd.)
Factor Regression Results: Controlling for Herd Size

D.V.: Controls: Factors	MILKPER HERDSIZE>119 N=65	NETFINC HERDSIZE>119 N=65
MGT1	176.3888 (401.3652)	-10443.0659 (14097.1977)
MGT2	-333.7469 (294.5789)	23958.3492* (10346.5296)
MGT3	76.9397 (272.8266)	5756.3277 (9582.5213)
MGT4	460.7330 (335.3810)	-7770.7794 (11779.6280)
R-barsqrd	-0.0169	0.0399
F	0.7342	1.6652
Significance	0.5722	0.1699
DEM1	578.3593 (301.6063)	X
DEM2	-307.2244 (289.3498)	-14954.6038 (8978.5133)
DEM3	-136.9039 (261.7916)	13316.7438 (8196.0924)
DEM4	507.5985 (293.1144)	-28508.9249** (9226.9853)
DEM5	-376.6479 (284.8000)	-19854.4957* (9067.5699)
R-barsqrd	0.0723	0.2705
F	1.9821	6.8399
Significance	0.0948	0.0001

APPENDIX B (cont'd)
Factor Regression Results: Controlling for Net Farm Income and Debt-Asset Ratio

D.V.:	MILKPER	NETFINC	MILKPER	NETFINC
Controls:	NETFINC<4 DARATIO<4	NETFINC<4 DARATIO<4	NETFINC>3 DARATIO<4	NETFINC>3 DARATIO<4
Factors	N=127	N=127	N=43	N=43
MGT1	1449.4841***	2170.4737*	895.5699*	16451.0662
	(262.6119)	(994.0819)	(512.6256)	(16502.1082)
MGT2	-370.1534	-2230.8100*	-602.3475	28724.7908
	(254.9971)	(965.2571)	(491.8936)	(15835.4926)
MGT3	171.2779	2286.4065*	185.1914	-2766.6356
	(280.0882)	(1060.2358)	(486.2602)	(15654.1614)
MGT4	1154.5841***	-283.9984	601.7237	4430.4288
	(250.9483)	(949.9308)	(467.8099)	(15060.1689)
R-barsqrd	0.3695	0.0709	0.0840	0.0216
F	19.4602	3.4061	1.9632	1.2323
Significance	0.0000	0.0112	0.1199	0.3135
DEM1	1390.9505***	X	254.4620	X
	(402.4086)		(350.6215)	
DEM2	1029.0013**	888.0406	-142.9498	-43599.8773*
(308.2646)	(1010.1351)	(452.5793)	(11483.9769)	
DEM3	8.2198	1675.9990	170.4836	15764.7762
	(300.3920)	(1025.6540)	(420.5695)	(10905.8261)
DEM4	730.8808*	2802.4574*	1259.9633**	-28085.2699*
(327.2224)	(1108.6773)	(365.5407)	(9491.8064)	
DEM5	-64.8911	-1015.7308	-151.3404	-16032.0703
	(307.2866)	(1046.3225)	(648.1414)	(16804.2203)
R-barsqrd	0.2295	0.0473	0.1722	0.4246
F	8.3854	2.5391	2.7477	8.7488
Significance	0.0000	0.0434	0.0330	0.0000

APPENDIX B (cont'd.)
Factor Regression Results: Controlling for Net Farm Income and Debt-Asset Ratio

D.V.:	MILKPER	NETFINC	MILKPER	NETFINC
Controls:	NETFINC<4 DARATIO>3	NETFINC<4 DARATIO>3	NETFINC>3 DARATIO>3	NETFINC>3 DARATIO>3
Factors	N=142	N=142	N=28	N=28
MGT1	676.7498*	1437.5806	2734.9806***	-25509.38876*
	(295.7101)	(935.5447)	(542.7542)	(9524.2593)
MGT2	-433.7627	998.0863	-224.5515	14515.2944*
	(293.1788)	(927.5365)	(300.7185)	(5277.0136)
MGT3	558.7261*	3468.4772***	172.8726	3664.0140
	(261.1600)	(826.2379)	(329.9560)	(5790.0744)
MGT4	398.4125	-1400.4254	468.8454	-15494.6739
	(294.5532)	(931.8846)	(446.6875)	(7838.4802)
R-barsqrd	0.0924	0.1083	0.5657	0.2734
F	4.5897	5.2813	9.7928	3.5404
Significance	0.0017	0.0005	0.0001	0.0216
DEM1	1108.1328**	X	922.4879	X
	(370.5648)		(585.5291)	
DEM2	451.7321	680.2457	603.0538	-10511.3564
	(288.9141)	(946.6728)	(487.6087)	(6613.3292)
DEM3	-377.1689	1855.7350	-464.3088	10670.4328
	(312.1442)	(988.3863)	(765.5432)	(9587.5112)
DEM4	378.0135	680.8447	-588.1410	5181.8359
	(281.1791)	(918.3024)	(727.2139)	(9891.0463)
DEM5	-426.2688	-3090.6777*	408.4201	-6457.9715
	(389.8977)	(1280.0617)	(950.3183)	(12107.9586)
R-barsqrd	0.0685	0.0364	0.0378	0.0311
F	3.0586	2.3205	1.2120	1.2167
Significance	0.0120	0.0600	0.3364	0.3309

APPENDIX B (cont'd.)
Factor Regression Results: Controlling for Specialized and Non-Specialized Dairy Operations

D.V.:	MILKPER	NETFINC	MILKPER	NETFINC
Controls:				
	SPECDAIR=1	SPECDAIR=1	SPECDAIR=0	SPECDAIR=0
Factors	N=283	N=283	N=57	N=57
MGT1	1134.2112***	9267.3991**	1294.5756***	5548.2387
	(198.8057)	(3396.3591)	(304.9932)	(6686.7703)
MGT2	-217.3952	5905.4036	-1155.8173***	-3859.0962
	(182.6178)	(3119.8081)	(352.1110)	(7719.7950)
MGT3	490.97**	7294.9447*	452.7592	6026.2445
	(181.2517)	(3096.4696)	(402.4538)	(8823.5267)
MGT4	715.7154***	199.6518	893.1359**	467.8544
	(197.9083)	(3381.0278)	(300.3745)	(6585.5075)
R-barsqrd	0.2093	0.0524	0.4164	-0.0453
F	19.6584	4.8995	10.9871	0.3931
Significance	0.0000	0.0008	0.0000	0.8127
DEM1	1261.8120***X956.4694*X			
	(192.7100)		(396.5458)	
DEM2	729.3069***	677.3604**	380.5248	-6300.3694
	(193.7014)	(207.6524)	(380.9220)	(5847.4744)
DEM3	-180.8698	39.1963	521.1090	12361.6624
	(189.2979)	(199.8752)	(465.0197)	(7184.9960)
DEM4	564.1962**	571.6381**	303.3758	-17609.1964**
(193.2808)	(207.3719)	(372.1173)	(5629.8042)	
DEM5	-841.3946*	-385.2080	-58.6329	-13279.0808
	(-481.3946)	(213.9328)	(351.0838)	(5245.9971)
R-barsqrd	0.1760	0.1677	0.0617	0.2457
F	13.0073	15.1573	1.7107	5.3984
Significance	0.0000	0.0000	0.1498	0.0011

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