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PREDICTING MILK PRODUCTION AND PROFIT IN MICHIGAN HOLSTEIN HERDS

By

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ABSTRACT

PREDICTING MILK PRODUCTION AND PROFIT IN
MICHIGAN HOLSTEIN HERDS

By

Ronald Edwin Buffington

Data were obtained on 201 Michigan Holstein herds that were enrolled on DHIA and Telfarm continuous from January 1, 1968 to December 31, 1972. Multiple regression analysis was used to determine the amount of variation that would be accounted for by different independent variables. Pounds grain, pounds hay, percent days in milk, cow numbers, and feed cost per 100 pounds of milk accounted for 47.1 percent of the variation. Accuracy in predicting value of product is very similar to predicting milk production when the same independent variables are used. Feed cost per 100 pounds of milk accounted for 54 percent of the variation when predicting expected profit per cow. Cattle income per cow and feed cost per cow were significant factors, $R^2 = .60$, in predicting return over feed cost. By adding net cost per cwt. of milk, milk price per cwt. of milk, and percent surplus milk to the previous two variables, they accounted for 76 percent of the variation in return over feed costs.

ACKNOWLEDGEMENTS

There are very few schools in the United States where Extension Specialists have graduate students. It is from this view that I express appreciation to Michigan State University for the opportunity to study under a committee where three of the four members have or had State Extension appointments and have active graduate programs.

Sincere appreciation is extended to Dr. Clint Meadows. I am particularly appreciative to Dr. Everett Rogers for his assistance in and out of the communication classroom. The statistical assistance provided by Dr. John Gill during my graduate study was very helpful. Dr. John Speicher's effects in dairy farm management have been useful in developing this project.

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CHAPTER I

INTRODUCTION

This study examines from a management viewpoint records of dairy farms subscribing to programs provided by the Michigan Dairy Herd Improvement Association (DHIA) and the Agricultural Economics Department at Michigan State University. Dairy farmers pay for these two university provided fee-basis services in return for recorded information and analysis that will prove helpful in decision making. This study focuses on the factors that affect milk production and profits. Of special interest is the degree to which these two records systems are of value for making valid decisions.

Production Testing

Testing dairy cows for the production of milk and butterfat started in Newaygo County, Michigan in 1905. Its purpose was to aid dairymen in evaluating the differences between their cows and to assist da men in making decisions for developing more profitable herds. In the beginning cow testers had two tools with which to conduct their work:

a scale to weigh the milk and a Babcock centrifuge to test butterfat content. Today production testing is being conducted by DHIA supervisors who collect milk samples, technicians who run butterfat tests, and computer keypunchers and programmers who reproduce the electronic processed records and analysis for the dairymen. Much information is collected and processed for research purposes, sire summaries, and cow indexing. And all is returned to the dairymen who pay for production testing.

Telfarm

"Today's Electronic Farm Records for Management" (Telfarm) is a program planned to utilize the facilities of the electronic data processing center at Michigan State University. It started in 1964 with the aid of a grant from the Kellogg Foundation as a new and expanded version of farm record keeping. Michigan State was the first land grant university to provide this service to large numbers of farmers on a fee basis. Cooperating farmers received account books and sheets on which to record their transactions. These were mailed to the university at monthly intervals. Participants received quarterly income and expense reports, and at the end of the year a complete business breakdown is provided. Telfarm cooperators could also elect to receive additional reports: hired labor, enterprise, farm credit, net worth, and family living.

Decision Process

The Cooperative Extension Service is responsible for teaching and implementing practices that will improve production and profits. Extension agents working with DHIA and Telfarm serve as the principal change-agents involved with the dairy farmers in bringing about progressive change. Effective change agents are aware of the diffusion process by which ideas are adopted and understand characteristics of innovations that will speed up the rate of adoption.

The Present Study

This study was undertaken in an attempt to evaluate DHIA and Telfarm record programs as they relate to dairy farm production and profits.

The objectives are:

1. To examine the factors affecting milk production.
2. To examine the factors affecting profit per cow.
3. To examine the type of record programs that would be most meaningful in the decision-making process.

CHAPTER II

REVIEW OF LITERATURE

Factors Affecting Milk Production

Miller (18) studied the factors influencing average milk production in 8,048 DHIA herds in the Northeast. The factors investigated were concentrate fed, silage fed, hay fed, days on pasture, percent days in milk, and herd size. The proportion of variation in predicting milk yield with all six variables was 42.1 percent. All factors except herd size had a positive effect on milk yield. An average increase of 98.3 pounds of milk was produced for each 100 pounds increase in the amount of grain fed per cow; 17.2 pounds of milk for each 100 pounds increase in hay fed; and 8.8 pounds of milk for each 100 pounds of silage fed. Each additional day on pasture yielded 5.0 more pounds of milk. An increase of one percent days in milk produced an additional 115.6 pounds of milk. On the other hand, there was a decrease of 1.1 pounds of milk per cow for each additional cow in the herd. To evaluate the significance of herd size in predicting milk production, the same multiple regression analysis was followed, leaving out herd size. The accuracy of predicting milk yield decreased to only 42.0 percent when herd size was omitted as compared to 42.1 percent with herd size included. Miller concluded that herd size was of no value in this situation.

Least Squares multiple regression techniques were employed by Brown (3) to identify management variables which influence milk production in 13,614 Holstein herds in eight Eastern and Southeastern states between 1965 and 1970. Of the nine measures analyzed, concentrate level, percent days in milk, other feed costs, and grain costs had the most significant affects on milk production. Brown noted that as herd size increased rapidly, production per cow dropped. A 100 pound increase in concentrate level resulted in a 74 pound increase in milk production while a one percent increase in percent days in milk resulted in a 161 pound increase in milk yield. The influence of grain price and probably also that of other feed costs reflected the value of increased grain and feed quality, and the returns expected per dollar increase in these costs.

For many years there has been increasing emphasis on feeding more grain to lactating cows. Excellent reviews (7, 9, 13, 14) have indicated a favorable but variable response to more liberal grain feeding.

One of the earlier, extensive input-output studies, that of Jensen et al. (8) with only moderate levels of production, found that at the lowest level of concentrate feeding one additional pound of concentrates resulted in a 1.7 pound increase in fat corrected milk, whereas at the highest level only a 0.6 pound increase resulted. These same trends have, in general, been reported by the more recent work with higher producing cows and higher levels of feeding. A major reason explaining why the requirement is increased at high levels of feed intake has been reported by Reid et al. (20) and supported by Brown (4). Their explanation is that, as the level of feeding increases, the digestibility of the diet decreases. The point of optimum level of grain feeding is where the last increment of grain fed still makes a profit in terms of milk produced.

Stone et al. (26) looked at changes in milk production in relation to changes in feeding practices. For the New York herds, milk production increased 157 pounds yearly and concentrate only 88 pounds -- a favorable ratio. However, when other factors were considered at the same time (multiple regression), only 0.84 pounds of extra milk was obtained for each extra one pound of grain fed.

The genetic difference between herds is a factor of importance in predicting milk production. Plowman (19) reported that genetics accounted for nearly 20 percent of the mean differences between herd averages. However, any two specific herds could vary genetically to a considerable degree. With the increased use of artificial insemination (A.I.) the expectations are that the variation between herds should decrease. Gaunt (6) stated that genetic improvement in New York A.I. sired Holsteins was 27 percent and environmental improvement was 73 percent per year from 1956 to 1962.

McDaniels (15) contends that if selection is strictly on milk production it appears that the upper limit of genetic progress per year is around 2.3 percent. This translates in terms of pounds of milk to slightly over 345 pounds based on a 15,000 pound breed average. The 345 pounds is far better than the 81 pounds (0.58%) per year that has been achieved during the last 10-15 years. The theoretical genetic improvement translated to what an individual dairyman with Holsteins could expect over a five year period in his own herd is up to a little over 1,700 pounds. If he put some emphasis on udder traits, but still placed primary emphasis on production and made all initial culls on yield, he would reduce his progress down to slightly over 1,000 pounds. If the dairyman is not using A.I. he would make an initial gain of approximately 600 pounds if he used the best of those bulls that are now available to Michigan dairymen. This 600 pounds is based on using the top bulls to the point where there are just enough bulls left to service all cows to A.I. Meadows (17) reported that the average predicted difference of 175 A.I.

Holstein bulls available to Michigan dairymen as of May, 1973 was +630 pounds.

Many dairymen fail to realize the genetic opportunities available to them through the extensive use of A.I. Dickinson et al. (5) summarized in 1972 that Michigan dairymen had naturally proven 132 registered Holstein bulls with 10 or more sire identified daughters in DHI tested herds. These 132 bulls with first proofs had an average Predicted Difference for milk yield of minus 34, a bit below the expected breed average for all tested bulls which is about zero. In that approximately 30 percent of Michigan Holsteins are on test and that about 50 percent of the DHI records are sire identified, it would be logical to conclude that approximately 800 or more bulls are naturally proven with 10 or more daughters each year in Michigan.

