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CORRELATION ANALYSIS OF DAIRY PRACTICES AND MANAGEMENT FACTORS ON NEW YORK DAIRY FARMS 1982

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Foreword

This publication is part of a research project supported by a special grant to the Agricultural Experiment Station at Cornell University by Agway, Inc., of Syracuse, New York.

Dairy management practices are one area of factors that affect dairy farm incomes. In this research project, data available from the New York Dairy Herd Improvement records and the farm business management projects at Cornell have been merged since 1974 and used to study the effects of dairy management practices on farm incomes and related factors. Studies done for each of the years 1974 through 1982, using tabular analysis methods, have been reported in Agricultural Economics Department publications.**

J. Clarke Fowers, an Agricultural Economics student in the Cornell Graduate School***, conducted the first study under the supervision of C.A. Bratton, Professor of Farm Management and Chairman of his graduate committee. H.R. Ainslie, Extension leader and Professor in Animal Science, was a member of the graduate committee and provided valuable assistance in the study. Both tabular and correlation analysis methods were used in that study.

The correlation analysis portion of Fowers' study was published by the Department of Agricultural Economics in A.E. Res. 79-14. The study reported in this publication updates Fowers' work on the 1974 data and is based on the information from 410 farms for the year 1982. The correlation results supplement the tabular analysis reported in A.E. Res. 84-6.

The encouragement given by Dr. Lewellyn S. Mix of Agway to pursue the investigation and publish the findings related to dairy management practices and the apparent effects on the incomes from New York dairy farm businesses is duely acknowledged by C.A. Bratton, leader of the research project.

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*Charles B. Williams is a doctoral candidate in the Cornell Graduate School. This phase of his work has been supervised by P.A. Oltenacu, Associate Professor of Animal Science and C.A. Bratton, Emeritus Professor of Agricultural Economics.

**Results are available in Cornell Agricultural Economics Staff Paper 75-27; A.E. Res. 77-20; A.E. Res. 78-19; A.E. Res. 79-5; A.E. Res. 79-14; A.E. Res. 80-1; A.E. Res. 81-2; A.E. Res. 82-13; A.E. Res. 83-2, and A.E. Res. 84-6.

***J. Clarke Fowers is now the owner-operator of a dairy farm in Hooper, Utah.

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Introduction

Dairy farm incomes are affected by many things. Farm management studies have identified general factors such as size, rates of production, labor efficiency, capital efficiency, and cost control as being related to farm incomes. In addition there are many practices which affect or determine these "general" management factors. Dairy and crop management practices which affect rates of production and cost control are examples.

Computer technology has added new dimensions to farm management studies. Computer facilities have made it possible to expand the kind and amount of information available to dairy farmers from their dairy herd improvement (DHI) production records. Likewise, farm business management summaries have been expanded since computer programs have been developed to summarize and analyze the data. These changes have brought new management "tools" to dairy farmers.

The first project to merge for analysis purposes the DHI dairy management practice information with the farm management business summary information was initiated in 1974. The project proved to be workable and the procedure has been repeated each year since. Data for 1982 were summarized and analyzed, and first presented in Cornell A.E. Res. 84-6. In this study the same data is analyzed statistically, using correlation and regression techniques.

Objectives of The Study

The objectives of this study were to examine statistically:

1. Relationships between selected business and dairy management practices.

2. Relationships between dairy farm incomes and selected business and dairy management practices.

3. The importance of several business and dairy management practices in determining dairy farm incomes and other selected business and dairy management practices.

Methodology

Two sources of management information for individual dairy farm operations were merged for analysis. The sources merged were the farm management business records (FBR) and the dairy herd improvement (DHI) records.

A computer listing was made of the 1982 dairy farm business records summarized by the Department of Agricultural Economics which indicated that they had dairy production records. This list was matched with the DHI records available in the Department of Animal Science. Selected information from the DHI records was merged with the business management data for each farm.

Correlation analysis was used in this study to identify and measure the interrelationships of the variables from the FBR and DHI information systems.

The correlation coefficient calculations were performed by the correlation procedure of the Statistical Analysis System using the following formula:

$$r_{xy} = \frac{\sum_{i=1}^{n} (X_i-\overline{X})(Y_i-\overline{Y})}{\sum_{i=1}^{n} (X_i-\overline{X})^2 \sum_{i=1}^{n} (Y_i-\overline{Y})^2}$$

Where: r_{xy} = Simple correlation coefficient between x and y (the two variables under study)

n = Number of observations on x and y

$$\overline{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

Seventy-one business and dairy management factors were studied. These 71 factors were grouped into management categories and their relationships are discussed in the text.

The correlation coefficient is a measure of the closeness of relationship between two variables, more exactly of the closeness of a linear relationship, and in making statistical inferences from this coefficient, it is assumed that the two variables have a bivariate normal distribution.

Correlation analysis also assumes that the two variables under study are independent. This assumption is not entirely true for farm management data, since several variables may interact in shaping the economy of the farm.

The relationship between several farm management variables may in fact be quadratic and not linear, and one should exercise care in interpreting the linear correlation coefficient where the relationship is known to be quadratic. In this case the correlation coefficient may be positive, negative or zero, depending on the location of the means of the observations and the variance of the observations. In addition, the observations in the data set studied were herd averages, hence, in interpreting a positive correlation, say between the number of cows and net cash income, one cannot rightly conclude that net cash income would increase as the number of cows within a herd increases, since the variation in cow numbers was between herds and not within herds.

If the simple correlation coefficients are squared and multiplied by 100, an estimate of the variance explained by each variable is obtained. Many explain a very small amount of variation and are labelled insignificant, i.e. not significantly different from a zero correlation. In this publication, the test of statistical significance is at the 0.05 level of committing a type I error. The significance level of any correlation coefficient is directly related to the number of observations and the magnitude (not direction) of the coefficient. In the bivariate correlation, the error in predicting the variable value would be large when the r^2 value is small. As the r^2 value approaches one, this error diminishes.

The importance of business and dairy management practices in determining dairy farm incomes and other selected business and dairy management practices, was examined by regression techniques using the Maximum R Square Improvement option of the Stepwise regression procedure of the Statistical Analysis System.

Regression differs from correlation in that it deals with the means of one variable and how their location is influenced by another variable, here only the dependent variable need be random and normally distributed. Correlation is associated with descriptive techniques whereas regression comes close to implying cause and effect relations. Thus, a regression coefficient tells us that if we alter the value of the independent variable, then we can expect the dependent variable to alter by a certain amount on the average, sampling variation making it unlikely that precisely the stated amount of change will be observed.

The regression coefficient b was obtained using the following formula:

$$b = \frac{\sum_{i=1}^{n} (X_i-\bar{X})(Y_i-\bar{Y})}{\sum_{i=1}^{n} (X_i-\bar{X})^2}$$

Where: X_i is the i^{th} observation on the independent variable, and
Y_i is the i^{th} observation on the dependent variable.

Regression uses the principle of least squares to produce estimates, that are the best linear unbiased estimates (BLUE) under classical statistical assumption.

For example, we can apply regression techniques to the behavior of net cash income (Y) as a linear function of milk sales per cow (X_1), total farm expenses per cow (X_2), and percent equity (X_3). To examine this behavior we can fit the model: $Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + e$.

The regression would give us BLUE of b_1, b_2, and b_3 and using the model we can predict Y for specific values of X_1, X_2, and X_3. Also, information can be obtained on the relative importance of b_1, b_2, and b_3 in determining values of Y.

The maximum R square improvement technique does not settle on a single model, it tries to find the best one variable model, the best two variable model, and so forth, given a number of independent variables to choose from.

Definitions of Measures Used

Selected measures used in the farm business summaries and the dairy herd improvement records are defined below.

Labor and management income per operator reflects the dollar return to the farmer-operator for his time, knowledge, and skills in operating the farm business unit. For calculation details, see Cornell's A.E. Res. 83-32.

Labor and management income per cow is the total return to the operator(s) of the farm divided by the average number of cows.

Milk sold per cow is the total pounds of milk sold for the year divided by the average number of cows.

Milk sold per worker is the total pounds of milk sold for the year divided by the worker equivalent for the year.

Average number of cows measures herd size and is the 12 month average of the milk cows reported monthly in the farm business records.

Number of cows per worker is calculated by dividing herd size by the worker equivalent. This includes all persons working on the farm.

Age of operator is reported for all operators but for studying the effects of age on the business, only the "individual" operators are included (partnerships and corporations are excluded).

Education of operator is the year of formal schooling completed.

Milk produced per cow is the total pounds of milk produced by each cow as computed from the 12 monthly dairy herd improvement sample weights. The herd average was used in this study for all dairy management practices.

Butterfat test is the herd average for the 12 monthly dairy herd improvement samples tested.

Concentrates fed is the yearly average pounds of concentrates fed per cow in the herd. The DHI supervisor records the pounds of concentrates fed each month and these are aggregated for the yearly figures.

The percent net energy figures are calculated for concentrates, succulents (silages), dry hay, and pasture. It reflects the relative amount of available therms (calories) the cows get from each source.

Body weight of all cows is rounded to the nearest ten pounds. This measure indicates the average weights of all cows in the herd during the year.

Body weight at first calving is rounded to the nearest ten pounds. Weight at first calving is likely to be lower for heifers that calve earlier.

Age at first calving is expressed in months and is recorded by the DHI supervisor. The average age for the herd was used in this study.

Projected minimum calving interval is the herd average of the number of months between calves.

Breedings per conception is the number of times a cow is bred.

Days dry is the number of days a cow is not milked per calving interval.

Percent of days in milk is the number of days milked divided by the number of days on test (usually 365).

Percent leaving the herd is the number of cows leaving the herd for nondairy purposes divided by the herd size.

Age of all cows is the average age in months of all milk cows in the herd during the year. Heifers that have not freshened are not included.

The feeding index equals the reported total net energy fed per cow divided by the "calculated" maintenance and production requirements.

Income over value of feed is the computed value of the milk produced minus the value of all feed fed. Value of feed is calculated by the farmer and DHI supervisor. This measure is based on only one cost variable, namely feed.

Somatic cell count was developed to indicate Mastitis awareness. The count is obtained for each cow for each test period. The measure used here is the average count for the entire herd.

Days open is the average number of days per cow from the last calving to date bred (provided that the cow was in milk over 40 days).

Machinery expense is the sum of the operating expenses and the ownership expenses.

Total farm expense includes variable and fixed expenses plus interest on equity capital at five percent.

Farms Studied

Cooperators in the farm business management project participated on a voluntary basis. Consequently, the average of the farms in the project tends to be better than the average of all farms in the State. Similarly, cooperators who have DHI records tend to be operating somewhat better than "average farms". A comparison of the farms in the dairy management practice study with all farms in the business management summary for 1982 is shown in Table 1.

The pounds of milk produced per cow by the 410 farms in the 1982 dairy management practices study averaged 16,000 compared with 12,100 pounds per cow reported by the New York Crop Reporting Service for all herds in the State. Similarly, the dairy management practices summary farms sold 14,900 pounds of milk per cow compared with 14,800 for all farms in the business management summaries. In general, the farms included in the dairy management practices summary had considerably better production than the average of all farms in the State and slightly better than all farms in the business summary.

Nearly two-thirds of the farms in the business management summary were in the dairy practices summary group. Farms in the dairy practices group had the same size herds as the business management group, 82 cows. In identifying DHI farms some of the larger ones had two DHI reports on different herds which made it impossible to merge them for this study. In general, the dairy practices group was a reasonable sample of all farms in the business management summary.

Correlations with Operator Income

Correlation coefficients for selected business and dairy management factors

Table 1. Comparison of All Farms in The Business Management Summary With Farms in The Dairy Management Practices Summary New York Dairy Farms, 1982

Item	Summary Group: Business Management	Summary Group: Dairy Practices
Number of farms	572	410
Operators:		
Average age	42	41
Years of education	13	13
Percent in partnerships or corporations	24%	24%
Barn Type:		
Percent with freestalls	32%	33%
Size of Business:		
Worker equivalent	2.83	2.92
Number of cows	82	82
Number of heifers	67	67
Total tillable acres	262	256
Total capital	$474,438	$476,525
Rates of Production:		
Pounds milk sold per cow	14,800	14,900
Tons hay crops per acre (H.E.)	2.6	2.6
Tons corn silage per acre	14.0	14.1
Labor Efficiency:		
Cows per worker	29	28
Pounds milk sold per worker	427,700	419,700
Capital Uses:		
Total capital per cow	$5,517	$5,606
Farm debt per cow	$2,261	$2,343
Total capital per worker	$167,646	$163,193
Percent equity	63%	62%
Cost Factors:		
Feed bought per cow	$482	$491
Crop expense per cow	$166	$168
Percent feed is of milk sales	24%	24%
Machinery cost per cow	$432	$433
Labor cost per cow	$352	$348
Real estate expense per cow	$150	$155
Total farm expense per cow	$2,247	$2,269
Cost per cwt. producing milk*	$14.87	$14.92
Price:		
Average price per cwt. milk sold	$13.56	$13.55
Income:		
Net cash income per farm	$36,129	$36,084
Net cash income per cow	$441	$440
Labor & management income per operator	$3,451	$3,408
Labor & management income per cow	$42	$42

*Including a management charge.

with labor and management income per operator (operator income) are given in Table 2. The coefficients have been divided into positive and negative groups and are sorted in decending order of magnitude within each group.

Generally for the business practices, those that were related directly to prodution such as number of cows, total pounds of milk sold per cow, etc., showed positive correlations with operator income. Whereas those that were related to cost of production such as production cost per hundredweight of milk, total farm expenses per cow, etc., showed negative correlations with operator income.

With respect to the dairy management practices, correlations with operator income were more subtle. However, it seems that management practices which are positively related to milk produced per cow, such as body weight of all cows, percent net energy from succulents and percent days in milk, were also positively related to operator income. In addition, management practices which are negatively related to total milk production such as average days dry, percent net energy from hay and pasture, days open, and projected minimum calving interval, also showed negative correlations with operator income.

Within both groups of correlations the business practices were more strongly correlated, than the dairy management practices, with operator income. This may be expected since the business practices are more directly related to income and the dairy practices are mostly related to milk produced per cow, which is only one of the business factors affecting income.

The individual correlations contained in this table will be discussed in more detail under appropriate sections in the text.

Relationships between labor and management income per operator and the 36 business and dairy management factors in Table 2 were also investigated within registered and grade herds. These correlation coefficients are listed in Table 3, where the business and dairy management factors are arranged in the same order as in Table 2.

Generally the negative correlations remained negative and a few positive correlations changed signs, but these were, in most cases, not statistically significant.

One major difference between Table 2 and Table 3 is that for all measures of size, (number of cows, total tillable acres, worker equivalents, total capital invested, and pounds of milk sold), the correlations with operator income were large and positive in registered herds. Whereas, in grade herds these correlations were small and not statistically significant, except for total tillable acres which was negative and significant (-0.119).

A large variance for labor and management income per operator in registered herds, relative to grade herds may account for these large differences in the correlation coefficients for the size measures with labor and management income per operator, between registered and grade herds. This was investigated and it was found that labor and management income per operator ranged from -\$39,000 to \$290,000, with a standard deviation of \$30,000 and a mean of \$5,200 in the registered herds. Whereas, in the grade herds it ranged from -\$73,000 to \$81,000 with a standard deviation of \$20,000 and a mean of \$1,300.

Table 2. Correlation Coefficients For Selected Business and Dairy Practices with Labor and Management Income per Operator 410 New York Dairy Farms, 1982

Variables	Labor and Management Income per Operator Correlation Coefficient
Positive Correlations	
Pounds milk sold per worker	0.301
Total pounds milk sold	0.277
Number of cows	0.233
Pounds milk sold per cow	0.218
Number of cows per worker	0.209
Total farm inventory	0.191
Income over value of feed	0.175
Yield of corn silage dry matter	0.123
Percent equity	0.093
Percent net energy from succulents	0.089*
Worker equivalents	0.088*
Average body weight of all cows	0.084*
Total tillable acres	0.082*
Investment per worker	0.082*
Percent days in milk	0.072*
Heifers as percent of cows	0.039*
Feed and crop expenses per cow	0.031*
Average price per hundredweight of milk	0.027*
Negative Correlations	
Production cost per hundredweight of milk	-0.606
Total farm expenses per cow	-0.248
Machinery cost per cow	-0.168
Land and building investment per cow	-0.168
Labor costs per cow	-0.135
Machinery investment per cow	-0.130
Total capital investment per cow	-0.123
Debt per cow	-0.120
Days open, all cows	-0.117
Percent leaving	-0.111
Feed and crop expenses per hundredweight of milk	-0.111
Projected minimum calving interval	-0.106
Average days dry	-0.080*
Percent net energy from concentrates	-0.073*
Butterfat test	-0.067*
Percent net energy from hay	-0.054*
Percent net energy from pasture	-0.035*
Pounds concentrates fed per cow	-0.035*

*Not significant at 0.05 level.