Factors Affecting Profit Per Cow

Many studies have indicated that feed costs represent approximately 50 percent of the cost in producing milk. Speicher and Brown (24) have alluded to this fact in a recent article. In an attempt to look at the literature in regards to profits per cow, we shall first look at factors affecting income over feed cost because many states include this information on their DHIA records program and do not have access to cost accounting programs.

Miller (18) pointed out that herd size, along with milk production, milk price, grain fed, percent days in milk, silage fed, hay fed, pasture days, grain price, and fat percent were the factors used to estimate their influence on income over feed costs. These factors accounted for 94.4 percent of the variation of income over feed costs. Of the variables, percent days in milk, fat percent, and herd size were of no additional value in the prediction. The most important factors, in order of importance were: milk price, percent days in milk, concentrates, grain price, pasture, and hay.

Brown (3) considered income over feed cost as the dependent variable, and 12 independent variables which were: milk price, milk production, feed cost per cwt. of milk, percent days in milk, concentrates fed, succulents fed, dry forage fed, herd size, other feed costs, fat percent, pasture, and grain price, all of which were significantly related to this economic measure. The final models accounted for 98 to 99 percent of the variation in income over feed cost estimates. Prediction equations based on linear regression coefficients appear to be extremely accurate in predicting income over feed costs.

Speicher and Brown (24) looked at the financial (Telfarm) records of 332 Michigan dairy farms to show what happens to income and expenses as the level of production increased. In Table 1, the cost of producing 100 pounds of milk is included. Cost per hundredweight decreased from $6.06 for the low production group to $4.75 for the group selling between 14,000 and 14,999 pounds of milk per cow. This study clearly points out high producing herds make more money...up to a point. All known production functions must conform to the laws of diminishing return. The same trends continue for 1970 Telfarm data on 389 Michigan dairy farms. Returns per cow for the lowest production group (-10,000 # Milk/Cow) are -$94 while returns per cow for the highest production group (+15,000 # Milk/Cow) are +$116. Speicher and Brown (23) pointed out that while the highest return per cow was for the highest production group, the dairymen received a slightly lower wage per hour because of the extra labor required to achieve the top production.

TABLE 1. Effect of level of milk production and size of herd on income and expense.

Milk sold per cow (pounds)	under 10,000	10,000-10,999	11,000-11,999	12,000-12,999	13,000-13,999	14,000-14,999	15,000 and over
Number of farms	26	36	66	83	73	29	19
Pounds milk sold per cow	9,300	10,600	11,500	12,500	13,500	14,400	16,000
Number of cows per herd	47	55	59	58	55	43	40
<u>Income per cow</u>							
Milk sales	$527	$618	$660	$721	$768	$814	$912
Cattle income	91	73	96	108	110	124	138
Total livestock income	$618	$691	$756	$829	$878	$942	$1,050
<u>Expense per cow</u>							
Labor	$150	$145	$140	$145	$149	$157	$180
Machinery	44	44	42	50	49	56	52
Improvements	43	46	45	51	51	50	63
Livestock expense	73	85	92	100	105	112	131
Other	20	22	21	25	24	28	30

TABLE 1. (cont'd.)

Milk sold per cow (pounds)	under 10,000	10,000-10,999	11,000-11,999	12,000-12,999	13,000-13,999	14,000-14,999	15,000 and over
Nonfeed expense	$330	$343	$340	$371	$379	$404	$457
Feed disappearance	332	340	362	359	388	406	452
Total expense	$652	$683	$702	$730	$767	$810	$909
Net per cow	$-34	$ -8	$ 54	$ 99	$111	$132	$141
Cost per cwt. of milk	$6.06	$5.77	$5.25	$4.98	$4.87	$4.75	$4.80

Albright (2) studied management factors influencing the percent return on capital investment for 39 Los Angeles County commercial dairies. The dairies ranged in size from 141 to 659 cows, with an average of 63 cows handled per man. Investment per cow ranged from $663 to $1,640 and the dairies purchased all or most of their herd replacements. The production levels of the herds varied from 11,619 to 15,893 pounds of milk per cow, with an average yearly concentrate consumption of 5,620 pounds per cow. Standard partial regression coefficients were calculated on a within year basis for the data from 1956 through 1960. The most important management factor for the study was production cost on a per cow basis. Feed costs, roughage and concentrates, were significant at the .05 level of probability 3 out of the 5 years studied; labor costs 2 out of 5 years; and the cost of herd replacements and operating costs were significant all 5 years. Prices received for butterfat and the pounds of butterfat produced were significant at the .05 level of probability 4 out of the 5 years studied. The farm management factors of cows per man, hours per cow, percent cows dry, milk produced per cow, culling rate, investment per cow, feeding efficiency, number of cows per herd, prices paid for hay and concentrate, and interest on assets failed to show a significant relationship at the .05 level of probability.

Speicher (25) studied the association between specified management factors and net income to determine the amount of variation in net income that could be explained by these factors and their relative importance in explaining this variation. The source of data was 340 Michigan dairy farms, utilizing both D.H.I.A. and Telfarm records from 1958 to 1962. A multiple regression analysis was used to study the relationship between 38 management factors and net income. The fourteen factors that were significant ($P<.05$) in explaining variations in net income are listed in Table 2. Factors related to size, cropping practices, and dairy herd operation accounted for 28, 25, and 29 percent of the explained variation. Machinery expense, organization and intensity factors accounted for the remaining 18 percent. Livestock income per $100 feed expense and crop value per tillable acre accounted for 87 percent of the variation in net income attributed to all livestock and crop factors. Efforts to determine sources of variation in livestock income per $100 feed expense and crop value per tillable acre resulted in coefficients of determination of .87 and .93.

TABLE 2. Explanation of variation in net income with 14 farm management factors.

Farm Management Factors	Path Coefficients (P^2)	% of Explained Variation: Individual Factors	% of Explained Variation: Area Totals
x(3) Number of cows	.038	5.2	27.7
x(4) Number of tillable acres	.163	22.5	
x(6) Crop values/tillable acre	.163	22.5	
x(9) Soil value rating	.002	.3	25.4
x(12) Percent cash crops	.019	2.6	
x(13) Machinery expense/tillable acre	.086	11.9	11.9
x(15) Percent rented land	.008	1.1	1.1
x(16) Tillable acres/cow	.032	4.4	4.8
x(18) Milk sold/man	.003	.4	
x(21) Milk sold/cow	.006	.8	
x(26) Milk price/cwt.	.002	.3	
x(30) Milk production distribution	.002	.3	29.1
x(31) Dairy cattle sales/cow	.019	2.6	
x(32) Livestock income/$100 feed	.182	25.1	

Ace (1) studied Pennsylvania farms and found three factors of extreme importance for sharing heavy responsibility to the level of profitability on any farm. These three items were size of herd, production per cow, and pounds of milk sold per man. He pointed out why some dairy farms fail:

1. Too much overhead.
2. Too many purchased inputs.
3. Consider the system you need.
4. Failure to use the professional manager's tools.
5. Failure to take advantage of built-in efficiency.
6. Failure to conduct the farm as a business.
7. Failure to save time to manage.
8. Management may mean making a decision that will not increase profits.

He concludes by pointing out that the finest barn, the best equipment, the highest quality feed, plus the highest genetic base in the world pale into insignificance if management fails to put it all together.

The Diffusion Process

Many agricultural leaders are concerned about why innovations like production testing, cost accounting or management techniques are not readily accepted. Some ideas take a relatively short period of time to become adopted while others are not adopted even after years of effort on the part of many people.

Adoption of a new idea is an intricate procedure involving a chain of thoughts and decisions. Usually decisions are made after a number of contacts have been made with various channels of communication. Once an idea has been introduced, any given person can be found at one of four stages of the innovation-decision model reported by Rogers (21). These four stages are: knowledge, persuasion, decision, and confirmation.

The knowledge stage. We conceive of the innovation-decision process as beginning with the knowledge function, which commences when the individual is exposed to the existence of the innovation and gains some understanding of how it functions.

The persuasion stage. The individual forms a favorable or unfavorable attitude toward the innovation. He actively seeks information about the idea. His personality as well as the norms of his social system may affect where he seeks information, what messages he receives, and how he interprets the information he receives.

The decision stage. The individual engages in activities which lead to a choice to adopt or reject the innovation. The activities involve an immediate consideration of whether or not to try the innovation, if it is triable. A small-scale trial is often part of the decision to adopt and is important as a means to decrease the perceived risk of the innovation for the adopter.

The confirmation stage. The individual seeks reinforcement for the innovation-decision he has made, but he may reverse his previous decision if exposed to conflicting messages about the innovation. This stage continues after the decision to adopt or reject for an indefinite period of time. Throughout the confirmation function the individual seeks to avoid a state of dissonance or to reduce it if it occurs.

It is important to be able to recognize and work with this model. To be effective in diffusing ideas one must know which approaches to use at the different stages and how to mobilize them effectively.

Realizing that not all individuals will respond at the same speed or in the same manner to an idea, one must understand characteristics of adopter categories. Rogers (21) defines adopter categories as "the classifications of individuals within a social system based on innovativeness." There are five basic categories.

1. Innovators: Venturesome. These individuals represent approximately two and one-half percent of the population. They are eager to accept and try new ideas. They usually have the ability to understand and apply complex technical knowledge.

2. Early adopters: Respectable. About 13.5 percent of the population are highly respected or a leader in the community. The early adopter serves as a model for other members in the community because he is not so far ahead of the rest that the majority have little trouble identifying with him.

3. Early majority: Deliberate. This category makes up approximately 34 percent of the population and has a unique position of being between the very early and relatively late to adopt an idea. Although they seldom lead, they follow with deliberate willingness in adopting innovations.

4. Late majority: Skeptical. Such individuals approach each new idea with skepticism and caution. The majority of public opinion must favor the innovation before a person in this category is convinced of its usefulness. They represent 34 percent of the population.

5. Laggards: Traditional. They represent only 16 percent and possess almost no opinion leadership. By the time laggards finally accept an innovation, it already may have been replaced by a more recent idea which innovators are using. Laggards have their attention focused on a

rear-view mirror suggests Rogers.

The rate of adoption of innovations can be directly related to their attributes. Rogers (21) lists this set of comprehensive characteristics of innovations which are as mutually exclusive and as universally relevant as possible.

Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes, often expressed in economic profitability.

Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of the receivers. It insures greater security and less risk to the receiver and makes the new idea more incomingful to him.

Complexity is the degree to which an innovation is perceived as relatively difficult to understand and use. The complexity of an idea as perceived by potential adopter, is negatively related to its rate of adoption.

Trialability is the degree to which an innovation may be experimented with on a limited basis. New ideas that can be tried on an installment plan will generally be adopted more rapidly than ideas that are not divisible.

Observability is the degree to which the results of an innovation are visible to others. The results that are more easily observed and communicated to others have a positive relation to rate of adoption.

Kucker (12) studied Michigan dairymen to ascertain their motives for adopting, discontinuing, or not adopting production testing and artificial insemination. Dairymen look to production records for a number of forms of information to help them in decision making. Table 3 is a list of major reasons cited by dairymen in Kucker's study.

A dairyman's failure to recognize the value of testing caused most individuals who dropped testing to do so (Table 4). The most common response of such dairymen when personally interviewed, was inability to understand the computerized results of the test. Kucker concluded that dairymen evidently received relatively little assistance from the supervisor in interpreting and using test data; thus it was of little value or no use.

Michigan dairymen do not appear to be unique in their slow acceptance of DHI or any other testing program. Table 5 points out that only one state has more than 50 percent of cows on any form of production testing. Data compiled as of January 1, 1972 by King et al. (10) verify that 18.2 percent (85,931 cows) of Michigan's 473,000 dairy cows are on DHIA, 8.8 percent (41,398 cows) on owner-sampler and 0.7 percent (3,227 cows) on Tri-Monthly testing, for a total of 130,556 cows or 27.6 percent. Michigan, the sixth largest milk producing state, ranks 24th on the percent of cows on a production testing program.

TABLE 3. Reasons cited for adoption of production testing.

Reason	Number of Respondents	Percent
Individual cow production	105	34
Culling guide	94	30
Comparison with creamery test	21	7
Feeding instructions	19	6
Breeding dates	18	6
Advertising and merchandising	17	6
Drying off dates	16	5
Participation in breed association programs	9	3
Sire proving	9	3
Totals	308	100

TABLE 4. Reasons cited for discontinuing production testing.

Reason	Number of Respondents	Percent
Could not realize the value of testing	61	30
Too much work	43	21
Too expensive	40	20
Poor service	36	18
Supervisor quit	12	6
Personality conflict with supervisor	11	5
Totals	203	100

TABLE 5. Percentage of U.S. dairy cows, by State, included in the program: Official DHI, Owner-Sampler, WADAM, and other unofficial plans, in 1971.

State	Rank	State	Rank
	%		%
Hawaii-------------	70.0	Kansas------------	26.2
California---------	48.0	Ohio--------------	25.6
South Carolina-----	45.8	Alabama-----------	25.0
Arizona------------	43.3	West Virginia-----	24.6
Connecticut--------	41.2	New Mexico--------	24.3
New Hampshire------	37.3	Colorado----------	22.4
Massachusetts------	34.7	Minnesota---------	21.9
North Carolina-----	33.8	Rhode Island------	21.3
Utah---------------	33.8	Iowa--------------	20.2
Pennsylvania-------	33.6	Indiana-----------	19.1
Maine--------------	33.4	Oklahoma----------	18.8
Nevada-------------	33.1	Idaho-------------	17.8
Washington---------	32.1	Florida-----------	17.3
Georgia------------	31.9	Montana-----------	15.7
Virginia-----------	31.7	Louisiana---------	15.6
New Jersey---------	31.6	Nebraska----------	14.6
Vermont------------	30.8	Tennessee---------	13.7
Oregon-------------	30.2	Mississippi-------	13.6
Delaware-----------	30.0	Missouri----------	13.0
Maryland-----------	29.4	Wyoming-----------	13.0
Wisconsin----------	29.4	South Dakota------	12.5
Alaska-------------	28.2	Arkansas----------	11.8
New York-----------	27.9	Texas-------------	10.9
Michigan-----------	27.6	Kentucky----------	9.2
Illinois-----------	26.3	North Dakota------	5.8
		United States-----	26.1

Dairy farmers in Michigan adopt A.I. for a variety of reasons as shown in Table 6. The greatest advantage of A.I. as viewed by the adopter is increased use of superior sires which has a marked effect on the efficiency of milk production. Of course, there are also dairymen who have tried it, and have not liked it. Their reasons are listed in Table 7. Different from production testing, many discontinuers of A.I. would go back if problems were remedied.

TABLE 6. Reasons cited for adoption of artificial insemination.

Reason	Number of Respondents	Percent
Higher quality sires	282	50
Did not want to keep a bull	206	34
Easier to keep breeding records	48	9
More economical	29	5
Because my neighbors adopted	12	2
Totals	577	100

TABLE 7. Reasons cited for discontinuing use of artificial insemination.

Reason	Number of Respondents	Percent
Poor conception rate	78	44
Too much work in heat detection	31	18
Poor technician	29	17
Too expensive	23	13
Lost technician	8	4
Desired to use own bull	4	2
Poor choice of bulls	3	2
Totals	176	100

While the history of artificial insemination is only half as old as production testing it has nearly twice the rate of adoption. In 1971, 48.6 percent of the dairy cows in the U.S. were bred artificially. Michigan dairymen rank 22nd on A.I. usage. Table 8 gives the rank of states on percentage of A.I. participation. From Kucker's study (12) one can conclude that Michigan dairymen used A.I. because of higher quality sires. Yet, only a small percentage of the dairymen would use production testing to find out if the daughters of these sires were really superior producing animals. Also the question of who should test young sires to find the high quality sires appears to go unanswered as the majority of dairymen are not adopting production testing.

TABLE 8. Percentage of U.S. dairy cows and heifers bred artificially, by States, in 1971.[1]

State	Percent	State	Percent
Hawaii	96.6	Idaho	44.3
Alaska	91.8	Maryland	43.9
Florida	77.4	Virginia	43.0
California	69.7	Louisiana	41.7
Washington	64.4	North Carolina	40.0
Connecticut	64.0	Kansas	37.3
Pennsylvania	64.0	Rhode Island	35.3
New Mexico	60.5	Colorado	34.5
Utah	60.0	Georgia	34.3
Delaware	59.8	Indiana	33.9
New Hampshire	59.3	West Virginia	30.2
New York	57.3	Alabama	29.6
Wisconsin	57.2	Missouri	29.4
New Jersey	56.2	Iowa	29.1
Vermont	55.9	Wyoming	28.2
Oregon	55.0	Kentucky	25.4
Maine	53.7	Texas	24.8
Massachusetts	53.4	Nebraska	24.1
Arizona	53.3	Tennessee	24.1
Ohio	52.6	Montana	24.0
Illinois	51.1	Arkansas	23.4
Michigan	48.9	North Dakota	22.0
Nevada	48.1	Oklahoma	21.4
Minnesota	47.6	Mississippi	20.7
South Carolina	44.7	South Dakota	19.0
		United States	48.6

[1]From Statistical Reporting Service (USDA) estimates of U.S. cow numbers. Percentage based on U.S. dairy cows and heifers that have calved January 1, plus 65 percent of milk cow replacements, 500 pounds and over. Values for breedings and values for cattle available for breeding are best estimates only.