Table 3. Correlation Coefficients For Selected Business and Dairy Practices with Labor and Management Income per Operator Registered and Grade Herds 410 New York Dairy Farms, 1982

Variables	Correlations with Labor and Management Income per Operator: Registered 134 Farms	Grade 276 Farms
Pounds milk sold per worker	0.472	0.179
Total pounds of milk sold	0.589	0.046*
Number of cows	0.605	-0.029*
Pounds milk sold per cow	0.138	0.270
Number of cows per worker	0.442	0.045*
Total farm inventory	0.532	-0.086*
Income over value of feed	0.098*	0.223
Yield of corn silage (tons DM)	0.101*	0.126
Percent equity	-0.037*	0.164
Percent net energy from succulents	0.115*	0.085*
Worker equivalents (years)	0.337	-0.052*
Average body weight of all cows	0.096*	0.048*
Total tillable acres	0.424	-0.119
Investment per worker	0.212	-0.054*
Percent days in milk	0.077*	0.074*
Heifers as percent of cows	-0.092*	0.105*
Feed and crop expenses per cow	0.037*	0.027*
Average price per hundredweight of milk	0.031*	0.018*
Production costs per hundredweight milk	-0.517	-0.688
Total farm expenses per cow	-0.199	-0.317
Machinery costs per cow	-0.247	-0.125
Land and building investment per cow	-0.210	-0.160
Labor costs per cow	-0.206	-0.107
Machinery investment per cow	-0.219	-0.083*
Total capital invested per cow	-0.181	-0.114
Debt per cow	-0.022*	-0.198
Days open, all cows	-0.080*	-0.149
Percent leaving herd	-0.001*	-0.166
Feed and crop expenses per hundredweight milk	-0.060*	-0.147
Projected minimum calving interval	-0.086*	-0.137
Average days dry	-0.091*	-0.078*
Percent net energy from concentrates	-0.030*	-0.098*
Butterfat test	-0.066*	-0.090*
Percent net energy from hay	-0.135	-0.001*
Percent net energy from pasture	-0.105*	-0.003*
Pounds concentrates fed per cow	-0.008*	-0.057*

*Not significant at 0.05 level.

Correlations for size measures with some important cost items were also investigated within registered and grade herds. These correlations are listed in Table 4.

Table 4. Correlations For Selected Cost Items With Various Measures of Size in Registered and Grade Herds 410 New York Dairy Farms, 1982

Item	Number of Cows	Total Tillable Acres	Worker Equiv.	Total Capital Invested	Pounds of Milk Sold
Machinery cost/cwt. milk					
Registered	-0.151	-0.030*	-0.119	-0.064*	-0.168
Grade	-0.150	-0.007*	-0.127	-0.040*	-0.171
Labor cost/cwt. milk					
Registered	-0.172	-0.117	-0.151	-0.175	-0.199
Grade	-0.168	-0.054*	-0.089*	-0.149	-0.201
Feed and crop expenses per cwt. milk					
Registered	-0.031*	-0.188	-0.078*	-0.150	-0.098*
Grade	-0.012	-0.098	-0.078*	-0.116	-0.025*
Cost of producing a cwt. milk					
Registered	-0.377	-0.259	-0.306	-0.333	-0.422
Grade	-0.145	-0.055*	-0.114	-0.125	-0.219

*Not significant at 0.05 level.

Machinery cost per hundredweight milk showed similar correlations with all measures of size in both registered and grade herds. Whereas, correlations for labor cost and feed and crop expenses per hundredweight milk, with the size measures, tended to be larger in the registered herds.

Correlations for cost of producing a hundredweight of milk, with the size measures, were all larger in the registered herds compared to the grade herds.

These results suggest that these cost items are more crucial to labor and management income in registered herds than in grade herds and, therefore, decreases in the cost items would have a bigger impact on the labor and management income in registered herds.

Correlations of selected business management factors with labor and management income per operator, by barn type, are given in Table 5. These correlations are for 382 New York dairy farms. Twenty-eight farms were eliminated, since they did not fit the two major barn types studied.

Table 5. Correlations of Selected Business Management Factors With Labor and Management Income For Operator by Barn Type
382 New York Dairy Farms, 1982

Item or Variable	Barn Type: Stanchion	Barn Type: Freestall
Number of farms	247	135
Percent of farms	60.2%	32.9%
	Correlation Coefficients[1]	
Pounds milk sold per cow	0.255	0.258
Pounds milk sold per worker	0.314	0.326
Herd size (number of cows)	0.116	0.287
Total investment per cow	-0.236	-0.038*
Percent equity	0.024*	0.211
Total farm expense per cow	-0.334	-0.224
Production costs per hundredweight of milk	-0.715	-0.660
Cows per worker	0.220	0.209

[1] Simple correlation of variable with labor and management income per operator.

*Not significant at 0.05 level.

Correlations for pounds of milk sold per worker and per cow, production costs per hundredweight of milk and cows per worker, with labor and management income per operator were similar for the two barn types.

For herd size the correlation with operator income was larger in freestall than in stanchion barns. This may be due to the positive correlation of herd size with operator income (Table 2), and the fact that the larger herds were associated with freestall barns in the data set.

Total investment per cow showed a negative correlation (-0.236) with operator income in stanchion barns, but there was very little relationship between these two variables in freestall barns. This suggests that total capital investment when calculated on a per cow basis was inefficient in stanchion barns.

Increased investment on a per cow basis should either reduce the unit cost of the farm operation (efficiency), or increase the output (productivity). If additional investment does not accomplish either or both ends, it will most certainly affect profitability.

Correlations for total capital investment per cow, with milk sold per cow, were similar in both barn types (0.251 in stanchion barns and 0.232 in freestall barns). This would suggest increased productivity with increased investment per cow. However, correlations for investment per cow with cost of producing a hundredweight of milk was 0.194 in stanchion barns and almost zero (0.038) in freestall barns. This would suggest decreased capital efficiency with increased investment per cow in stanchion barns, and would explain the correlations observed for total capital investment per cow and operator income in both barn types.

In addition, the correlations for total capital investment per cow, with number of cows, was almost zero (-0.037) in stanchion barns, but was statistically significant in freestall barns (-0.215). This is due to the fact that herds with freestall barns were much larger and had a greater variation in number of cows than herds with stanchion barns (see Table 8 for further discussion).

Percent equity was positively related to operator income (0.211) in freestall barns but there was little relationship between these two variables in stanchion barns. This may be due to the fact that total capital investment was much higher in freestall barns. Hence, percent equity would become more crucial in determining operator income in herds with freestall barns.

Analysis of Farm Business Management Variables

Relationships between business management variables and several business and dairy management practices are examined in this section. The business management variables studied were measures of size of business, rates of production, labor and capital efficiency, and cost control, and the correlations with the business and dairy management practices are reported with respect to these categories.

Size of Business

Cross-tabulation analysis on FBR data has shown size to be a major factor affecting labor and management income (Bratton, 1982). Correlations for various measures of size with selected business and dairy management practices are given in Tables 6, 7, 8, and 9.

Correlations between the different measures of size used were very high and positive (Table 6). These results suggest that in quantifying size there may be very little difference in which measure is used. However, number of cows, total capital invested, and pounds of milk sold may be better measures than total tillable acres and worker equivalents since, overall, they showed higher correlations with all size variables.

Table 6. Correlations of Various Measures of Size
410 New York Dairy Farms, 1982

Measures of Size	Number of Cows	Total Tillable Acres	Worker Equiv.	Total Capital Invested	Pounds Milk Sold
Number of cows	1.00	0.820	0.866	0.898	0.979
Total tillable acres	0.820	1.00	0.774	0.813	0.802
Worker equivalent	0.866	0.774	1.00	0.797	0.866
Total capital invested	0.898	0.813	0.797	1.00	0.902
Pounds milks sold	0.979	0.802	0.866	0.902	1.00

Table 7 shows the correlation coefficients for various measures of size and farm incomes. Of all the income measures, net cash income had the highest correlations with size measures and labor and management income per cow the lowest. Also, for all income measures, correlations with pounds of milk sold were the highest. This may be expected since the other size measures are input variables and pounds of milk sold is related to output, therefore, it has a direct effect on net returns from the business. The measures of size which had the highest correlations with all the income measures were number of cows, pounds of milk sold, and total capital, and, as suggested in Table 6, size may be more effectively quantified by these measures.

Table 7. Correlations of Measures of Size and Farm Incomes
410 New York Dairy Farms, 1982

Measures of Size	Net Cash Income	Labor & Management Income per Operator	Labor & Management Income per Cow	Labor, Mgmt. & Ownership Income
Number of cows	0.678	0.226	0.069*	0.477
Total tillable acres	0.526	0.079*	-0.059*	0.313
Worker equivalent	0.553	0.084*	-0.003*	0.363
Total capital invested	0.700	0.183	0.017*	0.482
Pounds milk sold	0.733	0.270	0.123	0.532

*Not significant at 0.05 level.

In any business enterprise, one would expect size of the operation to have an effect on other business factors. Some of these relationships are given in Table 8 where correlations of several measures of size with selected business factors are listed.

Of all the size meaures, only pounds of milk sold was significantly correlated (-0.149) with production cost per hundredweight of milk. The sign of the coefficient indicates that as total production increases, production costs per unit may decrease. This is the result of spreading fixed costs over a larger volume of production.

Table 8. Correlations of Measures of Size and Farm Business Factors
410 New York Dairy Farms, 1982

Measures of Size	Production Costs per Cwt. Milk	Pounds Milk Sold per Cow	Pounds Milk Sold per Worker	Capital Invested per Cow	Total Farm Exp. per Cow
Number of cows	-0.086*	0.119	0.583	-0.256	0.085*
Total tillable acres	0.010*	0.094*	0.420	-0.095*	0.160
Worker equivalent	-0.040*	0.187	0.222	-0.191	0.185
Total capital invested	-0.061*	0.224	0.562	0.131	0.228
Pounds milk sold	-0.149	0.286	0.621	-0.200	0.179
Heifers as percent of cows	-0.084*	0.178	-0.066*	0.143	0.158

*Not significant at 0.05 level.

The correlations of milk sold per cow with measures of size were not large but were positive. This suggests that size of operation does not have a great effect on milk productivity, or that the relationship between size and milk productivity may be quadratic and not linear, with a certain size being the most optimum. This latter argument is supported by cross-tabulation tables (Bratton, 1982). The positive correlation does show that the larger herds do tend to have better production than the small herds.

Correlations for pounds of milk sold per worker with most of the size measures were high and positive, with number of cows, total pounds of milk sold, and total capital invested having the largest coefficients. This suggests that as we go from the smaller farms to larger farms, the increase in number of cows is not accompanied by a proportionate increase in worker equivalents and, thus, the number of cows per worker would tend to increase. This is supported by a correlation of 0.565 between number of cows and cows per worker (Table 15). The end result would be a greater amount of milk sold per worker and, hence, a greater labor efficiency on the larger farms.

Heifers as percent of cows showed very little relationship to milk sold per worker, this suggests that labor on heifers did not affect the milk sold per worker. Hence, the raising of replacements may not result in any loss in labor efficiency.

Correlations for number of cows and pounds of milk sold with capital invested per cow were -0.256 and -0.200 respectively. This suggests that the larger farms are more efficient in their use of capital than the smaller farms since total capital invested would be spread over a larger number of cows.

The correlations for total farm expenses per cow with the measures of size were positive, indicating that on the larger farms, total farm expenses per cow did tend to be larger.

On a per cow basis, one may expect total cost per cow to decrease as size of the operation increases. However, if increased expenditures per cow results in an increase in gross returns, which more than compensates for the added costs, then the increased expenditure per cow would tend to increase profitability.

The positive correlation (0.179) for total pounds of milk sold and total farm expenses per cow may be due to the fact that total pounds of milk sold can be increased through an increase in the herd average for pounds of milk sold per cow. This can be accomplished by higher levels of feeding, which would increase total farm expenses per cow. Therefore, this correlation is probably the result of the high positive correlation (0.437) between milk sold per cow and feed and crop expenses per cow (Table 22).

The positive correlation (0.131) for total capital invested with total capital investment per cow, would suggest that increases in total capital invested are not always accompanied by a proportionate increase in cow numbers. Hence, the total capital investment per cow may increase with increases in the total capital invested.

Real estate expense per cow was positively correlated with capital investment per cow (0.119) and total farm expenses per cow (0.574) (Table 24). Therefore, the positive correlation for total capital invested with total farm expenses per cow may be due to an increase in real estate cost per cow, as total capital invested increased.

Similarily the positive correlation (0.160) for total tillable acres, with total farm expenses per cow, may be due to the positive correlation (0.124) for total tillable acres with real estate cost per cow (Table 23).

Size of the business might also be expected to have an affect on the dairy practices used. Correlation coefficients for measures of size with selected dairy practices are listed in Table 9.

Correlations for all size measures with concentrates, succulents, and dry roughages fed were similar. These coefficients suggest that as size increases, more concentrates and succulents, and less dry roughages are fed per cow. These feeding practices also have similar effects on pounds of milk sold, as illustrated by the correlations with this variable. This suggests that high concentrate and succulent feeding would tend to increase total milk production and high dry roughage feeding would tend to decrease it. Therefore, it seems that silage systems are more common on larger farms, whereas hay systems tended to be found on the smaller farms.

Table 9. Correlations of Measures of Size With Selected Dairy Practices
410 New York Dairy Farms, 1982

Dairy Practices	Number of Cows	Total Tillable Acres	Worker Equiv.	Total Capital Invested	Pounds Milk Sold
Pounds concentrates fed	0.267	0.235	0.221	0.245	0.268
Pounds succulents fed	0.408	0.351	0.357	0.378	0.472
Pounds dry roughages fed	-0.381	-0.368	-0.310	-0.373	-0.406
Number of cows milked 3 times	0.903	0.868	0.777	0.914	0.910
Cow days in milk 3 times	0.885	0.835	0.746	0.896	0.888
Breedings per conception	0.166	0.135	0.156	0.158	0.178
Days open	0.066*	0.096*	0.073*	0.038*	0.032*
Days dry	-0.170	-0.107	-0.140	-0.190	-0.207
Projected min. calving interval	0.038*	0.078*	0.042*	0.044*	0.014*
Percent days in milk	0.100	0.075*	0.098*	0.126	0.154
Percent leaving herd	0.021*	0.049*	0.005*	0.022*	0.021*

*Not significant at 0.05 level.

Milking three times per day had very high positive correlations with all measures of size, which suggests that this practice may be more common on the larger farms.

The small positive correlations for number of breedings per conception with the size measures suggest that on large farms heat detection rate may be less efficient than on smaller farms. Also, high levels of milk production may result in lower fertility and this would tend to increase the number of breedings per conception. However, all of these correlations were small and, therefore, their effects on net returns from the business may be small.

For days dry and percent days in milk, it seems that larger farms tend to have slightly fewer days dry and slightly more days in milk than smaller farms.

This would support the positive correlations for milk sold per cow with the size measures in Table 8. Since decreases in days dry and increases in percent days in milk would increase milk sold per cow (see Table 27).

Rates of Production

Productivity, which is usually measured by rate of production, is an important factor affecting farm incomes with high levels being conducive to increased incomes. Four measures of rates of production were looked at and their relationships with other business factors are given in Tables 10, 11, and 12.

Table 10. Correlations of Selected Rates of Production Measures
410 New York Dairy Farms, 1982

Rates of Production	Milk Sold per Cow	Yield of Hay (tons DM)	Yield of Corn Silage (tons DM)	Yield of Corn Grain (bushels)
Milk sold per cow	1.00	0.179	0.232	0.089*
Yield of hay (tons DM)		1.00	0.126	0.063*
Yield of corn sil. (tons DM)			1.00	0.129
Yield of corn grain (bu.)				1.00

*Not significant at 0.05 level.

Relationships between the measures of rates of production looked at were small and it would seem that livestock and crop productivity were not very much related. However, the correlations were positive, and this would suggest that farmers who were more efficient with crop production also were for livestock production.

Table 11. Correlations of Rates of Production with Productivity,
Labor Efficiency, and Income
410 New York Dairy Farms, 1982

Rates of Production	Pounds Milk Sold per Cow	Pounds Milk Sold per Worker	Labor & Management Income per Operator
Milk sold per cow	1.00	0.413	0.218
Yield of hay (tons DM)	0.179	0.123	0.041*
Yield of corn silage (tons DM)	0.232	0.210	0.136
Yield of corn grain (Bu.)	0.089*	0.064*	0.109*

*Not significant at 0.05 level.

Milk sold per cow showed a high positive correlation (0.413) with milk sold per worker (Table 11). This is expected since increased production per cow even with small decreases in cows per worker could result in increased production per worker. Milk sold per cow also had a positive effect on operator income (0.218).

Of the three crop production rates, yield of corn silage seems to have the largest effect on labor efficiency and operator income.

Table 12. Correlations of Rates of Production and Other Business Factors 410 New York Dairy Farms, 1982

Business Factors	Milk Sold per Cow	Yield of Hay (tons DM)	Yield of Corn Silage (tons DM)	Yield of Corn Grain (bushels)
Number of cows	0.119	0.152	0.116	-0.001*
Total tillable acres	0.094*	0.063*	0.019*	-0.022*
Worker equivalent	0.187	0.172	0.087	-0.017*
Capital invested per cow	0.231	0.056*	0.089*	0.078*
Farm expenses per cow	0.579	0.097*	0.129	0.010*
Production costs per cwt. milk	-0.465	-0.121	-0.181	-0.064*

*Not significant at 0.05 level.

The correlations of different rates of production with other business factors are reported in Table 12.

Milk sold per cow was negatively correlated (-0.465) with production costs per hundredweight milk. This is understandable since increased productivity per cow would tend to spread fixed costs over a larger volume of production and, hence, reduce the cost of production on a per unit basis. However, increased productivity would require higher levels of variable inputs and this is illustrated by the positive correlation (0.579) for milk sold per cow and total farm expenses per cow. Other correlations suggest increases in the number of cows, worker equivalent, and capital invested per cow would tend to increase milk sold per cow. This was discussed in connection with Tables 8 and 9.

Yield of hay and corn silage were negatively related to production costs per hundredweight milk (-0.121 and -0.181 respectively). The size of these correlations suggest the input levels used by farmers for the production of hay and corn silage are approaching the point where marginal costs would be equal to marginal returns. Production of corn grain seems to be at this point (-0.064), but there may be room for increased input levels in the hay and corn silage enterprises.

Only yield of corn silage was significantly correlated (0.129) with total farm expenses per cow. This may be due to the fact that corn silage is one of the most common feeds used on dairy farms. The sign of the correlation coefficient would suggest that increased productivity would require increased input levels, which would increase the total farm expenses per cow.

It is not surprising that total tillable acres was not significantly correlated with any of the measures of rates of production, since increased acreage may not, in all cases, imply increased efficiency. Also, increased acreage may mean, in some cases, the use of marginal land.

Worker equivalent had a small positive correlation (0.187) with milk sold per cow. One might expect this type of relationship since higher levels of production per cow would require more milking labor. This is discussed in more detail under cost control. On the other hand, an increase in worker equivalent may result in greater specialization and better animal husbandry, and this would have positive effects on milk sold per cow. The small positive correlation for worker equivalent with crop yields may be related, in some degree, with timeliness of field operations.

Labor Efficiency

Labor accounts for nearly 12 percent of total farm expenses and is an important cost factor in producing milk, therefore, it is important that labor be used efficiently. Correlations for labor efficiency, measured by cows per worker and milk sold per worker, with various business and dairy management factors, are given in Tables 13, 14, 15, and 16.

Table 13. Correlations of Labor Efficiency with Labor and Management Income per Operator by Barn Type and Milking System 410 New York Dairy Farms, 1982

Category	Number of Farms	Measures of Labor Efficiency	
		Cows per Worker	Pounds Milk Sold/Worker
Stanchion barns	247	0.220	0.314
Dumping station	50	0.135*	0.260
Pipeline	179	0.222	0.299
Parlor	13	0.132*	0.411*
Freestall barns	135	0.209	0.326
Dumping station	---	---	---
Pipeline	7	-0.322*	-0.193*
Parlor	128	0.223	0.342

*Not significant at 0.05 level.

Labor efficiency seems to have about the same relationship with operator income in both stanchion and freestall barns (Table 13). This is illustrated by correlations of 0.220 and 0.209 for cows per worker with operator income in stanchion and freestall barns respectively, and correlations of 0.314 and 0.342 for pounds of milk sold per worker with operator income in stanchion and freestall barns, respectively.

Correlations for cows per worker, using pipeline systems in stanchion barns and parlor systems in freestall barns, with operator income are nearly the same (0.222 versus 0.223). But, pounds of milk sold per worker seems to have a stronger relationship with operator income for parlor systems in freestall barns than pipeline systems in stanchion barns. This may be due to the fact that average herd size was larger in freestall than in stanchion barns, and the efficiency with which hired labor is utilized is more critical to labor and management income in these large herds.

The efficiency of labor use would decrease if a pipeline system is used in freestall barns. This is illustrated by the negative correlations for cows per worker (-0.322) and pounds milk sold per worker (-0.193) with operator income whereas operator income can be increased through increased labor efficiency with parlor systems in stanchion barns.

Over all farms, increases in labor efficiency would tend to increase operator income (Table 14). This is seen in correlations of 0.209 and 0.301 for cows per worker and milk sold per worker respectively with operator income.

Cows per worker had a high positive correlation (0.885) with pounds milk sold per worker and increases in milk productivity was highly correlated (0.413) with milk sold per worker.

Table 14. Correlations of Labor Efficiency with Productivity, Milk Sold per Worker, and Income 410 New York Dairy Farms, 1982

Measures of Labor Efficiency	Pounds of Milk Sold per Cow	Pounds of Milk Sold per Worker	Labor & Management Income per Operator
Cows per worker	0.039*	0.885	0.209
Milk sold per worker	0.413	1.00	0.301

*Not significant at 0.05 level.

Correlations for selected business factors with measures of labor efficiency are listed in Table 15. Cows per worker and pounds of milk sold per worker showed positive correlations with all the size measures. This would suggest that the larger farms would tend to have a higher labor efficiency than the smaller farms.

The relationships for pounds of milk sold per worker with the size measures were discussed in Table 8 and it seems that in this case these relationships may be due to the positive correlations for cows per worker with the measures of size, since increases in cows per worker would tend to increase the pounds of milk sold per worker.

Table 15. Correlations of Labor Efficiency with Selected Business Factors 410 New York Dairy Farms, 1982

Business Factors	Cows per Worker	Pounds Milk Sold per Worker
Number of cows	0.565	0.583
Pounds of milk sold	0.518	0.621
Total tillable acres	0.398	0.420
Worker equivalent	0.131	0.222
Capital invested per cow	-0.234	-0.106
Capital invested per worker	0.642	0.659
Machinery investment per cow	-0.177	-0.062*
Total farm expenses per cow	-0.120	0.151
Production cost per cwt. milk	-0.208	-0.392
Heifers as percent of cows	-0.177	-0.065*

*Not significant at 0.05 level.

Number of cows, total pounds of milk sold, and capital invested per cow showed high correlations with cows per worker and pounds of milk sold per worker. This would be expected, since the larger farms tend to be more capital intensive and this would result in an increase in the number of cows per worker which, in turn, would increase the pounds of milk sold per worker. This is supported by the high positive correlations for total capital investment per worker with cows per worker (0.642) and pounds of milk sold per worker (0.659).

The positive correlations for total tillable acres and worker equivalents with the measures of labor efficiency is probably due to the high positive correlation for number of cows with these two measures of size (Table 6).

The negative correlation for capital invested per cow and cows per worker (-0.234) may be a result of the negative correlation (-0.256) for number of cows with capital invested per cow in Table 8. This suggests that the larger farms have less capital invested per cow than the smaller farms and also more cows per worker. This would explain the negative correlation for capital invested per cow with cows per worker (see discussion on Table 8 for more details).

The negative correlation for machinery investment per cow with cows per worker would support the conclusion that the larger farms tend to be more capital intensive.

Relationships for total farm expenses per cow indicate that decreases in labor efficiency (cows per worker) would result in increased expenses per cow (-0.120) and increased milk production per worker would tend to increase total farm expenses per cow (0.151). This latter relationship is probably due to the positive correlation for total farm expense per cow with milk sold per cow (Table 12) and milk sold per cow was positively correlated with pounds milk sold per worker (Table 14).

Other correlations indicate that production costs would tend to rise with decreases in labor efficiency and increases in the number of heifers would reduce the number of cows per worker, but this relationship was small.

Table 16. Correlations of Measures of Labor Efficiency with Selected Dairy Practices 410 New York Dairy Farms, 1982

Dairy Practices	Cows per Worker	Milk Sold per Worker
Pounds concentrates fed	0.119	0.303
Pounds succulents fed	0.385	0.443
Pounds dry roughages fed	-0.316	-0.389
Number of cows milked 3 times	0.671	0.700
Cow days in milk 3 times	0.682	0.703
Average bodyweight all cows	0.091*	0.225
Days dry	-0.171	-0.309
Days open	0.022*	-0.078*
Percent days in milk	0.082*	0.247
Breedings per conception	0.074*	0.113
Percent cows leaving herd	0.012*	0.019*

*Not significant at 0.05 level.

Table 16 shows correlations for various dairy practices with measures of labor efficiency.

Pounds concentrates and succulents fed, number of cows milked three times, and cow days in milk three times were positively correlated with milk sold per worker and cows per worker whereas pounds dry roughages fed was negatively correlated with these measures of labor efficiency. Similar correlations were found for these dairy practices with number of cows and total pounds milk sold (Table 9). Also, number of cows and pounds of milk sold was found to be highly correlated with labor efficiency (Table 15).

It would seem, therefore, that these dairy practices are important in determining labor efficiency and that high concentrate feeding, silage systems, and milking three times a day are good practices to follow, and, as suggested in Table 9, these practices seem to be more common on the larger farms.

The other dairy practices studied were not related to any great extent with cows per worker but some of them, such as percent days in milk and days dry, had significant correlations with pounds of milk sold per worker. These results are probably due to the positive effect which fewer days dry have on increased current lactation milk production per cow, through an increase in the number of days in milk. Hence, percent days in milk was positively correlated with pounds milk sold per worker (0.247).

Capital Efficiency

Capital is a major farm resource and the efficiency with which it is used affects the profitability of the farm business. Correlation coefficients for various measures of capital efficiency with various business and dairy practices are given in Tables 17, 18, 19, and 20.

Table 17. Correlations of Capital Efficiency with Labor and Management Income by Barn Type and Milking System 410 New York Dairy Farms, 1982

Category	No. of Farms	Total Capital Investment Per Cow	Total Capital Investment Per Cwt. Milk	Total Capital Investment Per Worker	Machinery Per Cow	Land & Buildings Per Cow
Stanchion Barns	247	-0.236	-0.339	-0.015*	-0.179	-0.246
Dumping Station	50	-0.376	-0.449	-0.195*	-0.276	-0.329
Pipeline	179	-0.237	-0.337	-0.002*	-0.212	-0.234
Parlor	13	-0.022*	-0.423*	-0.018*	-0.055*	-0.065*
Freestall Barns	135	-0.038*	-0.153*	-0.138*	-0.095*	-0.142*
Dumping Station	---	---	---	---	---	---
Pipeline	7	0.502*	0.344*	0.035*	-0.102*	0.518*
Parlor	128	-0.046*	-0.158*	-0.142*	-0.090*	-0.155*

*Not significant at 0.05 level.

In general, for different types of barns and milking systems, it would seem that increased capital investment, per worker, per cow, and per hundredweight milk is associated with decreased labor and management income per operator (Table 17), except for pipeline milking systems in freestall barns. Here labor and management income per operator is positively associated with these measures of capital efficiency. This result may be due to the inefficiency of pipeline milking systems in freestall barns. However, there were only seven farms in this category and the correlation coefficients were not significantly different from zero.

With the exception of total capital investment per worker, correlations for the other measures of capital efficiency with operator income in stanchion barns were negative and statistically significant. On the other hand, correlations for the various measures of capital efficiency with operator income in freestall barns were not significantly different from zero.

The correlations for total capital investment per cow with operator income, in both barn types, were discussed in detail in Table 5. In this discussion it was pointed out that production costs per hundredweight of milk was positively correlated with capital investment per cow in stanchion barns, whereas in free-stall barns this correlation was not significantly different from zero. Hence, it may be that the correlations for these measures of capital efficiency with operator income is a result of their effect on production costs per hundred-weight milk in the two barn types.

Correlations for several measures of capital efficiency with milk sold per cow and per worker, and labor and management income per operator, are listed in Table 18.

Milk sold per cow showed significant positive correlations with all of the measures of capital efficiency, except land and building investment per cow. This suggests that the farms with higher levels of milk sold per cow have higher capital investment and machinery capital per cow, also capital per worker, machinery capital per tillable acre, and percent equity.

Table 18. Correlations of Capital Efficiency with Productivity Labor Efficiency and Income
410 New York Dairy Farms, 1982

Measures of Capital Efficiency	Pounds of Milk Sold Per Cow	Pounds of Milk Sold Per Worker	Labor & Management Income Per Operator
Capital investment per cow	0.231	-0.106	-0.123
Capital investment per worker	0.160	0.659	0.082*
Machinery capital per cow	0.233	-0.082*	-0.130
Machinery capital per tillable acre	0.153	0.081*	-0.009*
Land & building capital per cow	0.093*	-0.154	-0.168
Percent equity	0.228	-0.036*	0.093

*Not significant at 0.05 level.

The negative correlation (-0.106) for capital investment per cow with pounds of milk sold per worker may be due to the fact that the larger farms tend to have less capital invested per cow and more cows per worker than the smaller farms. This is supported by the correlation (-0.256) for number of cows with capital investment per cow (Table 8), and the positive correlation (0.565) for number of cows with cows per worker (Table 15). Therefore, decreased capital efficiency, i.e. an increase in the capital investment per cow, may result in decreased labor efficiency, i.e. a decrease in the number of cows per worker. This is supported by the negative correlation (-0.234) for capital invested per cow with cows per worker in Table 15, which would explain the negative correlation (-0.106) for capital invested per cow with pounds of milk sold per worker. The same argument is applicable to the correlation (-0.154) for land and building investment per cow with milk sold per worker.

Capital investment per worker showed a high correlation (0.659) with milk sold per worker. This result is in agreement with the finding that the larger farms tend to have a higher labor efficiency, i.e. more cows per worker (see Table 15), and, hence, a higher level of capital investment per worker. This is supported by the correlation (0.642) for cows per worker with capital investment per cow (Table 15).

Statistically significant negative correlations were obtained for labor and management income per operator, with capital investment (-0.123), machinery investment (-0.130), and land and building investment (-0.168) all on a per cow basis.

These results agree with the fact that the efficiency of capital utilization would increase as the number of productive units per $1,000 invested increases. As the efficiency of capital utilization increases, one would expect production costs per unit of product to decrease. This is illustrated in Table 19 by the positive correlations for production costs per hundredweight milk with capital invested per cow (0.165), machinery capital per cow (0.120), and land and building capital per cow (0.221).

Correlations for some other selected business factors with several measures of capital efficiency are also listed in Table 19. Capital invested per cow showed negative correlations with number of cows and worker equivalents. These relationships were discussed in Table 8.

Total tillable acres showed a small negative correlation with capital invested per cow. This is probably due to the high correlation (0.820) for total tillable acres with number of cows (Table 6). Although increased acreage would result in a higher capital investment per cow, a compensatory increase in cow numbers would tend to reduce the capital investment per cow.

Table 19. Correlations of Capital Efficiency With Other Business Factors
410 New York Dairy Farms, 1982

Capital Measures	No. of Cows	Total Tillable Acres	Worker Equiv.	Farm Expenses Per Cow	Production Cost Per Cwt. Milk
Capital per cow	-0.258	-0.095*	-0.191	0.384	0.165
Capital per worker	0.251	0.258	-0.049*	0.236	-0.063*
Machinery capital per cow	-0.269	-0.166	-0.231	0.284	0.120
Land & building capital/cow	-0.230	-0.077*	-0.168	0.266	0.221
Machinery capital per tillable acre	-0.085*	-0.314	-0.114	0.132	-0.031*
Percent equity	-0.042*	-0.018*	0.040*	0.059*	-0.147
Heifers as percent of cows	-0.005*	0.115	0.090	0.158	-0.084*

*Not significant at 0.05 level.

The negative correlation (-0.314) for total tillable acres with machinery capital per tillable acre suggests that increases in tillable acreage would increase the efficiency of machinery capital utilization since this capital would be spread over a larger number of tillable acres and on a per acre basis it would be reduced.

Capital invested per worker showed positive correlations with both number of cows (0.251) and total tillable acres (0.258). This supports the suggestion that the larger farms tend to be more capital intensive and employ fewer workers per $1,000 of capital invested. Also, because of the large number of cows on these farms it is logical that machinery capital per cow would tend to decrease. This is illustrated by the negative correlations for machinery capital per cow with number of cows (-0.269) and total tillable acres (-0.166).

The correlation of 0.115 for total tillable acres with heifers as a percent of cows would suggest that there is a slight tendency for heifers as percent of cows to increase with tillable acres. This is understandable in that greater number of tillable acres could facilitate a larger heifer enterprise.

Increases in heifers as percent of cows was not associated with any significant increase in labor as illustrated by the correlation (0.090) for worker equivalents with heifers as percent of cows. However, as heifer numbers increase relative to cow numbers, one would expect total farm expenses on a per cow basis to increase. This is seen in the correlation (0.158) for heifers as percent of cows with total farm expenses per cow.

The general relationship for worker equivalents with most of the measures of capital efficiency was negative. This may be due to the high correlations for worker equivalents with other size measures (Table 6) and is a reflection of the substitution of capital for labor factor. Hence, the overall effect of increasing worker equivalents would tend to be similar to the effects of increasing size and this would tend to reduce capital investment on a per cow basis.

Decreased efficiency of capital utilization would be reflected in increases in capital investment per unit of production. This would result in a higher real estate cost per unit of production and, hence, would increase the total farm expenses per cow. This would explain the positive correlations for total farm expenses per cow with the measures of capital efficiency.