McMillan (16) examined 500 cooperators of the Telfarm program in 1965 on the use of the data for making management decisions. It was possible to rank the following ten statements in terms of the total amount of use given to the records by the cooperators. In order of decreasing importance these were:

1. Income tax planning.
2. Improve a farm enterprise.
3. Planning next year's financial needs.
4. Planning next year's crop and livestock programs.
5. Effects an expansion plan will have on income, net worth and debts.
6. Deciding on whether or not to buy machinery.
7. Identifying the results of different cropping and feeding practices.
8. Deciding on whether or not to buy more land.
9. Deciding on whether or not to continue farming.
10. Planning family living expenditures.

If a conclusion can be derived from this review, it would relate to the fact that many fine programs are available to dairymen in Michigan. Yet, the dairymen are adopting these programs slower than communicators would suggest. Perhaps the needs of the clients have changed faster than the programs, or perhaps the programs have changed faster than the needs of the clients or both.

It is felt that a study looking at the factors which affect production and profit using production testing data, genetic values for herds and Telfarm data would be of help in determining a type of record program that would increase rate of adoption of present programs.

CHAPTER III

Methods and Procedures

Sample and Design

To fulfill the objectives of the present study, data were obtained on all Michigan Holstein herds that were enrolled on DHIA and Telfarm continuous from January 1, 1968 to December 31, 1972. Five years of continuous data were available on 201 herds. In addition to being enrolled on Telfarm, the 201 herds were also considered to be specialized dairy farms in that more than 80 percent of the gross income was derived from the dairy enterprise, either through the sale of dairy products or dairy animals.

Since 1963, data from Michigan DHIA herds have not been analyzed. Partly responsible for this fact is that the Michigan DHIA Center was developed, machine processing completed, and a new computer system was co-purchased with Michigan Animal Breeders Cooperative. Data for the 201 herds were in storage for the years 1968 and 1969, 1970 and 1971; data were on 11 special packed IBM 9 track tapes, and the remaining data were on the Honeywell Computer System that is in use at the present time. Matching data for the 201 herds were difficult to obtain but were completed.

Multiple regression analysis, by least squares, was the procedure selected to analyze the data in this study. The procedure of least squares not only allows one to make specific, independent tests of significance on the direct effects of the various factors, but it also permits one to attempt to identify which combinations of variables is the most reasonable predictor of the dependent variable under question. Unlike the works of Brown, Miller, and Speicher (3, 18, 25) which used either one or two different dependent variables, an attempt was made to look at several different dependent variables in arriving at models which will more nearly account for a higher proportion of the variation. Likewise, variables that are correlated higher than .9 with the dependent variable will not be included as an independent variable.

It should be recognized that there are some limitations to this type of analysis which should not be overlooked. Some variables that may influence the dependent variable may not have been included in the study. Also, in multiple regression analysis, it is assumed that all independent variables are not representative of the population, but are fixed. Most independent variables in this study are random and thus estimates of partial regression coefficients may be biased and the variance-covariance matrix may not be correct.

In multiple regression analysis, it is assumed that the effects of all independent variables are linearly related in a model describing the dependent variable. A linear association between an independent variable and the dependent variable is one where a constant amount of increase in the dependent variable is associated with a unit increase in the independent variable. Any other relationship would be curvilinear. Economic theory would indicate that an assumption of curvilinearity in some of the dairy herd factors would be valid.

The association between each dependent variable and each of the independent herd factors was studied to establish linearity or the degree of curvilinearity. A tabular analysis was performed in which the separate herd factors were plotted by the DAP-22 (3600 Fortran). This program forms scatter diagrams between pairs of variables, and in addition, print out the mean, standard deviation, variance for each variable, the covariance, the product moment correlation, the curvilinear correlation ratios Eta (y, x), Eta (x, y), the regression coefficient, the slopes B (y, x), B (x, y), the intercepts A (y, x), and A (x, y); the scatter diagrams are plotted on standard score axis in categories, each of ¼ standard deviations width.

Results of the DAP-22 program indicated that one of several basic relationships existed between each set of dependent and independent variables. The three relationships used in this study were either linear, second degree or third degree curves. Any relationships beyond this point would be of little value to this study. The simple linear statistical model may be written as $y = B_o + B_1 x + E$, where y is the primary variable of interest, x if the fixed variable, B_1 is the "slope", or average change in y per unit change in x, B_o is the "origin", or extrapolated value of y when x is fixed or zero, and E is the random error of the relationship (failure to explain y by the form $B_o + B_1 x$). One can attempt to approximate the non-linear response with various degrees of polynomials, such as the quadratic model, $y = B_o + B_1 x + B_2 x^2 + E$, or for the cubic model as $y = B_o + B_1 x + B_2 x^2 + B_3 x^3 + E$. The degree of polynomial influences the shape of its graph. A first degree equation such as $y = B_o + B_1 x$ is a straight line but not horizontal, if B_1 is different from zero. A second degree equation $y = B_o + B_1 x + E_2 x^2$ can bend once, either upwards or downwards. A third degree equation $y = B_o + B_1 x + B_2 x^2 + B_3 x^3$ can bend twice, upwards or downwards. In general, the graph of an mth-degree equation can bend a maximum of (m-1) times.

DHIA Herd Factors

Measures of herd production were pounds of milk produced by each cow for the year as well as pounds of butterfat. Butterfat percent is arrived at by dividing the pounds butterfat by pounds milk and multiplying the result by 100.

A measure of size is represented by the number of cows per herd which is calculated as the number of cow days for the year divided by the number of days in the year, where a cow day was equal to one cow in the herd for one day. Cow days are counted on all animals which have freshened but which are now dry as well as all cows in milk. Percent days in milk measures the usefulness or productiveness of herd size as to the proportion of days the cows are in milk. The factor is calculated by dividing total days in milk by total cow days.

Rate of feeding the herd is defined by five variables. With the pounds of silage and hay fed in the herds, hay equivalents can be arrived at by dividing the pounds of silage fed by three and adding it to the pounds of hay. Pounds of concentrate fed as well as the number of days the cows were on pasture complete the feeding variables.

Eight economic variables are a part of the prediction model. Value of product per cow is milk price per cwt. minus a marketing fee, hauling included, times the number of cwts. of milk produced. This value represents the only source of revenue from DHIA herd factors. Expenses are represented by concentrate cost and forage cost which when added together are the total feed costs. Returns over concentrate costs, return over forage costs, and return over feed costs are three methods to evaluate returns to the operation. In the literature, income over feed cost or income over concentrate costs often are misleading in that many people in the industry think of them as profit, which they are not. Feed costs, as cited by Speicher (23), only represent 50 percent of total expenses. With this in mind, an expected profit variable is defined as value of product minus two times the total feed cost.

Milk price per cwt. as well as grain price per cwt. are recorded for evaluation. Concentrate costs per cwt. milk produced and feed costs per cwt. milk produced, represent the last of the 22 DHIA herd factor variables.

Telfarm Herd Variables

The Telfarm records program is for all types of farms in Michigan. To assist farmers with specific enterprises, special analysis factors are developed for year-end evaluations. It is these specific 21 dairy analysis factors that are under study.

Two measures of size are average number of cows and total cwt. of milk sold. All cooperators of Telfarm are encouraged to report the number of cows as arrived at through the DHIA program whenever possible. The total milk sold represents the actual pounds of milk paid for by the milk processing plant.

Two ways of measuring a dairyman's ability to properly manage his dairy herd are to evaluate the number of calves born per cow and the percent calf death losses before weaning. These two variables are produced from dividing the number of calves born by number of cows, and by dividing the number of calves that died before weaning by the number of calves born.

Productivity of the dairy enterprise is measured either by pounds of milk sold per cow or by milk sales per cow. Cattle income per cow can also be interpreted as a productivity measure. It is the difference in the beginning and ending dairy cattle inventories plus dairy cattle sales minus dairy cattle purchases. Since inventory change and purchases were included in the computation of the factor, it was possible to have a negative cattle income per cow. Gross income per cow is the result of milk sales plus cattle income.

Feed disappearance per cow is the value of feed for a cow and her replacement. This figure is considerably higher than that of DHIA feed cost because of the replacement portion of the feed bill. Likewise return over feed cost should be lower than the DHIA figure.

Total dairy investment per cow is broken down into five categories: land, machinery, buildings, cattle, and supplies.

Net cost per cwt. of milk sold includes all of the dairy farm expenses including labor that is involved with the production of milk. It serves as an excellent indicator of efficiency in production.