Percent equity showed a negative correlation (-0.147) with production costs per hundredweight milk. This may be a result of reduced interest payment since interest charged on equity capital was less than that charged on borrowed capital.

Table 20 lists correlation coefficients for measures of capital efficiency with several selected dairy practices. Correlations for capital investment per worker with pounds concentrate, pounds succulents, and pounds dry roughages fed were similar to the correlations for measures of size with these feeding practices in Table 9 where it was suggested that higher concentrate feeding and silage systems were more common on larger farms. It was also shown in Table 19 that these larger farms tend to have a higher level of capital invested per worker. Hence, these positive correlations for investment per worker with the three feeding practices may be expected. Pounds concentrates fed was not significantly correlated with the other measures of capital efficiency. This may be due to the fact that concentrates fed is derived from both home grown and purchased concentrates.

Table 20. Correlations of Measures of Capital Efficiency with Selected Dairy Practices 410 New York Dairy Farms, 1982

	Capital Invested		Mach. Capital		Land & Bldg. Capital
Dairy Practices	Per Cow	Per Worker	Per Cow	Per Tillable Acre	Per Cow
Pounds concentrates fed	0.060*	0.185	0.050*	0.027*	-0.011*
Pounds succulents fed	-0.216	0.182	-0.129	-0.023*	-0.229
Pounds dry roughages fed	0.073*	-0.233	0.080*	0.076*	0.087*
Number of cows milked 3 times	-0.229*	0.396	-0.453	-0.268*	-0.234*
Cow days in milk 3 times	-0.253	0.405	-0.399	-0.178*	-0.279*
First calf cows entering herd	-0.249	0.236	-0.248	-0.064*	-0.230
Other cows entering herd	-0.074*	0.267	-0.075*	0.043*	-0.091*

*Not significant at 0.05 level.

The negative correlations for pounds succulents fed with the other measures of capital efficiency suggest that for farms with a high level of capital investment per cow, less succulents may be fed. It seems that silage systems are more common on the larger farms (Table 9). And, these farms tend to have a lower level of capital investment per cow (Table 19). This would explain these negative correlations for pounds succulents fed with the other measures of capital efficiency.

Correlations for the other dairy practices studied with capital efficiency measures seem to follow a similar trend, in that correlations with capital investment per worker were positive and correlations with the other measures of capital efficiency were negative. This suggests that the better herds have a lower level of capital investment on a per cow basis and a higher level on a per worker basis, and that these herds tend to follow good dairy practices such as milking three times per day and have a higher level of culling.

Cost Control

Feed, machinery, and labor are major cost items in any dairy farm business. Management of these costs, so that they are kept within reasonable limits, would determine, to a large extent, the net returns from the business. Relationships for these cost factors with business and dairy management practices are given in Tables 21 through 25.

Correlations for machinery, labor, and real estate cost on a per cow basis with labor and management income per operator are listed in Table 21. These correlations were all negative for both stanchion and freestall barns and milking system within these barn types; except for labor cost per cow with pipeline systems in freestall barns and real estate cost per cow for parlor systems in stanchion barns. However, the number of farms in these two categories were only 13 and 7 respectively, and the correlations were not significantly different from zero. The other negative correlations are understandable in that decreases in any of these cost items would tend to have a positive effect on labor and management income per operator.

Table 21. Correlations of Selected Cost Factors With Labor and Management Income per Operator by Barn Type and Milking System 382 New York Dairy Farms, 1982

Category	No. of Farms	Machinery Cost Per Cow	Labor Cost Per Cow	Real Estate Cost Per Cow
Stanchion Barns	247	-0.278	-0.176	-0.123
Dumping Station	50	-0.302	-0.084*	-0.152*
Pipeline	179	-0.335	-0.196	-0.142
Parlor	13	-0.274*	-0.150*	-0.203*
Freestall Barns	135	-0.078*	-0.103*	-0.184
Dumping Station	---	---	---	---
Pipeline	7	-0.491*	-0.118*	-0.476*
Parlor	128	-0.066*	-0.107*	-0.174

*Not significant at 0.05 level.

Both machinery and labor cost per cow seem to be more closely associated with operator income in stanchion barns than in freestall barns. This may be due to the fact that herd size was much larger in the freestall barns and that these two cost items were lower in herds with freestall barns than in herds with stanchion barns. Hence, management of these cost items may tend to be more crucial to income in herds with stanchion barns.

The correlation for real estate cost per cow with operator income was slightly greater in freestall barns than in stanchion barns (-0.184 versus -0.123), also for parlor systems in freestall barns than for pipeline systems in stanchion barns (-0.176 versus -0.142). This small difference may be due to the fact that herds with freestall barns were much larger and, hence, real estate costs may be more related to operator income in these herds.

Correlations for selected cost factors with milk sold per cow and per worker, and labor and management income per operator are given in Table 22.

The negative correlation (-0.161) for milk sold per cow with purchased feed as percent of milk sales, may be due to the fact that higher rolling herd averages would result in a higher volume of milk sales and this would tend to reduce the purchased feed costs as a percent of milk sales.

High levels of milk production per cow would require high levels of feeding, however, for a given increase in feed costs per cow, the increase in milk sold per cow should be greater in order to maximize net returns from the business. This is illustrated by the positive correlations for milk sold per cow with feed purchased per cow (0.242) and feed and crop expenses per cow (0.437) and the negative correlation for milk sold per cow with feed and crop expenses per hundredweight milk sold (-0.186). Correlations for milk sold per worker with these variables were similar but smaller. These correlations may be a result of the positive correlation (0.413) for milk sold per worker with milk sold per cow (Table 14).

Both labor cost per cow and machinery cost per cow showed positive correlations with milk sold per cow. In this case it may be that farms with high rolling herd averages for milk produce more home grown feeds, which would require more machinery capital per cow and result in higher machinery costs per cow. This is supported by the positive correlation (0.233) for machinery capital per cow with milk sold per cow (Table 18). These farms may also pay their workers higher wages and more milking labor would be required for higher levels of production per cow, and this would result in a higher labor cost per cow.

However, on a per hundredweight milk basis, the correlations for milk sold per cow with labor cost and machinery cost were negative (-0.365 and -0.164 respectively). This suggests that the added production more than compensates for the increased machinery and labor costs.

Table 22. Correlations of Selected Cost Factors With Productivity, Labor Efficiency, and Income 410 New York Dairy Farms, 1982

Cost Factors	Milk Sold Per Cow	Milk Sold Per Worker	Labor & Mgmt. Per Operator
Purchased feed as % of milk sales	-0.161	-0.080*	-0.018*
Feed purchased per cow	0.242	0.111	-0.080*
Feed & crop expenses per cow	0.437	0.225	0.031*
Feed & crop expenses per cwt. milk	-0.186	-0.037*	-0.111
Machinery cost per cow	0.326	-0.047*	-0.168
Machinery cost per cwt. milk	-0.164	-0.167	-0.283
Labor cost per cow	0.210	-0.479	-0.135
Labor cost per cwt. milk	-0.365	-0.683	-0.227
Veterinary expenses per cow	0.264	0.128	-0.060*
Livestock expenses per cow	0.468	0.134	0.039*
Real estate cost per cow	0.051*	-0.059*	-0.140*

*Not significant at 0.05 level.

The positive correlation (0.264) for veterinary expense per cow with milk sold per cow suggests that better herd health programs may have positive effects on milk sold per cow. Also, it may mean that those farms which have high levels of milk production per cow spend more money on preventative veterinary care.

Labor cost per cow showed a high negative correlation with milk sold per worker (-0.479). This is expected since an increase in labor efficiency, i.e. more cows per worker, would result in lower labor costs per cow and more pounds of milk sold per worker. This is supported by the correlation (0.885) for cows per worker with pounds milk sold per worker (Table 14).

Labor and management income per operator was only significantly correlated with one of the feed cost variables, which was feed and crop expenses per hundredweight milk (-0.111). This is understandable in that on a per cow basis, increased feed expenses would be compensated for by increased milk sales. But, on a per hundredweight milk basis, increased feed expenses would have a negative effect on operator income, since the efficiency with which feed is used would be reduced.

Both machinery and labor cost per hundredweight milk and per cow showed negative correlations with labor and management income per operator. The correlations on a per hundredweight milk basis may be expected since these cost factors represent the efficiency with which labor and machinery are used in the production process.

Correlations for these cost factors, with other business factors, were also studied and are listed in Tables 23 and 24.

Number of cows showed very small negative correlations with machinery and labor cost per cow. This may be due to a more efficient use of labor and machinery in the larger herds. This is supported by the significant negative correlations for number of cows with labor and machinery cost on a per hundredweight milk basis (-0.171 and -0.152 respectively).

The negative correlation (-0.269) for number of cows and machinery capital per cow (Table 19) and the positive correlation (0.583) for number of cows with pounds milk sold per worker would also support the point that the larger farms tend to be more efficient in their use of machinery and labor.

The correlation (0.136) for number of cows with veterinary expense per cow suggest that the larger herds tend to have higher veterinary expenses per cow. This was also found by Smith and Putnam, 1982. This increase in veterinary expense per cow may be due to increased incidences of mastitis in the larger herds. This was shown in cross tabulation tables for somatic cell count and number of cows (Bratton, 1982).

Table 23. Correlations of Selected Cost Factors With Some Measures of Size of Business 410 New York Dairy Farms, 1982

Cost Factors	No. of Cows	Total Tillable Acres	Worker Equivalents
Purchased feed as % of milk sales	-0.081*	-0.260	-0.130
Feed purchased per cow	-0.007*	-0.209	-0.042*
Feed & crop expense per cow	-0.060*	-0.052*	-0.039*
Machinery cost per cow	-0.087*	0.050*	-0.034*
Labor cost per cow	-0.088*	-0.010*	0.249
Machinery costs per cwt. milk	-0.152	-0.009*	-0.125
Labor cost per cwt. milk	-0.171	-0.076*	0.106
Veterinary expense per cow	0.136	0.033*	0.164
Livestock expense per cow	-0.004*	-0.016*	-0.060*
Real estate expense per cow	-0.051*	0.124	0.025*

*Not significant at 0.05 level.

Total tillable acres showed negative correlations with purchased feed as percent of milk sales (-0.260) and feed purchased per cow (-0.209). This suggests that the larger herds may be producing more of their feeds at home and the negative correlations would indicate that home grown feeds are probably produced at a lower cost than the cost of purchased feed.

Both labor cost per cow and per hundredweight milk showed positive correlations with worker equivalents. This may be expected since an increase in the number of worker equivalents may tend to reduce the efficiency of labor use and result in higher labor cost on a per unit basis.

Heifers as percent of cows showed significant positive correlations (Table 24) with machinery cost (0.147), labor cost (0.129), livestock expense (0.102), and real estate cost (0.109) all on a per cow basis. This may be expected since raising more heifers does cost more.

The correlation (-0.087) for heifers as percent of cows with feed purchased as percent of milk sales seems to be due to an increase in milk sales as heifers as percent of cows increases since there is no evidence to support a decrease in purchased feed. This is supported by the positive correlation (0.178) for heifers as percent of cows with milk sold per cow (Table 8). It seems that raising more replacements may tend to improve production per cow and would also improve incomes. This was discussed in greater detail in Table 19.

Table 24. Correlations of Selected Cost Factors With Selected Business Factors 410 New York Dairy Farms, 1982

Cost Factors	Heifers as % of Cows	Capital Invest. Per Cow	Production Costs Per Cwt. Milk	Total Farm Expenses Per Cow
Purchased feed as % of milk sales	-0.087*	-0.215	0.080*	-0.099*
Feed purchased per cow	-0.016*	-0.141	-0.096*	0.156
Feed & crop expenses per cow	0.071*	-0.031*	-0.120	0.422
Machinery cost per cow	0.147	0.378	0.152	0.537
Labor costs per cow	0.129	0.182	0.111	0.310
Labor cost per cwt. milk	0.022*	0.062*	0.399	-0.039*
Veterinary expenses per cow	0.070*	0.002*	-0.115	0.266
Livestock expense per cow	0.102	0.157	0.182	0.338
Real estate expense per cow	0.109	0.119	0.031*	0.574

*Not significant at 0.05 level.

Capital invested per cow was negatively correlated with feed purchased as percent of milk sales (-0.215) and purchased feed per cow (-0.141). This suggests that increases in capital investment per cow may be associated with an increased production of home grown feeds, which would result in a decrease in purchased feed. This is supported by a correlation of (0.261) for capital invested per cow with tillable acres per cow. However, an increased level of capital investment per cow would tend to increase machinery cost per cow, livestock expense per cow, and real estate expense per cow. This is illustrated by the positive correlation for capital invested per cow with these three cost items in Table 24.

Feed purchased per cow and feed and crop expenses per cow were negatively correlated with production costs per hundredweight milk and positively correlated with total farm expenses per cow. These relationships may be due to the fact that increases in feed expenses, either produced or purchased, on a per cow basis, was found to be positively related to milk sold per cow but negatively related to milk sold per cow when calculated on a per hundredweight basis (Table 22). This would explain the negative correlation for feed and crop expenses per cow with production cost per hundredweight milk. However, total farm expenses per cow would tend to increase because of higher levels of feeding per cow.

Therefore, it is important that these two business factors, production costs per hundredweight milk and total farm expenses per cow, be considered together. Since for high producing cows, increases in total farm expenses per cow could result in a lower production cost per hundredweight milk through a higher level of production per cow.

The correlations for veterinary expense per cow with production costs per hundredweight milk (-0.115) and total farm expenses per cow (0.266) suggest that increased veterinary cost may increase milk sold per cow or increased milk sold per cow may require a higher level of expenditure on veterinary care.

The interpretation of this correlation is admissable both ways in that in order to increase production per cow, one of the prerequisites would be healthy cows. On the other hand, high producers tend to be more susceptible to disease, especially mastitis, and would require a higher level of veterinary care.

For the other cost factors studied, positive correlations were found with both production costs per hundredweight milk and total farm expenses per cow. This is expected since increases in these cost factors would tend to increase production cost per unit and total expenses per cow.

Correlations for some of the cost factors studied with selected dairy practices are listed in Table 25.

Pounds concentrates fed showed positive correlations with purchased feed per cow (0.118), feed and crop expenses per cow (0.282) and machinery cost per cow (0.213). These correlations suggest that as the level of concentrate feeding increases, both production and purchase of concentrates increases. This is probably related to the correlation (0.441) for pounds concentrates fed with milk sold per cow (Table 26), and the positive correlations in Table 22 for milk sold per cow with machinery cost, feed and crop expense, and feed purchased, all on a per cow basis.

The negative correlation (-0.145) for machinery cost per cow with pounds dry roughages fed may be due to the fact that feeding of dry roughages tend to be more common on smaller farms (see Table 9), and that these smaller farms may tend to have a slightly higher machinery cost per cow (see Table 23).

Table 25. Correlations of Selected Cost Factors With Selected Dairy Practices 410 New York Dairy Farms, 1982

Dairy Practices	Feed Purchased Per Cow	Feed & Crop Exp. Per Cow	Machinery Cost Per Cow	Labor Cost Per Cow
Pounds concentrates fed	0.118	0.282	0.213	0.060*
Pounds succulents fed	0.023*	0.140	0.098	-0.141
Pounds dry roughages fed	0.104	-0.014*	-0.145	0.157
Number of cows milked 3 times	-0.081*	-0.135*	-0.170*	-0.001*
Cow days in milk 3 times	-0.076*	-0.124*	-0.260*	0.036*
Breedings per conception	0.023*	0.087*	0.050*	0.002*
Days dry	-0.127	-0.183	-0.199	0.058*
Days open	-0.049*	-0.092*	-0.046*	0.025*
Percent days in milk	0.128	0.207	0.201	0.021*

*Not significant at 0.05 level.

Pounds succulents fed was not significantly correlated with feed purchased per cow since succulents are home grown. However, one would expect feed and crop expenses and machinery cost per cow to increase with increasing levels of succulent feeding. This is illustrated by the positive correlations for pounds succulents fed with these two variables.

The negative correlation (-0.141) for pounds succulents fed with labor cost per cow is probably due to a positive relationship (0.408, Table 9) for pounds succulents fed with number of cows. It was suggested that succulent feeding was more common on the larger farms and that these farms tend to have more cows per worker (see Table 15). Hence, it may be expected that high levels of succulent feeding may result in lower labor costs per cow.

Similarly, the feeding of dry roughages seem to be more common on the smaller farms (see Table 9), and this would explain the positive correlation (0.157) for pounds dry roughages fed with labor costs per cow since these farms seem to have a lower efficiency in the utilization of labor.

Feed purchased per cow showed a positive correlation (0.104) with dry roughages fed. This may be due to the fact that farmers who feed high levels of dry roughages need to balance their ration with more concentrates and, in this case, a large part of the concentrates may be purchased.

Correlations for days dry and percent days in milk with feed purchased per cow, feed and crop expenses per cow, and machinery costs per cow were significant but opposite in sign. This is due to the high correlation for days dry with percent days in milk (-0.810) since increase in days dry would decrease the number of days in milk.

These results indicate that increasing the percent days in milk, or reducing the number of days dry, may result in an increase in purchased feed per cow, feed and crop expense per cow, and machinery cost per cow. These relationships may be expected since the number of milking days would increase and, hence, feed requirements would also increase.

Dairy Management Practices

Dairy management practices are also important in determining the efficiency of a dairy operation. In Tables 26, 27, and 28, relationships of several dairy practices with productivity, labor efficiency, and income are examined.

Analysis of Feeding Practices

Correlations for various feeding practices with milk sold per cow, milk sold per worker, and labor and management income per operator are noted in Table 26. In general, correlations for milk sold per worker with the various feeding practices had the same sign as those for milk sold per cow. This may be a result of the positive relationship (0.413) between milk sold per cow and milk sold per worker (Table 8). In addition, feeding practices which were positively correlated with milk sold per cow were also positively related to labor and management income per operator. This is in line with the positive relationship (0.213) between milk sold per cow and labor and management income per operator (Table 8).

Therefore, good feeding practices tend to have positive effects on milk sold per cow which, in turn, was found to be positively related to labor and management income per operator.

Table 26. Correlations of Feeding Practices with Productivity, Labor Efficiency, and Income 410 New York Dairy Farms, 1982

Feeding Practices	Milk Sold Per Cow	Milk Sold Per Worker	Labor & Management Income Per Operator
Feeding index	0.017*	0.054*	-0.054*
Rate of roughage feeding	0.078*	-0.003*	0.061*
Pounds concentrates fed	0.441	0.304	-0.035*
Pounds succulents fed	0.223	0.443	0.099
Pounds dry roughage fed	-0.231	-0.389	-0.094
Value of feed	0.363	0.249	0.067*
% net energy from concentrates	0.168	0.126	-0.073*
% net energy from succulents	0.153	0.321	0.089*
% net energy from hay	-0.248	-0.416	-0.054*
% net energy from pasture	-0.227	-0.378	-0.035*
Body weight all cows	0.344	0.225	0.084*
Body weight at first calving	0.272	0.148	0.000*

*Not significant at 0.05 level.

This is a good illustration of how one may take the business analysis a step further by studying the effects of various dairy management practices on the business practices.

Feeding index showed a small positive correlation (0.017) with milk sold per cow. This suggests that dairy farmers are probably feeding their cows for maximum production. This may not be the best decision to make, since feeding index showed a small negative correlation (-0.054) with labor and management income per operator, which suggests that the marginal cost of feed may be slightly higher than marginal revenues. Because of the small size of the negative correlation, it is quite possible that on most farms the decision to maximize output is compatible with the decision to maximize profits.

Correlations for pounds concentrates and pound succulents fed with milk sold per cow and per worker were positive, whereas pounds dry roughages fed was negatively correlated with milk sold per cow and per worker.

Percent net energy from concentrates, succulents, hay, and pasture showed similar correlations with milk sold per cow and per worker.

These results support the conclusion that high concentrate and succulent feeding is necessary for high levels of milk production on a per cow basis, whereas high levels of roughage feeding in the form of hay and pasture would have negative effects on productivity.

Correlations for labor and management income per operator with pounds concentrates fed and percent net energy from concentrates were small and negative but not significant. This suggests that, although at the margin, increased concentrate feeding would increase productivity, the marginal cost of the concentrate may be slightly higher than the marginal revenue. These correlations support the relationship for feeding index with operator income.

Succulent feeding, on the other hand, was positively correlated with operator income. This is probably due to the fact that succulents are home grown and high quality succulents can replace part of the concentrates in dairy rations. This would reduce feed costs and, thus, increase net returns from the business, which supports the recommendations that growing high quality succulents is economical. Pounds dry roughages fed, percent net energy from hay and from pasture, were negatively correlated with labor and management income per operator. This is expected since these feeding practices have a negative effect on productivity.

Both body weight of all cows and body weight at first calving were positively correlated with milk sold per cow and per worker. This is most likely due to the fact that heavier cows produce more milk.

Analysis of Breeding Practices

Correlation coefficients for breeding practices with milk sold per cow, milk sold per worker, and labor and management income per operator are listed in Table 27. The signs of these correlations follow a similar pattern as those for feeding practices. Breeding practices which were negatively correlated with milk sold per cow, were also negatively correlated with milk sold per worker and labor and management income per operator, except for cows not bred after 100 days with milk sold per worker, and breedings per conception with labor and management income per operator.

Days open and calving interval showed similar correlations with milk sold per cow and per worker, and labor and management income per operator. This may be expected since increasing days open would also increase the calving interval. Increase in days open or longer calving intervals would increase the length of the lactation and one may expect milk sold per cow would also increase. Days open and calving interval showed negative correlations with milk sold per cow.

These results may be due to the fact that milk sold per cow is calculated as total annual milk sold divided by number of cows. A decrease in the average calving interval for the herd may mean that the majority of cows would be milking at higher levels of production and this would tend to increase milk sold per cow.

Table 27. Correlations of Breeding Practices with Productivity, Labor Efficiency, and Income
410 New York Dairy Farms, 1982

Breeding Practices	Milk Sold Per Cow	Milk Sold Per Worker	Labor & Management Income Per Operator
Calving interval	-0.150	-0.052	-0.106
Days dry	-0.367	-0.309	-0.080*
Cows not bred after 100 days	-0.138	0.101*	-0.071*
Days open cows not bred	-0.125	-0.031*	-0.033*
Days open all cows	-0.188	-0.078*	-0.117
% days in milk	0.398	0.247	0.072*
Breedings per conception	0.080*	0.115	-0.029*
Age at first calving	-0.137	-0.153	-0.099

*Not significant at 0.05 level.

Milk sold per cow was shown to be positively related to operator income and since longer calving intervals and days open would tend to decrease milk sold per cow, one may also expect that labor and management income per operator may decrease with longer calving intervals and days open. This is illustrated by the negative correlations for labor and management income per operator with calving interval (-0.106) and days open (-0.117).

Correlations for milk sold per cow with days dry and percent days in milk were opposite in sign. This may be a result of the negative correlation (-0.810) between days dry and percent days in milk. Percent days in milk showed a correlation of 0.398 with milk sold per cow. This may be due to the fact that increases in percent days in milk would mean fewer days dry, and this would tend to increase milk sold per cow.

In addition, fewer days dry may mean more days in milk and this would explain the correlation of -0.367 for days dry with milk sold per cow. Correlations for milk sold per worker with days dry and percent days in milk were similar to those for milk sold per cow, and is a result of the correlation (0.413) for milk sold per cow with milk sold per worker (Table 14).

The correlation for average days dry and operator income was small (-0.080). The higher the number of days dry, the longer the cow remains out of production, and no income is realized from her during this period. However, very few days dry would have negative effects on milk production in the succeeding lactation. Hence, the relationship for average days dry with labor and management income would tend to be quadratic and this would explain the small linear correlation for this variable with operator income.

Although percent days in milk was significantly correlated with milk sold per cow, the correlation for this variable with labor and management income per operator was small and not significant. This may be due to the fact that as percent days in milk increase, feed and crop expenses per cow also increase (Table 25). Increases in percent days in milk would also most likely occur during that part of the lactation where daily milk yields are declining.

An increase in the percent days in milk may have very little effect on operator income, when the combined effects of increased feed costs and decreased daily milk yield are taken into consideration. The correlation for percent days in milk with operator income, although small, was positive. This is reassuring since it would indicate that dairy farmers are operating at a level where net returns from the business are still being maximized relative to feed costs.

Cows not bred after 100 days is an absolute measure and as such it would tend to increase with number of cows. This is supported by a correlation of 0.294 for cows not bred after 100 days with number of cows. The positive correlation (0.101) for milk sold per worker with cows not bred after 100 days may be more a result of the positive relationship between size and pounds of milk sold per worker (see Table 8).

Number of breedings per conception showed a very small correlation (0.080) with milk sold per cow. This result may be due to two opposite effects. First, high producing cows usually have lower fertility and, hence, number of breedings per conception would tend to increase with high producers. On the other hand, an increase in the number of breedings per conception would tend to increase days open and this would have a negative effect on milk sold per cow.

Age at first calving was negatively correlated with milk sold per cow and per worker, and labor and management income per operator. This may be expected since the practice of calving heifers early is positively related to production per cow and this is in keeping with the recommendation for early calving.

Other Dairy Practices

Table 28 lists the correlation coefficients for other dairy practices with milk sold per cow, milk sold per worker, and labor and management income per operator. The correlations follow the same pattern as those for feeding and breeding practices in that dairy practices which were positively correlated with milk sold per cow were also positively correlated with milk sold per worker and operator income and vice versa.

The percent of first calf cows and other cows entering the herd are measures of replacement rates and when compared to the percent of cows leaving the herd for dairy and other purposes, would give information on rates of herd increases or decreases. In this data set, the average for cows entering the herd was 2.6 percent higher than the mean for cows leaving the herd. This would indicate that the average herd size increased by about 2.1 cows during 1982. Approximately 82 percent of all cows entering the herd were first calf cows and approximately 83 percent of all cows leaving the herd were for purposes other than dairy.

Table 28. Correlations of Other Dairy Practices With Productivity, Labor Efficiency, and Income
410 New York Dairy Farms, 1982

Practices	Milk Sold Per Cow	Milk Sold Per Worker	Labor & Management Income Per Operator
% first calf cows entering herd	0.172	0.140	0.051*
% other cows entering herd	-0.112	-0.062*	0.000*
% cows leaving herd for dairy	0.166	0.056*	0.094*
% other cows leaving herd	0.069*	0.050*	-0.118*
Average age of all cows	-0.240	-0.225	-0.085*
Somatic cell count	-0.322	-0.099*	-0.228
Cow days in milk 3 times	0.017*	0.703	0.583
Number of cows milked 3 times	-0.002*	0.700	0.602
Fat test	-0.279	-0.133	-0.067*

*Not significant at 0.05 level.

The positive correlation (0.172) for percent first calf cows entering the herd with milk sold per cow may be due to the positive correlation of 0.263 for percent days in milk with percent first calf cows entering the herd and the positive relationship between percent days in milk and milk sold per cow (Table 27).

These relationships may be a result of the fact that first calf cows enter the herd at the beginning of their lactation. Therefore, an increase in the number of first calf cows entering the herd would tend to increase the number of cow days in milk and percent days in milk and decrease the average days dry since there would be more cows in milk on any given day of the year. This is supported by a correlation of 0.235 for percent first calf cows entering the herd with cow days in milk and -0.113 for percent first calf cows entering the herd with average days dry.

In addition, first calf cows entering the herd usually come from raised replacements, whereas other cows entering the herd are usually purchased replacements. This is supported by correlations of 0.199 and -0.131 for heifers as percent of cows with percent first calf cows entering the herd and percent other cows entering the herd, respectively. As more heifers are raised relative to the number of cows, one may expect an increase in the number of replacements raised on the farm and a decrease in the number of replacements bought off the farm.

The correlations for milk sold per cow with percent first calf cows entering the herd (0.172) and percent other cows entering the herd (-0.112) support the management recommendation that replacements should be raised instead of being purchased.

Farmers who raise their own replacements can choose the sires of their replacements and would have data on all the heifers available for selection. The accuracy of selection would tend to be high since all the heifers are raised under the same management conditions and, in this case, phenotype would be more closely related to genotype.

The positive correlation (0.166) for percent dairy cows leaving the herd with milk sold per cow may be due to the fact that herds with higher rolling herd averages would tend to sell more cows for dairy purposes than herds with lower rolling herd averages.

With respect to these four culling and replacement practices, milk sold per worker was only significantly correlated with percent first calf cows entering the herd (0.140). This may be a result of the high positive correlation for number of cows with pounds milk sold per worker (0.583 - Table 15), and the positive correlation of 0.176 for number of cows with percent first calf cows entering the herd. These results suggest that the larger herds tend to have a higher level of labor efficiency and raise most of their replacements.

The correlation 0.051 for percent first calf cows entering the herd with labor and management income per operator may be due to the positive effects of milk sold per cow on operator income (Table 11). Whereas, the positive correlation of 0.094 for percent dairy cows leaving the herd with labor and management income per operator may be due to the higher prices which are paid for dairy cows relative to culled cows. This positive relationship suggests that the prices received for dairy cows are higher than replacement costs. This is supported by the negative correlation (-0.118) for percent other cows leaving the herd with labor and management income per operator, which suggests that these cows are sold at prices which are lower than replacement costs, which is generally true since these cows are sold for processed meats.

Average age of all cows showed negative correlations with milk sold per cow and per worker, and labor and management income per operator. These negative relationships are probably a result of the correlations for average age of all cows with cow days in milk (-0.222), percent days in milk (-0.285), calving interval (0.218), and average days dry (0.201). It seems that herds with higher average age of all cows would tend to have longer average calving intervals, more days dry, and fewer days in milk all of which would have negative effects on milk sold per cow, labor efficiency, and operator income.

High somatic cell counts usually is an indication of high levels of subclinical mastitis in the herd, and subclinical mastitis would reduce daily milk yield per cow. This would explain the high negative correlation for somatic cell count with milk sold per cow (-0.322) and labor and management income per operator (-0.228).

Cow days in milk in herds with three times a day milking and number of cows milked three times per day were not significantly correlated with milk sold per cow. This is interesting since one would expect milk sold per cow to increase under three times a day milking. One possible explanation for these low correlations is that in herds with three times a day milking, approximately 80 percent of the cows present were milked three times per day. This would suggest that the data does not include herds with both three and two times a day milking. Hence, for herds with a similar number of cows, there would be very little difference in the number of cows milked three times per day and differences in the number of cows milked three times per day would be very similar to differences in number of cows. In addition, there were only 39 herds with three times a day milking.

An examination of milk sold per cow in herds with twice per day milking showed it was 1,100 pounds less than in herds with three times per day milking.

The high positive correlation for cow days in milk three times and number of cows milked three times with milk sold per worker and labor and management income per operator, may be due to the fact that the herds with three times a day milking were, on the average, large herds (132 cows), but the standard deviation for number of cows milked three times was high (84 cows). Hence, the variation in number of cows milked three times would be very high and one would expect labor efficiency and operator income to increase as the number of cows milked three times per day increased. This would suggest that milking three times per day is a profitable practice.

Other Factors Studied

Management information of various kinds was available for each of the 410 farms. This made it possible to study possible relationships of various factors to the dairy management practices and the farm business in general. These relationships are presented in Tables 29 through 39 in this section and they may be helpful in understanding how certain dairy practices are used on New York farms.

Milk Price

Price received per unit of output determines, to a large extent, the profitability of a business enterprise. If increases in price per unit of output is associated with increased production cost per unit, then profits would be maximized where marginal cost equals unit price. Dairy farms are business firms and, as such, profit maximization is one of the primary objectives of dairy operators.

Relationships of several business and dairy practices with milk price are examined in Table 29. Milk sold per cow was negatively correlated with milk price (-0.179). This may be due to the fact that fat test affects the price paid per hundredweight of milk and high levels of production per cow is antagonistic to fat test. This is supported by correlations of 0.518 for fat test with milk price and -0.279 for milk sold per cow with fat test (Table 28).

Table 29. Correlations of Selected Business and Dairy Practices With Milk Price 410 New York Dairy Farms, 1982

Factors	Correlations With Milk Price
Milk sold per cow	-0.179
Fat test	0.518
Labor & management income per operator	0.027*
Labor, management, & ownership income	0.047*
Net cash income	0.091*
Production costs per hundredweight milk	0.231
Pounds concentrate fed	0.077*
Pounds succulents fed	0.136
Pounds dry roughages fed	-0.160

*Not significant at 0.05 level.

The negative correlations for milk sold per cow with fat test and milk price is also reflected in the relationship between production costs per hundredweight milk and milk price, the correlation for this relationship being 0.231. Herds with high levels of milk sold per cow would tend to have lower production costs per hundredweight milk because fixed costs would be spread over a larger volume of production. This was illustrated by a correlation of -0.465 for milk sold per cow with production costs per hundredweight milk (Table 12). Herds with low levels of milk sold per cow would tend to have high production costs per hundredweight milk and high fat tests and would thus tend to receive a higher price for their milk.

Correlations for milk price with labor and management income per operator, labor, management, and ownership income, and net cash income were all small and not significantly different from zero. These relationships are probably due to the positive correlation for production costs per hundredweight milk with milk price. Herds which receive higher prices for their milk may also have higher production costs per hundredweight milk, and this would tend to cancel the positive effects of increased milk price on income. However, these correlations were positive and this suggests that milk price would still tend to have some positive effects on net returns from the farm business.

Correlations for milk price with the three feeding practices studied suggest that farmers who feed concentrates and succulents with no dry roughages (i.e., hay and pasture) would tend to receive higher prices for their milk. These results may be related to the fact that seasonality of production also affects the price of milk and farmers who depend on hay and pasture may produce more of their milk during the spring when the nutrient value of pasture is high, but when prices tend to be low. Succulents, on the other hand, provide a feedstuff that is more constant in quality throughout the year, and this tends to reduce seasonal fluctuations in production.

Somatic Cell Count

The somatic cell count program was developed by DHI as a way of helping dairy farmers to detect mastitis. New technology now makes it possible to determine cell counts in individual milk samples. This program was made available to New York dairy farmers early in 1978 and it added another tool for use in herd health management.