The last of the 21 Telfarm herd variables is the percent excess milk sold. Because most dairymen in Michigan are on a base plan this variable will serve to indicate the dairymen's ability to produce milk at a certain marketable level.

DISCUSSION AND RESULTS

Information is the chief by-product from the DHIA and Telfarm record programs. The dairy farmers supply data to be processed through a computer and to be returned in the form of useful information. The more useful the information the higher the rate of adoption because of its relative advantage to the clients. Additional analysis can be generated and more information forwarded to the receiver to a point where overload becomes a burden and the system breaks down. A fine line exists between too little information for effective decision making and too much information. The results from this project are intended to fall in the middle of this scale.

Herd production data for 1968 through 1972 is summarized for the 201 Michigan Holstein herds on DHIA in Table 9. The 67,335 cow years in 201 herds over five years averaged 13,752 pounds of milk, 507 pounds of fat with a 3.69 percent test. The standard deviation of 1,629 for milk and 63 for fat agree with previous workers. Changes in herd factors over the five year period are recorded in Table 10. Milk production increased 157 pounds per year while herd

TABLE 9. Overall minimums, maximums, means, and standard deviations of herd factors on a per cow basis for 201 Michigan Holstein herds on DHIA from 1968 to 1972.

Factor	Minimum	Maximum	Mean	Std. Dev.
Milk Produced (lbs.)	9,029	19,473	13,752	1,629
Fat Produced (lbs.)	338	735	507	63
Butterfat (%)	3.11	4.47	3.69	0.16
Number of Cows	18	218	67	34
Days in Milk (%)	69.9	96.3	87.5	2.9
Silage (lbs.)	----	30,851	12,406	5,074
Hay (lbs.)	----	11,001	3,382	1,957
Hay Equivalents (lbs.)[1]	732	15,955	7,517	2,378
Grain (lbs.)	2,101	10,233	5,086	1,095
Days on Pasture	----	204	42	58
Value of Product ($)	508	1,169	788	105
Grain Cost ($)	51	269	123	35
Forage Cost ($)	48	278	116	24
Total Feed Cost ($)	104	446	238	46
Return Over Grain ($)	409	969	665	96
Return Over Forage ($)	390	1,037	672	102
Return Over Feed ($)	226	842	550	95
Expected Profit ($)[2]	-37	654	312	104
Milk Price/Cwt. ($)	4.75	6.55	5.72	0.31
Grain Price/Cwt. ($)	0.90	4.08	2.40	0.42
Grain Cost/Cwt. Milk ($)	0.35	1.93	0.89	0.23
Feed Cost/Cwt. Milk ($)	0.72	2.85	1.74	0.31

[1]Hay Equivalents = Hay (lbs.) + (Silage (lbs.) ÷ 3).

[2]Expected Profit = Value of Product ($) - [2 x Feed Cost ($)].

TABLE 10. Change in herd factors on a per cow basis for 201 Michigan Holstein herds on DHIA from 1968 to 1972.

Factor	1968	1972	5 Year Change	Change/ Year
Milk Produced (lbs.)	13,389	14,175	+786	+157
Fat Produced (lbs.)	493	529	+36	+7
Butterfat (%)	3.68	3.74	+0.06	+0.01
Number of Cows	59	76	+17	+3
Days in Milk (%)	87.5	87.5	0.0	0.0
Silage (lbs.)	13,960	11,672	-2,288	-458
Hay (lbs.)	3,887	2,919	-968	-194
Hay Equivalents (lbs.)[1]	8,540	6,810	-1,730	-346
Grain (lbs.)	4,934	5,410	+476	+95
Days on Pasture	61	34	-27	-5
Value of Product ($)	730	853	+123	+25
Grain Cost ($)	114	141	+27	+5
Forage Cost ($)	112	124	+12	+2
Total Feed Cost ($)	226	265	+39	+8
Return Over Grain ($)	616	712	+96	+19
Return Over Forage ($)	618	729	+111	+22
Return Over Feed ($)	504	588	+84	+17
Expected Profit ($)[2]	279	323	+44	+9
Milk Price/Cwt. ($)	5.46	6.02	+0.56	+0.11
Grain Price/Cwt. ($)	2.31	2.61	+0.30	+0.06
Grain Cost/Cwt. Milk ($)	0.85	1.00	+0.15	+0.03
Feed Cost/Cwt. Milk ($)	1.70	1.88	+0.18	+0.04

[1]Hay Equivalents = Hay (lbs.) + (Silage (lbs.) ÷ 3).

[2]Expected Profit = Value of Product ($) - [2 x Feed Cost ($)]

size increased three cows per year. Silage and hay consumption decreased by 346 hay equivalents per year while grain fed increased by 95 pounds per year. Over the five years the price of milk per 100 pounds increased $0.56, the price of grain per 100 pounds increased $0.30, and the feed cost per 100 pounds of milk increased by only $0.18, which verifies a good economic picture and the need for dairymen to better understand cost and return concepts, particularly in view of the changing cost of feed ingredients in 1973 and the near future. Minimums, maximums, means, and standard deviations of herd factors on a per cow basis are listed for each of five years in Tables 20 to 24. It is of interest to note the consistency from year to year. For example, the overall standard deviation for milk production is 1,629 while the individual year standard deviations are 1,593, 1,575, 1,647, 1,648, and 1,579.

Some of the herd factors recorded by the Telfarm record program, Table 12, are in nearly perfect agreement with the DHIA record program, Table 10. Herd size increased three cows per year as previously mentioned and pounds milk sold per cow increased 151 pounds per year versus 157 pound increase each year as recorded by DHIA. Telfarm records only milk sold per cow which is 771 pounds less per cow than DHIA; the difference being colostrum milk, calf milk, and home use of the milk.

The difference in pounds of milk produced and what is actually sold would also be reflected on the value of each if the milk price was constant for both record programs. However, milk price per 100 pounds was $5.72 for DHIA and $5.98 for Telfarm; value of milk produced was $788 per cow on DHIA and $777 per cow on Telfarm.

TABLE 11. Overall minimums, maximums, means, and standard deviations of herd factors on a per cow basis for 201 Michigan Holstein herds on Telfarm from 1968 to 1972.

Factor	Minimum	Maximum	Mean	Std. Dev.
Cows	19	342	67	36
Calves Born	8	372	67	37
Calves Died	----	126	10	10
Calves Per Cow	0.11	3.15	1.01	0.21
Calf Loss (%)	----	293	15	15
Milk Sold (lbs.)	5,353	19,580	12,981	1,673
Milk Sales ($)	333	1,147	777	108
Cattle Sales ($)	-611	864	131	90
Gross Income ($)	266	1,632	908	155
Feed Cost ($)	----	990	420	119
Return Over Feed ($)	-27	1,185	488	155
Total Dairy Investment($)	39	2,750	979	314
Land Investment ($)	----	226	20	26
Machinery Investment($)	16	998	155	89
Building Investment($)	----	1,372	319	199
Cattle Investment ($)	----	1,120	485	134
Milk Price/Cwt. ($)	3.49	7.40	5.98	0.32
Net Cost/Cwt. ($)	1.18	10.23	5.68	1.12
Excess Base (%)	0	3.7	2.9	2.9

TABLE 12. Change in herd factors on a per cow basis for 201 Michigan Holstein herds on Telfarm from 1968 to 1972.

Factor	1968	1972	5 Year Change	Change/ Year
Cows	59	74	+15	+3
Calves Born	57	73	+16	+3
Calves Died	8	11	+3	+1
Calves Per Cow	0.98	0.99	+0.01	+0.00
Calf Loss (%)	14	15	+1	+0
Milk Sold (lbs.)	12,674	13,421	+757	+151
Milk Sales ($)	728	845	+117	+23
Cattle Sales ($)	106	160	+54	+11
Gross Income ($)	834	1,005	+171	+34
Feed Cost ($)	390	442	+52	+11
Return Over Feed ($)	444	563	+119	+24
Total Dairy Investment($)	883	1,092	+209	+42
Land Investment ($)	25	17	-8	-2
Machinery Investment($)	131	186	+55	+11
Building Investment($)	293	341	+48	+10
Cattle Investment ($)	433	549	+116	+23
Milk Price/Cwt. ($)	5.76	6.30	+0.54	+0.11
Net Cost/Cwt. ($)	5.44	5.81	+0.37	+0.07
Excess Base (%)	4.4	5.2	+1.8	+0.4

Multiple regression analysis was used to determine the amount of variation that would be accounted for by different independent variables. Miller (18) used six variables to predict milk production with 42.1 percent of the variation explained. The six variables that Miller used were identical to the independent variables in the present study and they are listed in Table 13. Pounds grain fed, pounds hay fed, pounds silage fed, percent days in milk, cow numbers, and days on pasture were the six variables that accounted for 28.1 percent of the variation. The level of significance was set at (P = .10) and all significant variables are listed. The partial correlation coefficients are given to verify the strength of the variable in the prediction equation. By adding grain price per 100 pounds to the equation the explained variation increased to 29.7 percent. However, of greater significance in predicting milk production is feed cost per 100 pounds of milk produced. In predicting milk yield with five variables, pounds grain fed, percent days in milk, cow numbers, pounds hay fed, and feed cost per 100 pounds of milk 47.1 percent of the variation is explained. Days on pasture and pounds of silage fed are two variables that were not significant ($P>.10$) in the final equation.