Of the 410 farms included in the dairy management practices study, 170 or 41 percent had information on somatic cell count. Correlations for somatic cell count for these farms with various business and dairy practices are listed in Tables 30 and 31.

Number of cows had a small positive correlation with somatic cell count, which suggests that the larger herds tended to have higher somatic cell counts.

High somatic cell counts are usually associated with increased incidences of mastitis which would tend to reduce the pounds of milk sold per cow. This is supported by the negative correlation (-0.322) for milk sold per cow with somatic cell count, and was documented by Bratton, 1982.

Reduced levels of milk sold per cow would tend to have negative effects on milk sold per worker, and would explain the negative correlation (-0.099) for milk sold per worker with somatic cell count.

Table 30. Correlations of Selected Business Factors With Somatic Cell Count 170 New York Dairy Farms, 1982

Business Factors	Correlations With Somatic Cell Count
Number of cows	0.083*
Milk sold per cow	-0.322
Milk sold per worker	-0.099
Difference in milk produced & sold per cow	0.056*
Veterinary expenses per cow	-0.092*
Total farm expenses per cow	-0.115*
Labor & management income per operator	-0.228
Net cash income	-0.125

*Not significant at 0.05 level.

In cases of acute mastitis, somatic cell counts would be very high for the infected cow and the milk produced by that cow would have to be dumped, once the cow has been treated with antibotics. This would tend to increase the difference in milk produced and sold and also increase the bulk tank somatic cell count, if the milk was included before treatment.

The very small positive correlation for somatic cell count with the difference in milk produced and sold per cow, suggests that clinical mastitis is not a very serious problem since the resulting loss in production seems to be small. On the other hand, the high negative correlation (-0.322) for the difference in milk produced and sold per cow with somatic cell count would indicate that subclinical mastitis is much more important and is a bigger problem than clinical mastitis.

High somatic cell counts may tend to increase veterinary expenses per cow since frequency of veterinary treatment would increase. On the other hand, herd health care is important in keeping somatic cell counts at low levels, e.g. through dry cow therapy and sanitation. Reducing the expenditure on veterinary care may result in increases in somatic cell count. The negative correlation for veterinary expenses per cow with somatic cell count would tend to support this latter reasoning.

The negative correlation (-0.115) for total farm expenses per cow and somatic cell count may be due to the overall result of trying to decrease farm expenses per cow by neglecting to maintain facilities and provide services which may be positively related to better herd health.

Somatic cell count was negatively correlated with labor and management income per operator (-0.228) and net cash income (-0.125). These relationships may be due to the negative correlation for milk sold per cow with somatic cell count.

Correlation coefficients for selected dairy practices with somatic cell count are listed in Table 31.

Table 31. Correlations of Selected Dairy Practices With Somatic Cell Count 170 New York Dairy Farms, 1982

Dairy Practices	Correlations With Somatic Cell Count
Days dry	-0.015*
Days open	0.245
Percent days in milk	-0.012*
Age of all cows	0.181
Number of cows milked 3 times	0.253*
Cow days in milk 3 times	0.280*
Number of breedings per conception	0.098*

*Not significant at 0.05 level.

Days open showed a significant correlation (0.245) with somatic cell count. This may be due to the fact that cows seem to be more susceptible to mastitis at peak lactation and since cows are rebred shortly after peak lactation, any clinical infection would tend to reduce their fertility and also increase somatic cell count. Therefore, days open would tend to increase. This argument is supported by the positive correlation (0.098) for number of breedings per conception with somatic cell count.

The effect of somatic cell count on days open may also be a result of the fact that high producers have a lower level of fertility and are difficult to rebreed. High producers tend to be more susceptible to mastitis, which will induce a positive relationship between days open and somatic cell count.

Finally, herds with a high number of days open would tend to have a longer average lactation length. This would cause an increase in somatic cell count since somatic cells in the milk increase towards the end of lactation.

Generally, as cows become older, susceptibility to mastitis tends to increase. This would explain the correlation 0.181 for average age of all cows with somatic cell count.

Correlation for somatic cell count with number of cows milked three times per day seem to indicate that somatic cell count would increase with frequency of milking. Only 14 farms were involved in this correlation and no definite conclusions can be drawn.

Age and Education of Individual Farm Operators

The age and education of the farm operator is obtained in the farm business management records. This makes it possible to observe how operators of different ages and education manage. Since partnerships and corporations have two or more operators who are often in different age groups, they have been excluded from the study of relationships of business and dairy practices with age and education. Of the 410 farms, 311 were individual operators. Of the 311 individual operators, 16 did not report the years of education so only 295 farms are included in the correlations for years of education. These correlations are reported in Tables 32 and 33.

Cow numbers tended to increase slightly with the older operators and also with the more educated operators, but the relationship was stronger with education than with age (0.146 versus 0.119). Similar results were obtained in cross tabulation tables (Bratton, 1982).

Age of operator showed very little relationship with milk sold per cow, milk sold per worker, total farm expenses per cow, production costs per hundredweight milk, net cash income, labor and management income per operator, and machinery cost per hundredweight milk. This suggests that the older operators were not necessarily better business managers than the younger operators.

Percent equity was positively correlated (0.388) with operator age. This is due to the fact that the older operators were in the business for a longer period of time than the younger operators. They were able to increase equity through inflation and savings. Similar results were obtained by cross tabulation analysis (Bratton, 1982).

The positive correlation for labor cost per hundredweight milk with operator age may be the result of younger operators providing more manual labor than the older operators.

Table 32. Correlations of Selected Business Factors With Age and Education of Individual Operators New York Dairy Farms, 1982

Business Factors	Correlations with: Age - 311 Farms	Education - 295 Farms
Number of cows	0.119	0.146
Milk sold per cow	0.060*	0.093*
Milk sold per worker	0.057*	0.195
Total farm expenses per cow	0.097*	0.028*
Production costs per cwt. milk	0.055*	-0.102*
Machinery cost per cwt. milk	0.020*	-0.164
Labor cost per cwt. milk	0.147	0.091*
Net cash income	0.058*	0.135
Labor & management income per operator	-0.082*	0.081*
Percent equity	0.388	-0.150

*Not significant at 0.05 level.

Correlations for education of operator with some key business factors suggest that those operators with more years of education are better business managers than those with fewer years of education. The correlations which support this conclusion are for milk sold per worker (0.195), production cost per hundredweight milk (-0.102), net cash income (0.135), machinery cost per hundredweight milk (-0.164), and milk sold per cow (0.093). Labor and machinery efficiency, productivity per cow, and net cash income would tend to increase, and production cost per hundredweight milk tend to be lower on those farms managed by operators with more education than those managed by less educated operators.

Correlations for age and education of individual operators with selected dairy practices related to feeding, breeding, and culling are listed in Table 33.

The feeding practices studied showed no significant correlations with age of operator. This suggests that feeding practices did not differ much between the young and old operators. It seems that the operators with more years of education tended to have better feeding practices than those with fewer years of education, since pounds concentrates and succulents fed were positively correlated with education, whereas pounds dry roughages fed was negatively correlated with education.

Days dry tended to decrease and days open and percent days in milk tended to increase as age of operator increased. This suggests the older operators tend to have fewer days dry and a higher percent days in milk, but the younger operators seem to get their cows rebred much earlier than the older operators.

Table 33. Correlations of Selected Business Factors With Age and Education of Individual Operators New York Dairy Farms, 1982

Dairy Practices	Correlations with: Age - 311 Farms	Education - 295 Farms
Pounds concentrates fed	0.051*	0.128
Pounds succulents fed	-0.030*	0.195
Pounds dry roughages fed	-0.009*	-0.160
Days dry	-0.165	-0.087*
Days open	0.116	-0.112
Percent days in milk	0.178	0.045*
Percent leaving herd	0.020*	0.050*
Number of cows milked 3 times	-0.276	0.504

*Not significant at 0.05 level.

Correlations for years of education with these breeding practices suggest that there may be slight decreases in days dry and days open and slight increases in percent days in milk as years of education increases. The operators with more years of education may be achieving slightly better results than the less educated operators with respect to these breeding practices.

Number of cows milked three times per day was negatively correlated (-0.276) with operator age, and positively correlated (0.504) with operator years of education. This suggests that the practice of milking three times per day is more prevalent among the younger and more educated operators.

Income Over Feed Cost

DHI records report an economic measure "Income over Feed Cost". This is the difference between the value of the milk produced at current prices and the computed cost of the feed fed. Income over feed cost must cover all the nonfeed costs, and one may expect that increases in feeding efficiency would tend to increase income over feed costs. In Tables 34 and 35, this measure is examined in relation to several business and dairy practices.

Number of cows was not significantly correlated with income over feed costs. Milk sold per cow showed a correlation of 0.774 with this variable. This may be expected since milk sold per cow was found to be positively correlated (0.285) with total pounds of milk sold (Table 8) and negatively correlated with feed and crop expenses per hundredweight milk (Table 22).

The positive correlation (0.336) for milk sold per worker with income over feed costs is most likely due to the positive correlation of 0.413 for milk sold per cow with milk sold per worker (Table 14).

Increased levels of milk production per cow would require higher levels of feeding. This would tend to increase feed and crop expenses per cow and also total farm expenses per cow, as was shown in Table 22. On a per hundredweight milk basis, feed and crop expenses would tend to decrease (Table 22), which indicates that the marginal value of the milk was higher than the marginal cost of the feed. These results would explain the correlations for income over feed costs with feed and crop expense per hundredweight milk (-0.261), total farm expenses per cow (0.484), and production costs per hundredweight milk (-0.323).

Table 34. Correlations of Selected Business Factors With Income Over Feed Costs 410 New York Dairy Farms, 1982

Business Factors	Correlations With Income Over Feed Costs
Number of cows	0.064*
Milk sold per cow	0.774
Milk sold per worker	0.336
Feed & crop expenses per cwt. milk	-0.261
Total farm expenses per cow	0.484
Production costs per cwt. milk	-0.323
Machinery costs per cwt. milk	0.065*
Labor costs per cwt. milk	-0.278
Labor & management income per operator	0.175
Net cash income	0.305

*Not significant at 0.05 level.

Machinery cost per hundredweight milk was not significantly correlated with income over feed cost. This may be expected since only feed cost is being considered. However, labor cost per hundredweight milk showed a significant correlation of -0.278 with income over feed cost. This is probably a result of the negative relationship (-0.365) for milk sold per cow with labor cost per hundredweight milk (Table 22).

Income over feed costs was more strongly correlated with net cash income (0.305) than with labor and management income per operator (0.175). Similar results were obtained by cross tabulation (Bratton, 1982). This may be expected since income over feed costs is more related to cash flow. This suggests that income over feed costs may not be a good measure of profitability, but it may be a good measure of the level of dairy herd management since those farmers who follow better dairy management practices would tend to have higher incomes over feed costs. This is supported by the correlations in Table 35 for income over feed costs with several feeding and breeding practices.

The correlations for income over feed costs with pounds concentrates fed (0.219), pound succulents fed (0.138), and pounds dry roughages fed (-0.302) are in general agreement with previous results. Concentrate and succulent feeding are good feeding practices in that they have positive effects on milk sold per cow (Table 23).

The correlations for income over feed costs with days dry (-0.330), days open (-0.150), percent days in milk (0.354), and average age of all cows (-0.130) suggest that herds with fewer days dry and days open, a higher percent days in milk, and a lower average age of all cows, would tend to have higher incomes over feed costs and, as was shown in Tables 27 and 28, these herds would tend to have a higher level of milk sold per cow. These are good dairy management practices to follow and in this case income over feed cost is a reasonable measure of the level of dairy herd management.

Table 35. Correlations of Selected Dairy Practices With Income Over Feed Costs 410 New York Dairy Farms, 1982

Dairy Practices	Correlations With Income Over Feed Costs
Pounds concentrates fed	0.219
Pounds succulents fed	0.138
Pounds dry roughages fed	-0.302
Percent days in milk	0.354
Days dry	-0.330
Days open	-0.150
Average age of all cows	-0.130
Percent leaving herd	-0.002*

*Not significant at 0.05 level.

The correlation for income over feed costs with labor and management income per operator was 0.175 (Table 34). This correlation was similar in stanchion barns (0.229) and freestall barns (0.193). For different milking systems within the stanchion and freestall barns, correlations for income over feed costs with labor and management income per operator were similar except for parlor systems within stanchion barns where only 13 farms were studied.

Table 36. Correlations of Somatic Cell Count and Income Over Feed Costs With Labor and Management Income Per Operator By Type of Barn and Milking System New York Dairy Farms, 1982

	Somatic Cell Count		Income Over Feed Costs	
Category	No. of Farms	Correlation	No. of Farms	Correlation
Stanchion	112	-0.206	247	0.229
Dumping station	28	-0.245*	50	0.195*
Pipeline	76	-0.158*	179	0.210
Parlor	8	-0.608*	13	0.092*
Freestall	58	-0.227*	135	0.193
Dumping station	---	---	---	---
Pipeline	3	0.088*	7	0.229*
Parlor	55	-0.227*	128	0.199

*Not significant at 0.05 level.

Correlations for somatic cell count and income over feed costs with labor and management income per operator, by barn type, and milking system are listed in Table 36.

The correlation for somatic cell count with labor and management income per operator, for all the farms studied, was -0.228 (Table 28). This correlation was found to be similar in stanchion (-0.206) and freestall barns (-0.227). Within stanchion barns, the correlation (-0.245) for dumping station with labor and management income per operator was slightly larger than that for stanchion barns (-0.206), whereas for pipeline systems it was lower (-0.158).

The number of stanchion barns with parlor systems was very small and the correlation (-0.608) for somatic cell count with labor and management income per operator was not statistically significant, hence no definite conclusions can be made about this relationship. Within freestall barns, only three farms had pipeline systems, and the correlation for somatic cell count with labor and management income per operator is not very meaningful. For parlor systems in freestall barns, the correlation for somatic cell count with labor and management income per operator was similar to that for all the farms (Table 30).

Milk Produced and Sold Per Cow

DHI records report milk produced per cow based on the samples taken each month and then composited for the year. The farm business records report the pounds of milk sold per cow based on the total amount marketed for the year. These two measures differ by the amounts used for calf feeding, the farm family and workers, milk loss from spillage, and milk unfit for use. In Table 37, correlations for milk produced and milk sold per cow, and also the difference in milk produced and sold, are listed for 392 farms. Eighteen farms had a negative difference and were deleted.

Table 37. Correlations of Milk Produced and Milk Sold Per Cow and Difference in Milk Produced and Sold 392 New York Dairy Farms, 1982

Measure	Milk Sold Per Cow	Milk Produced Per Cow
Milk sold per cow	1.00	0.922
Milk produced per cow	0.922	1.00
Difference in milk produced & sold per cow	-0.077*	0.251
Difference as % of milk sold per cow	-0.369	-0.063*
Difference as % milk produced per cow	-0.352	-0.037*

*Not significant at 0.05 level.

The very high correlation of 0.922 for milk sold per cow with milk produced per cow would indicate that either of the two measures may be used to indicate rates of production. The fact that the correlation between these variables was not perfect indicates that there is some variability in the difference in milk produced and sold per cow. Bratton (1982), in cross tabulation tables, showed that this difference tended to vary from 5.4 percent to eight percent of milk produced per cow.

The correlation for difference in milk produced and sold per cow with milk sold per cow was small and not statistically significant. This suggests that there was no definite relationship between these two variables. When the difference in milk produced and sold per cow was expressed as percent milk sold per cow and percent milk produced per cow, statistically significant correlations were obtained with milk sold per cow. Similar findings were reported by Bratton 1982 in cross tabulation analysis.

These correlations are most likely due to the fact that increasing levels of milk sold per cow, together with small changes in the difference in milk produced and sold per cow, would tend to decrease the difference as percent milk sold per cow.

Milk produced per cow was significantly correlated (0.251) with the difference in milk produced and sold per cow. This suggests that in herds with high rolling herd averages, the quantity of milk which is produced and not sold per cow would tend to be higher than in herds with lower rolling herd averages.

Correlations for the difference in milk produced and sold per cow as percent of milk sold per cow, and percent milk produced per cow with milk produced per cow were not significantly different from zero. It seems that with higher levels of milk produced per cow, there may be a proportionate increase in the milk which is not sold.

Correlations for several business factors with the difference in milk produced and sold per cow are listed in Table 38. When the difference was expressed in hundredweights of milk, no significant correlations were obtained with all of the business factors studied. Many of these business factors showed significant correlations with the difference in milk produced and sold per cow as percent of milk sold per cow and percent milk produced per cow.

Table 38. Correlations of Selected Business Factors With Difference in Milk Produced and Sold Per Cow 392 New York Dairy Farms, 1982

		Difference as Percent	
Business Factors	Difference Cwt. Milk	Milk Sold Per Cow	Milk Produced Per Cow
Number of cows	-0.067*	-0.099*	-0.093*
Total farm expenses per cow	0.018*	-0.159	-0.149
Production costs per cwt. milk	0.090*	0.275	0.243
Machinery costs per cwt. milk	0.073*	0.124	0.119
Labor costs per cwt. milk	-0.020*	0.151	0.120
Feed & crop expenses per cwt. milk	0.048*	0.084*	0.086*
Net cash income	-0.066*	-0.155	-0.150*
Labor & management income per operator	-0.041*	-0.098*	-0.095*

*Not significant at 0.05 level.