Previous investigations have pointed out that one can predict with a high degree of accuracy the value of product per cow. Brown (3) and Miller (18) both used milk production as an independent variable. However, milk production and

TABLE 13. Multiple regression analysis with milk production per cow as the dependent variable.

Ind. Variables	$R^2 = .28$ Sig.	$R^2 = .28$ P.C.C.[a]	$R^2 = .30$ Sig.	$R^2 = .30$ P.C.C.[a]	$R^2 = .47$ Sig.	$R^2 = .47$ P.C.C.[a]
$Grain^2$	.01	.12	.01	.10	.01	-.07
Grain	.01	-.11	.01	-.10	.07	-.17
$Grain^3$	.01	-.11	.01	-.10	.01	-.08
Days in $Milk^3$	.02	-.08	.02	-.08	.02	-.07
Days in $Milk^2$	.02	.07	.02	.07	.03	.07
Days in Milk	.03	-.07	.02	-.07	.03	-.07
Cows	.01	-.13	.01	-.15	.03	.07
Hay	.01	.09				
$Silage^3$	.02	-.08	.01	-.11		
Days on Pasture	.07	-.06	.06	-.06		
Grain Price/Cwt.^{2}			.01	.15		
Hay $Equivalent^3$			.01	.08		
Feed Cost/Cwt. Milk					.01	-.17
Feed Cost/Cwt. $Milk^2$					.01	.08
$Cows^2$					.02	-.07
$Cows^3$					.03	.07
Hay^3					.10	-.06
Hay^2					.01	.11

[a]P.C.C. = Partial Correlation Coefficients.
2 = Quadratic Function; 3 = Cubic Function.
Underlined variable was added to the Prediction Equation.

value of product have a correlation of .91 and this would indicate why the percent of variation explained for both studies was greater than 90 percent. In Table 14, value of product per cow was the dependent variable and six herd factors were used to account for 30 percent of the variation in value of product. By adding grain cost per 100 pounds of milk the explained variation increased to 38 percent; and when adding milk price per 100 pounds was included in the model, the explained variation was increased by 13 percent over the original equation. One could conclude that the accuracy in predicting value of product is very similar to predicting milk production when the same independent variables are used. Only when variables extremely highly correlated with value of product are used in the prediction equation, does the R^2 greatly increase, and to a point that is a bit uninformative because the result could have been predicted prior to the calculations.

Return over feed cost is a useful factor in management decision making. Dairymen continue to feed more grain as long as their return over feed cost continue to increase. In predicting return over feed cost, six variables were used, Table 15. Pounds grain fed, cow numbers, pounds silage fed, percent days in milk, days on pasture, and hay equivalents were used to predict 19 percent of the return over feed cost. When feed cost per 100 pounds milk was added to the model, the R^2 increased from .19 to .47, but

TABLE 14. Multiple regression analysis with value of product per cow as the dependent variable.

	R^2 = .30		R^2 = .38		R^2 = .43	
Ind. Variables	Sig.	P.C.C.[a]	Sig.	P.C.C.[a]	Sig.	P.C.C.[a]
$Grain^2$	.01	.09	.01	.25	.01	.12
$Grain^3$	.01	-.09	.01	-.15	.01	-.10
Grain	.01	-.08			.01	-.11
Days in $Milk^3$	.03	-.08	.04	-.06	.02	-.07
Days in $Milk^2$	.02	.07	.04	.06	.03	.07
Days in Milk	.03	-.07	.05	-.06	.04	-.07
Days on Pasture	.01	-.09	.05	-.06	.06	-.06
Days on $Pasture^2$	.03	.07	.07	.06		
Days on $Pasture^3$	.03	-.07	.05	-.06		
Hay $Equivalent^2$	.09	-.05				
Hay $Equivalent^3$	.08	.05				
Cows	.01	-.09			.01	-.13
$Silage^3$	.01	-.16	.01	-.17		
<u>Grain Cost/Cwt. Milk</u>^{2}			.01	.13		
<u>Grain Cost/Cwt. Milk</u>^{3}			.01	-.11		
<u>Grain Cost/Cwt. Milk</u>			.01	-.17		
$Cows^2$			.02	-.08		
$Cows^3$			.04	-.07		
<u>Milk Price/Cwt.</u>^{3}					.05	-.06
<u>Milk Price/Cwt.</u>^{2}					.05	.06
<u>Milk Price/Cwt.</u>					.06	-.06
Hay					.03	.09

[a]P.C.C. = Partial Correlation Coefficients.
2 = Quadratic Function; 3 = Cubic Function.
Underlined variable was added to the Prediction Equation.

TABLE 15. Multiple regression analysis with return over feed cost per cow as the dependent variable.

Ind. Variable	$R^2 = .19$ Sig.	$R^2 = .19$ P.C.C.[a]	$R^2 = .47$ Sig.	$R^2 = .47$ P.C.C.[a]	$R^2 = .90$ Sig.	$R^2 = .90$ P.C.C.[a]
Grain^2	.01	.14	.01	.19	.01	-.23
Cows	.02	-.08				
Cows^3	.04	-.07			.01	-.09
Cows^2	.04	.07			.05	.06
Silage^3	.01	-.10	.01	-.15	.01	-.14
Silage^2	.02	.08			.01	.16
Days in Milk	.01	.37	.01	.26	.01	.14
Days on Pasture	.01	-.09	.03	-.07		
Days on Pasture^2	.04	.07	.04	.07		
Days on Pasture^3	.10	-.05	.03	-.07	.01	.16
Hay Equivalent^2	.01	-.09	.01	.10	.03	-.07
$\text{Feed Cost/Cwt. Milk}^2$			.01	-.11	.01	-.30
$\text{Feed Cost/Cwt. Milk}^3$			.01	.11	.01	.39
Feed Cost/Cwt. Milk			.01	.09	.01	.29
Grain^3			.01	-.10	.01	.16
Milk Price/Cwt.^3					.01	.76
Grain Cost/Cwt. Milk					.01	-.49
$\text{Grain Cost/Cwt. Milk}^2$					.01	.32
$\text{Grain Cost/Cwt. Milk}^3$					.01	-.25

TABLE 15. (cont'd.)

	$R^2 = .19$		$R^2 = .47$		$R^2 = .90$	
Ind. Variable	Sig.	P.C.C.[a]	Sig.	P.C.C.[a]	Sig.	P.C.C.[a]
Grain Price/Cwt.					.01	.30
Grain Price/Cwt.^{2}					.01	-.18
Hay^2					.02	.08
Days in Milk^2					.01	-.15
Days in Milk^3					.01	.15
Grain					.01	.39

[a]P.C.C. = Partial Correlation Coefficients.
2 = Quadratic Function; 3 = Cubic Function.
Underlined variable was added to the Prediction Equation.

cow numbers were no longer significant ($P > .10$). Finally, four variables were added to the equation to see their effects in predicting return over feed cost. The six variables plus feed cost per 100 pounds milk, milk price per 100 pounds, grain cost per 100 pounds milk, and grain price per 100 pounds account for 90 percent of the variation in return over feed cost. In order of importance the added factors would rank: 1st - milk price per 100 pounds, 2nd - grain cost per 100 pounds milk, 3rd - feed cost per 100 pounds milk, and 4th - grain price per 100 pounds.

Profit expected per cow is a relatively new term and one that was generated for this study. It is the value resulting from multiplying feed cost per cow by two and subtracting it from the value of product per cow. Speicher (19) and other workers have found that feed cost per cow represent 50 percent of the cost. With this in mind, profit expected per cow becomes a realistic factor to evaluate what a dairyman could expect to be returned after all expenses are paid.

Profit expected per cow was used as the dependent variable along with herd factors as the independent variables, Table 16. The results were that an $R^2 = .24$ was obtainable. When grain cost per 100 pounds milk was added to the equation the R^2 increased to .59. But when feed cost per 100 pounds of milk was added to the equation, the $R^2 = .78$ was achieved. An increase of 54 percent of

TABLE 16. Multiple regression analysis with profit expected per cow as the dependent variable.

Ind. Variables	$R^2 = .24$ Sig.	$R^2 = .24$ P.C.C.[a]	$R^2 = .59$ Sig.	$R^2 = .59$ P.C.C.[a]	$R^2 = .78$ Sig.	$R^2 = .78$ P.C.C.[a]
Grain	.01	-.09				
$Grain^2$	.02	.07	.01	.21	.01	.20
$Grain^3$	.04	-.07	.01	-.15	.01	-.13
Cows	.01	-.11	.01	-.16		
$Cows^2$	.01	.10				
$Cows^3$	.01	-.09	.01	.13		
Days in $Milk^3$	.06	-.06			.04	-.07
Days in $Milk^2$	.06	.06			.03	.07
Days in Milk	.07	-.06	.01	.25	.03	-.07
Hay^2	.01	-.25	.02	-.08	.01	-.10
$Silage^3$	.01	-.23	.01	-.11		
Days on Pasture	.01	-.13	.01	-.09	.01	.09
Days on $Pasture^2$	.01	-.09			.02	.08
Grain Cost/Cwt. Milk			.01	-.23		
Grain Cost/Cwt. $Milk^2$			.01	.14		
Grain Cost/Cwt. $Milk^3$			.01	-.12		
Hay^3			.01	.08		
Hay			.03	.07		
Silage			.02	.08		
Hay $Equivalent^2$			.01	-.08		

TABLE 16. (cont'd.)

	$R^2 = .24$		$R^2 = .59$		$R^2 = .78$	
Ind. Variables	Sig.	P.C.C.[a]	Sig.	P.C.C.[a]	Sig.	P.C.C.[a]
Feed Cost/Cwt. Milk					.01	-.33
Feed Cost/Cwt. Milk[2]					.01	.10
Hay Equivalent[3]					.01	.09
Silage[2]					.01	-.19
Days on Pasture[3]					.01	-.08
Hay[3]					.03	.07

[a]P.C.C. = Partial Correlation Coefficients.
2 = Quadratic Function; 3 = Cubic Function.
Underlined variable was added to the Prediction Equation.

the variation accounted for by feed cost is closely associated with the previous workers' results that indicated that feed cost represented 50 percent of the total expenses per cow. This further strengthens the need for very accurate feed cost estimates and the need for more and better ways to record feed weights and to keep prices as close to accurate as possible. At present dairymen on test go for six months to a year or longer without changing the cost of their feed ingredients and forages fed to their dairy herd.

The Telfarm records program adds an extra dimension to predicting production and profit because of the uniqueness of some of the recorded data. Of the 21 dairy analysis variables made available annually to every dairyman on Telfarm, nine were used to predict gross income per cow. Total dairy investment, land investment, building investment, machinery investment, cattle investment, feed cost, calves per cow, percent calf loss, and percent surplus milk account for 38 percent of the variation in gross income per cow (Table 17). Milk price per 100 pounds does not have a strong positive influence on gross income per cow as it only increased the explained variation by 5 percent. However, pounds milk sold per cow has a tremendous influence with the partial correlation coefficient being .71 and raising the R^2 to .69. When pounds milk sold per cow was a part of the prediction equation the following variables were significant ($P<.10$): total dairy investment, building investment, machinery investment, feed cost, calves per cow, percent calf loss, percent surplus milk, cow numbers, and milk sold per cow.

A concern over the years has been to find a useful economic factor or factors that would be easier to measure than milk production. It would appear from Table 18 that cattle sales per cow and feed cost per cow are significant factors (R^2 = .60) in predicting return over feed cost. From an economic viewpoint, return over feed cost is of real importance and it is of interest to find two variables accounting for 60 percent of the variation. Cattle sales are extremely easy to record, are easily documented, and provide very small opportunity for error, less so than with feed cost or milk production per cow. When net cost per 100 pounds of milk was added to the previously discussed variables the prediction accuracy increased seven percent. When milk price per 100 pounds and percent surplus milk were added to the previous three variables, 76 percent of the variation in return over feed costs were taken into account.

The final multiple regression analysis was an attempt to see the effects of investment per cow and of calf factors on milk production per cow (Table 19).

The only variables used to predict milk production were total dairy investment, land investment, machinery investment, building investment, cattle investment and the number of cows. These combined variables account

TABLE 17. Multiple regression analysis with gross income per cow as the dependent variable.

	$R^2 = .38$		$R^2 = .43$		$R^2 = .69$	
Ind. Variable	Sig.	P.C.C.[a]	Sig.	P.C.C.[a]	Sig.	P.C.C.[a]
Total Dairy Investment^3	.01	-.21	.01	-.19		
Total Dairy Investment^2	.01	.24	.01	.23		
Land Investment^2	.01	-.10				
Building Investment	.01	-.21	.01	-.21	.01	-.24
Machinery Investment^2	.01	-.09			.01	-.11
Cattle Investment^3	.01	-.09	.01	-.09		
Feed Cost^2	.01	.15	.01	.16	.01	.09
Feed Cost^3	.03	-.07	.01	-.08	.03	-.07
Calves Per Cow	.01	.18	.01	.25	.01	.18
Calves Per Cow^2	.01	-.10			.05	.06
Percent Calf Loss	.01	.18	.01	-.17		
Percent Calf Loss^2	.02	.08	.01	.08		
Percent Calf Loss^3	.07	-.05	.04	-.06	.10	-.05
Percent Surplus Milk	.01	.11	.01	.09	.06	.06
Percent Surplus Milk^2	.01	-.11	.01	-.09	.02	.08
Percent Surplus Milk^3	.01	.10	.01	.09	.02	.08
Milk Price Per Cwt.			.01	-.15		
Milk Price Per Cwt.^{2}			.01	-.16		
Milk Price Per Cwt.^{3}			.01	.16		
Machinery Investment			.01	-.10		
Land Investment			.01	-.09		
Calves Per Cow^3			.01	-.11		

TABLE 17. (cont'd.)

Ind. Variable	R^2 = .38		R^2 = .43		R^2 = .69	
	Sig.	P.C.C.[a]	Sig.	P.C.C.[a]	Sig.	P.C.C.[a]
Milk Sold Per Cow					.01	.71
Building Investment[3]					.01	.10
Total Dairy Investment					.01	.32
Feed Cost					.03	-.08
Cows					.01	.10
Calves Per Cow[3]					.03	-.07

[a]P.C.C. = Partial Correlation Coefficients.
2 = Quadratic Function; 3 = Cubic Function.
Underlined variable was added to the Prediction Equation.

TABLE 18. Multiple regression analysis with return over feed cost per cow as the dependent variable.

Ind. Variable	$R^2 = .60$ Sig.	$R^2 = .60$ P.C.C.[a]	$R^2 = .67$ Sig.	$R^2 = .67$ P.C.C.[a]	$R^2 = .76$ Sig.	$R^2 = .76$ P.C.C.[a]
Cattle Sales	.01	.59	.01	.45	.01	.43
Cattle Sales^2	.01	-.15	.01	.10	.01	.09
Cattle Sales^3	.02	.07	.01	-.10	.04	-.07
Feed Cost	.01	-.25	.01	-.30	.01	-.29
Feed Cost^2	.01	.09	.01	.17	.01	.16
Feed Cost^3	.04	-.07	.01	-.13	.01	-.12
Net Cost Per Cwt. Milk			.01	.12	.01	.14
Net Cost Per Cwt. Milk^2			.01	-.13	.01	-.17
Net Cost Per Cwt. Milk^3			.01	.12	.01	.15
Cows			.01	-.12	.01	-.17
Cows^2			.01	.09	.01	.12
Milk Price Per Cwt.					.01	-.11
Milk Price Per Cwt.^{2}					.01	.12
Milk Price Per Cwt.^{3}					.01	-.11
Percent Surplus Milk					.01	.10
Percent Surplus Milk^2					.07	-.06
Cows^3					.01	-.09

[a]P.C.C. = Partial Correlation Coefficients.
2 = Quadratic Function; 3 = Cubic Function.
Underlined variable was added to the Prediction Equation.

TABLE 19. Multiple regression analysis with milk production per cow as the dependent variable.