These results may be due to the fact that the difference in milk produced and sold per cow as percent of milk sold per cow and percent of milk produced per cow showed more variation than the difference in milk produced and sold per cow expressed on a hundredweight milk basis.

The correlations for the business factors with the difference in milk produced and sold per cow as percent of milk sold per cow and percent of milk produced per cow were similar in sign and magnitude.

The difference in milk produced and sold per cow as percent of milk sold per cow and percent of milk produced per cow would tend to increase in herds with low levels of milk sold per cow and milk produced per cow. This would tend to result in increased production costs per hundredweight milk and would explain the positive correlations for production cost, machinery cost, labor cost, and feed and crop expenses, all on a per hundredweight milk basis, with the difference in milk produced and sold per cow as percent of milk sold per cow and percent of milk produced per cow.

These positive relationships for the cost items studied on a per hundredweight milk basis, with the difference in milk produced and sold per cow as percent of milk sold per cow, and percent milk produced per cow, would tend to have negative effects on income. This is illustrated by the negative correlations for net cash income and labor and management income per operator with the difference in milk produced and sold per cow as percent of milk sold per cow and percent of milk produced per cow.

The negative correlations for total farm expenses per cow with the difference in milk produced and sold per cow as percent of milk sold per cow and percent of milk produced per cow, may be a result of the positive relationship (0.579) between milk sold per cow and total farm expenses per cow (Table 12).

Correlations between several dairy practices and the difference in milk produced and sold per cow were also studied and are reported in Table 39.

Table 39. Correlations of Selected Dairy Practices With Difference in Milk Produced and Sold Per Cow 392 New York Dairy Farms, 1982

		Difference as Percent	
Dairy Practices	Difference	Milk Sold Per Cow	Milk Produced Per Cow
Pounds concentrates fed	0.099	-0.059*	-0.038*
Pounds succulents fed	0.025*	-0.034*	-0.030*
Pounds dry roughages fed	-0.032*	0.043*	0.033*
Days dry	-0.022*	0.100	0.091*
Days open	0.035*	0.139	0.122
Percent days in milk	0.078*	-0.050*	-0.043*
Calving interval	0.048*	0.122	0.108
Percent leaving herd	-0.010*	-0.011*	-0.011*

*Not significant at 0.05 level.

Most of the correlations were not significant at the 0.05 level, but they seemed to follow a certain trend. Those dairy practices which were positively related to milk sold per cow, such as pounds concentrates fed, pounds succulents fed, and percent days in milk (Tables 26 and 27), tended to have negative correlations with the difference in milk produced and sold, as percent of milk sold per cow and percent of milk produced per cow. On the other hand, those dairy practices which were negatively related to milk sold per cow, such as pounds dry roughages fed, days dry, days open, and calving interval, were positively correlated with the difference in milk produced and sold as percent of milk sold per cow and percent of milk produced per cow.

These correlations support the argument that the difference in milk produced and sold per cow tended not to vary much and, hence, when it was expressed as percent of milk sold per cow or percent of milk produced per cow, the percentages tended to increase as milk sold per cow on milk produced per cow decreased and vice versa.

Models for Predicting Selected Business and Dairy Factors

Relationships between single variables were examined in the preceding sections of this document. Several of these relationships were strong. It was also observed that certain groups of variables showed high correlations with some variables on an individual basis.

Business and dairy factors, which were highly correlated, were selected and used to construct equations which would provide information on the importance of these factors in explaining variation in other business and dairy management practices.

These equations were constructed using the Maximum R-square Improvement Option, in the Stepwise Regression procedure of the Statistical Analysis System. Models were developed to: a) predict various measures of income from selected business factors; b) predict various measures of income from selected dairy management practices; c) predict selected dairy practices from business factors; and d) predict selected business factors from dairy practices. Although the purpose for developing these models was primarily to obtain information on groups of independent variables which best explained variation in selected dependent variables, the results can be used to predict the dependent variables in cases where r^2 is high. Since the error in predicting the dependent variable would be high when the r^2 is low, and as the r^2 value approaches one, the error decreases and for a value of one there is no error. These r^2 values are reported, under the dependent variables, in all the tables in this section.

Results are reported in Tables 40, 41, 42, and 43. The dependent variables are listed in the columns and rows represent the independent variables. All analyses were programmed to select the six independent variables which gave the highest r^2 for each dependent variable, and the regression coefficients for the selected independent variables are listed in the tables.

Observations on several of the independent variables were squared in order to detect nonlinear relationships. The squared observation on any one variable is referred to as the quadratic term for that variable. Finally, very small coefficients are written in exponential notation, e.g., 0.000013 would be written as 1.3×10^{-5}.

Net Returns From The Business

The following measures were used to quantify net returns from the business.

1. Net cash farm income (NETCINC).
2. Labor and management income per operator (LMINC).
3. Labor, management, and ownership income per operator (LMOINC).
4. Net cash farm income per cow (NETCOW).
5. Labor and management income per cow (LMCOW).
6. Labor, management, and ownership income per cow (LMOCOW).

These income measures were used as the dependent variables along with 16 dairy practices in one run, and 24 business practices in a second run, as the independent variables in the regression analysis.

Regression of Income Measures on Business Factors

The 24 business factors which were available for selection are listed in Table 40, and for each of the income measures, the regression coefficients for the six selected business factors are listed.

Labor cost per cow, machinery cost per cow, and feed and crop expenses per hundredweight milk, were all important cost items in determining net cash farm income since these items are directly related to cash expenses.

The negative coefficient for number of cows suggests that this variable is acting in a similar manner as a cost item, i.e., increases in the number of cows would increase cost, this will have a negative effect on cash income. Pounds of milk sold would also increase, and this would have a positive effect on cash income.

In this six variable model, the inclusion of number of cows caused the coefficient associated with total pounds of milk sold to increase from 2.61 to 5.57. The negative coefficient for number of cows was balanced by a compensating increase in the weight placed on total pounds of milk sold. Total pounds of milk sold was also found to have a high positive correlation with net cash farm income (Table 7).

Percent equity was an important business factor in determining net cash farm income, and labor and management and ownership income, both on a per operator and per cow basis. This is probably due to the fact that high equity farms have less interest payments and, also, owners of such farms may make production decisions which involve a greater amount of risk. This would tend to increase income in the long run.

Percent equity was not an important factor in determining labor and management income per operator and per cow. This may be due to the fact that in calculating labor and management income, an interest charge is placed on equity, which probably resulted in a reduction of the positive effects of percent equity on income.

Table 40. Regression of Income Measures on Business Factors
410 New York Dairy Farms, 1982

Business Factors	NETCINC r^2=0.71	LMINC r^2=0.36	LMOINC r^2=0.43	NETCOW r^2=0.55	LMCOW r^2=0.39	LMOCOW r^2=0.33
Percent equity	398.89		347.13	4.74		5.34
Feed & crop expenses per cwt. milk	-7612.68			-110.30	-75.15	-70.43
Machinery cost per cow	-24.72		-39.67		-0.72	-0.65
Labor cost per cow	-65.60		-70.75	-0.58	-0.55	-0.77
Number of cows	-557.09	-447.82				
Total pounds of milk sold	6.05					
Land & building investment per cow		-5.82			-5.52×10^{-2}	
Labor cost per cwt. milk		-6862.14				
Machinery cost per cwt. milk		-6727.05		-39.82		
Total capital invested[2]		0.3×10^{-7}	0.8×10^{-7}			
Total pounds of milk sold[2]		3.33×10^{-5}				
Total capital invested			-8.48×10^{-2}			
Milk sold per cow[2]			1.58	1.27×10^{-2}	1.91×10^{-2}	2.28×10^{-2}
Real estate cost per cwt. milk				-96.32	-97.45	-82.24
Milk sold per cow						
Milk sold per worker						
Cows per worker						
Total capital investment per cow						
Machinery investment per cow						
Purchased feed as % of milk sales						
Number of cows[2]						
Cows per worker[2]						
Total capital investment per cow[2]						
Feed & crop expenses per cwt. milk[2]						

[2]Quadratic term.

With respect to labor and management income per operator, important cost items were labor cost and machinery cost per hundredweight milk. Land and building investment per cow had a negative coefficient but this was balanced by a small positive coefficient for the quadratic term for total capital invested. This suggests that the relationship between total capital invested and labor and management income per operator is convex, but due to the small size of the coefficient, very high levels of capital investment would be needed for this variable to have a positive effect on income. Large farms would tend to be more efficient in their use of capital. This was suggested in previous discussion (see Table 18).

The negative coefficient (-447.32) for number of cows, which in this case is acting like a cost item, is balanced by the positive coefficient for the quadratic term for total pounds of milk sold (3.33×10^{-5}).

Both linear and quadratic terms for total capital invested were included in the model for labor and management and ownership income per operator. The sign and relative size of each of the regression coefficients support the argument that the relationship between total capital invested and income is convex, and that the larger farms would have a higher efficiency of capital use.

Machinery and labor costs per cow were important cost items in determining labor, management, and ownership income whereas percent equity and the quadratic term for milk sold per cow would tend to have positive effects on this income measure.

Analysis of these income measures on a per cow basis showed that for all three measures, the quadratic term for milk sold per cow was important, and regression coefficients for this quadratic term were all positive. This suggests that the relationship between milk sold per cow and these income measures on a per cow basis is convex, and that income per cow would increase at an increasing rate with milk productivity.

Feed and crop expenses and real estate cost per hundredweight milk sold, machinery cost and labor cost per cow, and machinery cost per hundredweight milk, were all important cost items in determining the three income measures on a per cow basis.

<u>Regression of Income Measures on Dairy Practices</u>

The 16 dairy practices which were available for selection are given in Table 41, and for each income measure the regression coefficients for the six selected practices are listed.

The quadratic term for pounds of succulents fed was included with a positive coefficient in the six variable models for net cash income, labor and management income per operator, and labor, management, and ownership income per operator. The linear term for this coefficient was included in the models for labor and management income per operator and labor, management, and ownership income per operator.

These results would explain the small positive correlation 0.099 for pound succulents fed with operator income in Table 26, since the relationship seems to be quadratic and not linear.

Table 41. Regression of Income Measures on Dairy Practices
410 New York Dairy Farms, 1982

Dairy Practices	NETCINC $r^2=0.17$	LMINC $r^2=0.07$	LMOINC $r^2=0.08$	NETCOW $r^2=0.12$	LMCOW $r^2=0.13$	LMOCOW $r^2=0.10$
Pounds succulents fed[2]	$5.11x10^{-5}$	$1.34x10^{-5}$	$3.61x10^{-5}$			
Average days dry[2]	-2.52					$2.64x10^{-2}$
Pounds concentrates fed	1.49*					
Number of breedings per conception	3520.07*			-88.16		
Average age at first calving	-1021.04		-746.87*	-6.31*	-8.93	-8.20*
Average age all cows	-402.89*	-388.93				
Pounds concentrates fed[2]		$-11.03x10^{-5}$			$-1.02x10^{-6}$	
Days open all cows		-0.71				
Percent days in milk		767.37*	19745.87*	29.37	26.89	
Percent cows leaving herd[2]		-8.07	-23.89	-0.28	-0.12	-0.13
Percent days in milk[2]			-107.58*			0.29
Percent cows leaving herd			1025.08	16.55		
Minimum calving interval				-51.63	-76.37	-54.16
Pounds succulents fed					$5.32x10^{-3}$	$5.32x10^{-3}$*
Days open[2]						
Average age all cows[2]						

*Not significant at 0.05 level.

[2]Quadratic term.

The positive regression coefficients for the quadratic term suggest that income would increase at an increasing rate with increases in succulent feeding. Pounds of concentrates fed was also an important factor in determining net cash income. This supports previous results in that high concentrate and succulent feeding are profitable dairy practices.

The regression coefficient for number of breedings per conception was positive (3520.07) which suggests that net cash income would increase with more breedings per conception. This coefficient was not significant and its positive effect may be through increasing the percent days in milk. For net cash income per cow, the regression coefficient for number of breedings per conception was negative, and in this case it is acting as a cost factor.

The regression coefficients for other dairy practices included in the model for net cash income, suggest that average days dry, average age at first calving, and average age of the herd are important dairy management factors, and fewer days dry, younger herds, and early calving of heifers would all have positive effects on net cash income.

Average age of all cows also showed a similar relationship with labor and management income per operator, and average age at first calving showed similar relationships with labor, management, and ownership income per operator and per cow, net cash income per cow, and labor and management income per cow.

With labor and management income per operator, the quadratic term for pounds concentrates fed was included in the model with a negative coefficient, this suggests a concave relationship between this variable and operator income. Because of the small size of the coefficient (-11.03×10^{-5}), the negative effects of concentrate feeding would be felt at levels which are higher than optimal.

The negative coefficient for days open (-0.71), suggest that herds with fewer days open would tend to have higher income per operator than herds with a large number of days open.

Percent days in milk was found to be positively related to total pounds of milk sold and milk sold per cow (Tables 9 and 27). Increases in percent days in milk would tend to increase income. In this analysis, percent days in milk was included in the models for labor and management income per operator, labor, management, and ownership income per operator, net cash income per cow, and labor and management income per cow. The regression coefficient was positive in all the models, suggesting that these income measures would increase with a higher percent days in milk.

For labor, management, and ownership income, the quadratic term for percent days in milk was also included in the model with a negative regression coefficient. This suggests a concave relationship between this income measure and percent days in milk. Increases in the percent days in milk would tend to have positive effects at first, but after a certain optimal value the negative effects of the quadratic term would result in lower income.

Percent cows leaving the herd is a measure of the rate of culling and, for all income measures except net cash income, the quadratic term for percent cows leaving the herd was included in the models. The linear term for percent cows leaving the herd was included in the models for labor, management, and ownership income per operator and net cash income per cow.

The signs of the regression coefficient for the linear and quadratic terms of percent cows leaving the herd, suggest a concave relationship between this variable and the measures of income. There is an optimal level of culling above which income would tend to decrease. This may be a result of more replacements being purchased off the farm with high levels of culling. Also, health problems in the herd may result in high levels of culling and these herds would tend to have low incomes.

Long calving intervals are unprofitable and this fact is clearly reflected in the negative regression coefficients for this variable in the models for the income measures on a per cow basis. Herds with shorter calving intervals would tend to have higher income per cow.

In summary, these results suggest that high levels of succulent feeding is a profitable dairy practice and that dairy farmers should try to reduce their calving intervals, days dry, days open, and the average age of their herd. They should also calve heifers at an early age and try to operate at an optimal level of culling and percent days in milk.

Regression of Selected Dairy Practices on Business Factors

The dairy practices selected for study were:

1. Pounds concentrates fed per cow per year (CONCEN).
2. Pounds succulents fed per cow per year (SUCC).
3. Percent cows leaving the herd for purposes other than being sold for dairy (PLEAVE).
4. The average age at first calving (AGFCAV).
5. Projected minimum calving interval (CALVINT).
6. Percent days in milk (PCTDIM).

These dairy practices are listed in Table 42 along with the 24 business factors. For each dairy practice, the regression coefficients for the selected business factors are given.

The model for pounds concentrates fed suggest that, at high levels of milk production per cow and for larger herds, more concentrates are fed per cow. This supports correlation results in Tables 9 and 26.

In addition, the regression coefficients for other business factors in the model indicate that herds with high real estate costs and feed and crop expenses per hundredweight milk, and machinery costs cow per cow, would tend to feed more concentrates per cow.

The quadratic term for total milk sold was included in the model with a negative coefficient, suggesting a concave relationship between total pounds of

Table 42. Regression of Selected Dairy Practices on Business Factors
410 New York Dairy Farms, 1982

Business Factors	CONCEN $r^2=0.29$	SUCC $r^2=0.33$	PLEAVE $r^2=0.03$	AGFCAV $r^2=0.06$	CALVINT $r^2=0.05$	PCTDIM $r^2=0.22$
Milk sold per cow (cwt.)	36.26			5.51×10^{-2}*	4.58×10^{-3}*	1.54×10^{-1}
Real estate cost per cwt. milk	283.86					
Feed & crop expenses per cwt. milk	235.13			-2.55×10^{-1}		
Machinery cost per cow	1.31	8.01	5.88×10^{-3}			
Number of cows	18.95		3.35×10^{-2}			
Total milk sold[2] (cwt.)	-1.78×10^{-6}	-4.57×10^{-6}				
Milk sold per worker (cwt.)		0.83			-2.87×10^{-4}	
Total capital investment per cow		-0.52				
Machinery investment per cow		-1.01*		6.48×10^{-4}		
Cows per worker[2]					-5.06×10^{-4}	-1.90×10^{-3}
Total milk sold (cwt.)		0.42				
Land & building investment per cow			9.25×10^{-4}			-2.26×10^{-4}
Purchased feed as % of milk sales			0.13			
Percent equity				8.25×10^{-3}*		1.97×10^{-2}*
Total capital invested				-1.56×10^{-6}	1.70×10^{-7}*	
Pounds milk sold per cow[2]				-2.77×10^{-4}*		-3.84×10^{-4}
Cows per worker					8.02×10^{-2}	1.48×10^{-1}
Labor cost per cwt. milk			-0.53*		1.38×10^{-1}	
Total capital invested[2]			-1.00×10^{-10}*			
Machinery cost per cwt. milk						
Labor cost per cow						
Number of cows[2]						
Capital investment per cow[2]						
Feed & crop expenses per cwt. milk[2]						

*Not significant at 0.10 level.

[2]Quadratic term.

milk sold and concentrates fed. The size of this coefficient was small and when the total model is considered it would cause the rate of increase of concentrate feeding to decrease. This decrease in rate would be more important in the larger herds and may be a result of larger herds tending to utilize more succulents in their feeding programs. This supports the correlations in Table 9.

The coefficient for machinery cost per cow was much larger in the model for pounds succulents fed than the model for pounds concentrates fed (8.01 versus 1.31). This is probably due to the fact succulents are homegrown and thus require a higher level of machinery input.

Both linear and quadratic terms for total milk sold were included in the model for pounds succulents fed. The signs on the regression coefficients for these terms suggest a concave relationship between total milk production and pounds succulents fed. Due to the small size of the coefficient for the quadratic term, the positive coefficient for the linear term would result in an overall increase in succulent feeding, even up to the upper range for succulents fed in the data set. Succulent feeding would not decrease with increases in total milk production, rather the rate of increase would decrease.

Regression coefficients for total capital and machinery investment per cow suggest increased levels of succulent feeding as these investments decrease on a per cow basis. These measures of capital use were shown to be negatively correlated with size (Table 8). The larger herds would tend to have lower total capital and machinery investments per cow and would tend to feed more succulents.

The model for percent cows leaving the herd indicate that the larger herds tend to have higher culling rates. The positive coefficient (5.88×10^{-3}) for machinery cost per cow in this model may be due to higher machinery costs per cow in the larger herds since these herds tend to feed more succulents and, thus, require higher machinery input per cow.

Other business factors in this model are difficult to explain, and their inclusion may be due to relationships with each other and with size of the business.

Both linear and quadratic terms for milk sold per cow were included in the models for average age at first calving and percent days in milk. The signs of the regression coefficients for these terms suggest a concave relationship between milk sold per cow and these two dairy factors.

For average age at first calving, the coefficients were not significant and, due to the size of the coefficient for the quadratic term, the effect of milk sold per cow on average age at first calving would be negligible in herds of above average milk productivity.

With percent days in milk, the effect of increased milk sold per cow would be to decrease the rate of increase in percent days in milk. This suggests that dairy farmers should strive for an optimal percent days in milk.

The regression coefficients for other business factors included in this model suggest that the larger herds (total capital invested) tend to calve their heifers at an earlier age. Larger herds would tend to have less machinery investment per cow (Table 19). This would explain the positive coefficient (6.48×10^{-4}) for this business factor.

The negative coefficient (-2.55×10^{-1}) for feed and crop expenses per hundredweight milk may be due to the fact that high planes of nutrition are needed in order to calve heifers at an earlier age.

Linear and quadratic terms for number of cows per worker were included in the models for calving interval and percent days in milk. The signs of the regression coefficients for these terms suggest a concave relationship between cows per worker and these two dairy factors. Due to small size of the coefficient for the quadratic term, calving interval and percent days in milk would continue to increase at a decreasing rate over the entire range of cows per worker in the data set.

This effect of cows per worker on calving interval may be due to a lower efficiency in heat detection as cows per worker increase. Larger farms tend to have more cows per worker (Table 15), and these farms may tend to have slightly longer calving intervals. This is supported by the small positive coefficient for total capital invested. Longer calving intervals would tend to increase the percent days in milk, hence, cows per worker showed a similar relationship in the model for percent days in milk.

High producing cows tend to be difficult breeders and this would explain the positive coefficient for milk sold per cow in the models for calving interval and percent days in milk.

Long calving intervals are usually associated with long lactations, and milk productivity decreases as lactation length increases. Herds with long calving intervals may be milking more cows at low levels of productivity, at the same labor cost. This would tend to reduce the amount of milk sold per worker and increase the labor cost per hundredweight milk. This would explain the regression coefficient for milk sold per worker and labor cost per hundredweight milk in the model for cavling interval.

For percent days in milk, the effects of milk sold per cow and cows per worker have already been discussed. The negative coefficient for land and building investment per cow suggest that the larger herds would tend to have a higher percent days in milk since these herds have lower land and building investment per cow.

In summary, these results suggest that both succulent and concentrate feeding are important for high levels of milk production. The rate of increase in succulent and concentrate feeding tends to decrease with increased total milk production. This is more biologically acceptable than a model with a constant rate of increase since cows have limited capacities for feed intake.

In addition, it seems that larger herds tend to calve their heifers at an earlier age, but have slightly longer calving intervals and higher percent days in milk than smaller herds.

Regression of Selected Business Factors on Dairy Practices

The following business factors were studied in this section.

1. Milk sold per cow per year (MSPERCOW).
2. Number of cows per worker (COWSMAN).
3. Number of cows (COWNO).
4. Feed and crop expenses per cow (FEDCRPCOW).
5. Labor costs per cow (LBPERCOW).
6. Cost of producing a hundredweight of milk (COSTOPM).

These business factors are given in Table 43 along with the 16 dairy practices available for selection and their regression coefficients.

The model for milk sold per cow supports previous results that concentrate and succulent feeding are profitable dairy practices. The inclusion of the quadratic term for concentrates fed in the model would decrease the rate at which milk sold per cow increases with increasing levels of concentrate feeding.

In this model, percent days in milk seem to be interacting with calving interval to produce a concave relationship with milk sold per cow since these two dairy factors were positively correlated and their regression coefficients were opposite in sign. The general relationship would be an increase in milk sold per cow with increases in percent days in milk or decreases in calving interval.

The quadratic term for percent leaving the herd suggests that dairy farmers should try to achieve an optimal level of culling. Since milk sold per cow would increase with increased culling, but at a decreasing rate, and it is possible that high rates of culling may actually decrease milk sold per cow.

For number of cows per worker, number of breedings per conception, concentrates and succulents fed were included in the model with positive regression coefficients, whereas average age at first calving and average days dry had negative regression coefficients. These results support the argument that larger herds tend to have a higher labor efficiency, i.e. more cows per worker (Table 15), feed more succulents and concentrates (Tables 9 and 42), calve their heifers at an earlier age (Table 42), and have fewer days dry and more breedings per conception (Table 9).

The negative regression coefficient (-0.60) for percent days in milk in this model is difficult to explain and it may be due to the high positive correlation (0.81) between average days dry and percent days in milk.

The regression coefficient for average days dry (-0.96) and number of breedings per conception (29.39) in the model for number of cows, support the above argument that larger herds tend to have more breedings per conception and fewer days dry. In this model, quadratic terms for concentrate and succulent feeding were included in the model with positive regression coefficients. This

Table 43. Regression of Selected Business Practices on Dairy Practices 410 New York Dairy Farms, 1982

Business Factors	MSPERCOW $r^2=0.31$	COWSMAN $r^2=0.18$	COWNO $r^2=0.31$	FEDCRPCOW $r^2=0.14$	LBPERCOW $r^2=0.05$	COSTOPM $r^2=0.16$
Percent leaving herd[2]	$-3.60x10^{-3}$					$1.23x10^{-3}$
Pounds concentrates fed[2]	$-6.50x10^{-7}$	$2.00x10^{-8}$	$2.60x10^{-7}$	$-6.77x10^{-6}$	$4.00x10^{-7}$	
Pounds concentrated fed	$1.26x10^{-2}$			0.11		
Pounds succulents fed	$3.60x10^{-4}$			$-9.87x10^{-3}$	$-8.33x10^{-3}$	$-8.39x10^{-5}$
Percent days in milk	2.60	-0.60				-0.25
Projected minimum calving interval	-5.01					
Pounds succulents fed[2]		$2.00x10^{-8}$	$1.40x10^{-7}$	$3.70x10^{-7}$	$1.80x10^{-7}$*	
Percent days in milk[2]			$-3.01x10^{-2}$			
Average days dry		-0.16	-0.96		1.95	
Number of breedings per conception		1.90	29.39			
Average age all cows			-1.04	-2.00*		$3.67x10^{-2}$
Days open[2]						$7.17x10^{-4}$
Average age at first calving		-0.19*				
Days open						-0.14
Average days dry[2]				$-1.09x10^{-2}$		
Percent leaving herd					-1.07	

*Not significant at 0.10 level.

[2]Quadratic term.

supports previous results that larger herds tend to feed more succulents and concentrates per cow.

In addition, the negative regression coefficient for average age of all cows (-1.04) suggests that the larger herds are on the average younger herds. This would support the result that larger herds tend to have a higher culling rate (Table 41). Percent leaving herd was negatively correlated with average age of all cows (-0.320).

Finally, the large herds seem to have fewer percent days in milk as illustrated by the negative regression coefficient for quadratic term for percent days in milk in the model for number of cows.

The model for feed and crop expenses per cow illustrates an ideal relationship between succulent and concentrate feeding and this business factor. The quadratic term for concentrates fed had a negative regression coefficient (-6.77×10^{-6}) and the linear term had a positive coefficient (0.11). Therefore, the relationship between feed and crop expenses per cow and concentrate fed is concave. Due to the small size of the coefficient for the quadratic term, its effect would be to decrease the rate at which feed and crop expenses increase with increasing levels of concentrate feeding. This relationship may be a result of more home grown feeds being produced and also higher quantity discounts on purchased concentrates as the level of concentrate feeding increases.

For succulents fed, the relationship with feed and crop expenses per cow is convex, and due to the small size of the coefficient for the quadratic term, the effect would be to reduce feed and crop expenses per cow at a decreasing rate, as the level of succulent feeding per cow is increased. Increased levels of succulent feeding would be a profitable dairy practice.

The negative coefficient for the quadratic term for average days dry suggest a decrease in feed and crop expense per cow as average days dry increase. This is expected since dry cows cost less to feed than lactating cows.

Pounds succulents fed showed a similar relationship in the model for labor cost per cow as in the model for feed and crop expenses per cow. This possibly is due to the fact that larger herds tend to feed more succulents per cow and also have a lower labor cost per cow.

The positive regression coefficient for concentrates fed per cow in this model is difficult to explain and it may possibly be due to an interaction with succulent feeding.

For average days dry, the regression coefficient (1.95) suggests an increase in labor costs per cow as average days dry increases, and the coefficient for percent leaving the herd suggests a decrease in labor cost as culling rate increases. These relationships are probably due to the fact that the larger herds have lower labor costs per cow, fewer days dry, and a higher rate of culling.

For cost of producing a hundredweight of milk, both linear and quadratic terms for days open were included in the model. The signs of the regression coefficients on these terms indicate a concave relationship between days open and unit cost of production for milk. This model suggests an optimal number of days open, at which cost of producing a hundredweight of milk would be at a global minimum, which was calculated to be 100 days open. Production cost per hundredweight milk would decrease up to 100 days open after which it would increase at an increasing rate.

The positive regression coefficient (1.23×10^{-3}) for percent cows leaving the herd support previous results that high levels of culling is unprofitable.

Other dairy practices included in this model support the fact that succulent feeding and a lower average herd age would have positive effects on income. With increased levels of succulent feeding, the effect on cost of producing milk is probably due to a substitution effect with concentrates which would tend to reduce unit production costs of milk.

The regression coefficient for percent days in milk (-0.25) is difficult to explain. It may be due to interactions with other dairy practices in the model. One possible interaction would be with percent leaving the herd to produce a concave relationship with cost of producing a hundredweight of milk.

Summary and Conclusions

The purpose of this study was to examine the relationships between business and dairy management practices. Data on selected dairy practices was merged with business summary data for the year 1982. Correlation and regression analyses were used to study the relationship between the different factors, and the results are included in this report.

Several measures of size of business were used, but number of cows, total capital invested, and total pounds of milk sold were found to be adequate. Total pounds of milk sold had the strongest relationship with income since it was an output measure.

The larger farms seemed to be more efficient in their use of labor and capital than the smaller farms. Production per cow and crop yields also tended to be higher on these farms. In addition, succulent feeding appeared to be more common on the larger farms, whereas the smaller farms tended to rely more heavily on hay and pasture.

The dairy practices studied showed significant relationships with milk sold per cow, but relationships for these practices with income measures were weaker. This is expected since milk production per cow is directly related to the level of dairy herd management, and this, in turn, would affect income. Dairy farmers should aim at maximizing income since a practice may increase production but reduce income if added costs exceed added returns.

Dairy feeding practices were found to be related to milk price, but this relationship may be a result of the effect these feeding practices have on fat test, which was found to be strongly related to milk price.

Farms with low somatic cell count seemed to have high production per cow and better incomes. Somatic cell count tended to be higher in herds with older cows.

The more educated farmers tended to have a higher level of dairy herd management and realized slightly higher incomes than the farmers with less education.

Some of the dairy practices which were found to have a positive effect on incomes were succulent feeding, fewer days dry, younger herds, and early calving of heifers. Incomes tended to be greater for the high equity farms.

Dairy farmers should try to achieve optimal levels for days open, percent leaving the herd, and percent days in milk since these factors had nonlinear relationships with income. In addition, the larger herds may have had more problems in heat detection since calving intervals tended to be longer in these herds.

The correlation and regression analyses used in this study in general quantified and amplified upon the findings reported in A.E. Res. 84-6 in which tabular analysis was used. The two studies of the same data might well be used together for comparative purposes.

In summary, the selected dairy management practices studied did have an effect on dairy farm incomes. Some practices have greater effects than others. In analyzing a dairy farm business, both dairy practices and business practices should be examined. Data from this study can be used in analyzing farm businesses, making decisions, or for reference purposes.

APPENDIX

Table 1
Mean, Standard Deviation, Minimum and Maximum Values For
Selected Farm Business Variables Studied

Variable	Mean	Standard Deviation	Minimum	Maximum
Number of cows	80•95	52•43	23	437
Total milk sold	1,215,400	839,300	171,200	6,764,000
Total capital invested	$455,962	$263,866	$116,358	$2,242,373
Total tillable acres	255.54	153.79	44.00	1,008.00
Worker equivalents (years)	2.83	1.34	1.00	11.17
Net cash farm income	$35,744	$31,297	$-26,144	$260,487
Labor & management income	$4,471	$27,993	$-73,510	$291,971
Labor, management & ownership income	$23,177	$38,302	$-107,939	$385,847
Milk sold per cow	14,852	2,123	5,350	21,568
Milk sold per worker	416,634	127,347	128,722	955,367
Cows per worker	28.09	7.90	12.00	62.00
Capital invested per worker	$168,148	$54,817	$46,150	$436,346
Capital invested per cow	$5,882	$1,498	$2,483	$13,989
Machinery capital per cow	$1,147	$475	$809	$3,065
Land & building capital per cow	$2,875	$1,090	$170	$10,000
Purchased feed as % of milk sales	24.93%	8.37%	3.00%	71.00%
Heifers as % of cows	82.23%	20.84%	0%	140.00%
Percent equity	60.95%	22.30%	3.00%	77.00%
Machinery cost per cow	$444	$135	$155	$1,133
Labor cost per cow	$354	$100	$148	$696
Average price per cwt. milk	$13.52	$0.69	$9.00	$17.19
Total farm expenses per cow	$2,315	$381	$1,317	$3,993
Cost of producing milk, cwt.	$15.50	$2.87	$9.41	$31.49
Feed & crop expense per cow	$678.81	$165.13	$227.06	$1,281.56
Debt per cow	$2,466.83	$1,429.67	$0	$7,490.66
Veterinary expenses per cow	$41.83	$21.67	$0	$155.53
Machinery cost per cwt. milk	$3.01	$0.88	$1.04	$7.58
Labor cost per cwt. milk	$2.42	$0.74	$0.99	$6.63

APPENDIX

Table 2
Mean, Standard Deviation, Minimum and Maximum Values For Selected Dairy Herd Management Variables

Variable	Mean	Standard Deviation	Minimum	Maximum
Pounds concentrates fed per cow per year	6,282	1,670	857	12,505
Pounds succulents fed per cow per year	16,024	5,226	604	33,136
Pounds dry roughages fed per cow per year	2,624	1,836	9	10,383
Butter fat test	3.64%	0.25%	3.00%	5.10%
Total milk produced per cow, pounds	16,035	2,165	8,266	21,718
Feeding index	113.29	20.88	17.00	190.00
Income over value of feed	$1,422	$275	$513	$2,140
Projected minimum calving interval (months)	13.04	0.62	11.80	16.80
Average days dry	62.39	10.06	38.00	103.00
Average days open	107.56	16.85	75.00	185.00
Percent days in milk	86.19%	2.53%	72.00%	92.00%
Number of breedings per conception	1.78	0.36	1.00	3.10
Percent other cows leaving herd	28.75%	8.89%	6.00%	69.00%
Average bodyweight of all cows, pounds	1,257	76	860	1,440