Ind. Variable	$R^2 = .10$ Sig.	$R^2 = .10$ P.C.C.[a]	$R^2 = .17$ Sig.	$R^2 = .17$ P.C.C.[a]	$R^2 = .23$ Sig.	$R^2 = .23$ P.C.C.[a]
Total Dairy Investment^2	.01	.18	.01	.19	.01	.14
Total Dairy Investment^3	.01	-.12	.01	-.13	.01	-.12
Land Investment^2	.01	-.13	.01	-.14		
Land Investment^3	.01	.09	.01	.10		
Machinery Investment^2	.01	-.13	.01	-.11	.01	-.09
Building Investment	.01	-.10	.01	-.12	.01	-.09
Building Investment^2	.01	-.10	.01	-.08	.01	-.11
Cattle Investment	.03	-.07	.03	-.07		
Cattle Investment^2	.07	.06				
Cattle Investment^3	.02	-.08	.01	-.11	.01	-.16
Cows	.01	-.09	.07	-.06		
Feed Cost			.01	.27	.01	.26
Calves Per Cow^2					.04	-.07
Calves Per Cow					.01	.13
Percent Calf Loss					.01	-.19
Percent Calf Loss^2					.01	.11
Total Dairy Investment					.02	-.07
Land Investment					.01	-.15

[a]P.C.C. = Partial Correlation Coefficients.
2 = Quadratic Function; 3 = Cubic Function.
Underlined variable was added to the Prediction Equation.

for 10 percent of the variation in milk production. After adding feed cost to the equation the R^2 increased to 17 percent. By including feed cost, calves per cow, and percent calf loss, the R^2 increased to 23 percent. One must conclude that these variables are of little value in predicting milk production, particularly in light of the previously discussed variables that were used to predict milk production with a much higher degree of accuracy.

SUMMARY AND CONCLUSION

Approximately 70 percent of the cows in Michigan are not on a DHIA testing program and 80 percent of the cows in Michigan are not on Telfarm records program. However, much of the generated information serves as guidelines and standards for many non-participants.

Results from 201 Michigan Holstein herds on DHIA and Telfarm from 1968 to 1972, clearly point out that these herds are making progress. The 67,335 cow years increased production by 786 pounds of milk per cow while herd size increased three cows per year. The average value of product per cow increased from $730 to $853 for a total of $123 over five years while feed costs only rose $39 over the same period of time giving an extra expected profit of $9 per cow per year. By comparing the results of both record programs, one finds that 771 pounds less milk per cow is sold than what is produced, possibly pointing out a need for adjusting DHIA records to more clearly point out the value of product from each cow each year. Total dairy investment data per cow show that 52 percent is for cattle, 32 percent is for buildings, 15 percent is for machinery, and 2 percent is for land.

The most important variables in predicting milk production are pounds grain fed, percent days in milk, feed cost per 100 pounds milk, cow numbers, and pounds hay fed. They account for 47 percent of the variation in milk production.

Value of product can also be predicted with the same variables used to predict milk production, and they account for about the same proportion of total variation. Knowing the milk price will increase the prediction by five percent. By knowing feed cost per 100 pounds of milk one can predict the return over feed cost with 47 percent of the explained variation. By combining milk price, grain cost per 100 pounds of milk, and grain price, one can be 90 percent certain in estimating return over feed cost.

Expected profit per cow is of real importance to any participant on or off a testing or records program. It is easily generated from both existing record programs.

Predicting gross income is not nearly as accurate until pounds milk sold per cow is added to the equation. But of greater importance is that two factors can predict with 60 percent accuracy the return over feed cost from Telfarm records. These two variables are cattle sales per cow and feed cost per cow. Cattle sales could be very easily added to the DHIA program and thus total gross income per cow could be calculated. Investment figures per cow appear to be of little value in regards to predicting milk production.

While both programs have much merit for the University to operate and provide many guidelines and standards, a need exists to serve the high percentage of dairymen that are not a part of either program. Economic data could be added to the DHIA program to increase its relative advantage and meaning to more dairymen. It does not follow strong logic to know to the nearest pound the production and yet not know the value of milk sold within $50. Likewise, pounds of grain fed per cow and percent days in milk, two highly significant variables in predicting milk production, are not included in the Telfarm records program.

Even a point on inventory needs to be clarified. DHIA personnel do not know the number of animals on the members' farms. For years they have just recorded the number of cows. Identification of animals on test is of extreme importance for genetic evaluations, but information on all animals is unavailable to the computer until heifers freshen at about two years of age.

As the need for program evaluation increases within both record systems, a growing concern by dairymen will emerge for a total records program that will provide many flexible options that can provide all or as little information as each dairyman can effectively use in decision making.

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APPENDIX

TABLE 20. Minimums, maximums, means, and standard deviations of herd factors on a per cow basis for 201 Michigan Holstein herds on DHIA in 1968.

Factor	Minimum	Maximum	Mean	Std. Dev.
Milk Produced (lbs.)	9,169	17,857	13,389	1,593
Fat Produced (lbs.)	338	659	493	61
Butterfat (%)	3.32	4.30	3.68	0.16
Number of Cows	18	161	59	28
Days in Milk (%)	73.5	93.8	87.5	2.8
Silage (lbs.)	----	29,429	13,960	5,217
Hay (lbs.)	----	8,644	3,887	1,765
Hay Equivalents (lbs.)[1]	4,059	14,735	8,540	1,863
Grain (lbs.)	2,800	8,141	4,934	1,010
Days on Pasture	----	204	61	67
Value of Product ($)	508	953	730	89
Grain Cost ($)	52	233	114	30
Forage Cost ($)	66	193	112	21
Total Feed Cost ($)	152	370	226	40
Return Over Grain ($)	422	810	616	83
Return Over Forage ($)	390	834	618	90
Return Over Feed ($)	303	694	504	85
Expected Profit ($)[2]	-38	484	279	98
Milk Price/Cwt. ($)	4.93	6.01	5.46	0.21
Grain Price/Cwt. ($)	0.90	3.63	2.31	0.38
Grain Cost/Cwt. Milk ($)	0.40	1.53	0.85	0.20
Feed Cost/Cwt. Milk ($)	1.06	2.61	1.70	0.30

[1]Hay Equivalents = Hay (lbs.) + Silage (lbs.) ÷ 3).

[2]Expected Profit = Value of Profits ($) - (2 x Feed Cost ($)).

TABLE 21. Minimums, maximums, means, and standard deviations of herd factors on a per cow basis for 201 Michigan Holstein herds on DHIA in 1969.

Factor	Minimum	Maximum	Mean	Std. Dev.
Milk Produced (lbs.)	9,029	17,678	13,571	1,575
Fat Produced (lbs.)	342	674	499	62
Butterfat (%)	3.24	4.47	3.68	0.16
Number of Cows	26	190	62	31
Days in Milk (%)	73.9	94.5	87.8	2.9
Silage (lbs.)	----	30,851	15,059	5,225
Hay (lbs.)	----	9,865	3,815	1,919
Hay Equivalents (lbs.)[1]	3,986	15,955	8,834	1,921
Grain (lbs.)	2,734	8,155	4,976	1,030
Days on Pasture	----	198	48	58
Value of Product ($)	514	988	751	91
Grain Cost ($)	51	251	117	32
Forage Cost ($)	66	218	112	23
Total Feed Cost ($)	146	364	229	39
Return Over Grain ($)	409	870	634	83
Return Over Forage ($)	406	870	639	94
Return Over Feed ($)	305	749	522	86
Expected Profit ($)[2]	-17	545	293	97
Milk Price/Cwt. ($)	4.75	6.31	5.54	0.21
Grain Price/Cwt. ($)	1.07	3.68	2.36	0.34
Grain Cost/Cwt. Milk ($)	0.42	1.55	0.86	0.20
Feed Cost/Cwt. Milk ($)	1.00	2.60	1.70	0.28

[1]Hay Equivalents = Hay (lbs.) + (Silage (lbs.) ÷ 3).

[2]Expected Profit = Value of Product ($) - (2 x Feed Cost ($)).

TABLE 22. Minimums, maximums, means, and standard deviations of herd factors on a per cow basis for 201 Michigan Holstein herds on DHIA in 1970.

Factor	Minimum	Maximum	Mean	Std. Dev.
Milk Produced (lbs.)	9,124	18,535	13,703	1,647
Fat Produced (lbs.)	339	735	503	65
Butterfat (%)	3.11	4.13	3.67	0.17
Number of Cows	25	218	67	34
Days in Milk (%)	69.9	96.3	87.5	3.0
Silage (lbs.)	----	25,626	10,722	4,444
Hay (lbs.)	----	10,083	3,360	1,876
Hay Equivalents (lbs.)[1]	1,979	14,152	6,934	2,249
Grain (lbs.)	2,465	8,390	4,967	1,098
Days on Pasture	----	166	30	47
Value of Product ($)	531	1,116	785	97
Grain Cost ($)	51	240	111	32
Forage Cost ($)	48	206	113	23
Total Feed Cost ($)	104	394	224	41
Return Over Grain ($)	460	918	674	87
Return Over Forage ($)	416	986	672	95
Return Over Feed ($)	241	792	561	96
Expected Profit ($)[2]	69	633	337	94
Milk Price/Cwt. ($)	5.19	6.32	5.73	0.22
Grain Price/Cwt. ($)	1.38	3.71	2.24	0.36
Grain Cost/Cwt. Milk ($)	0.35	1.44	0.81	0.20
Feed Cost/Cwt. Milk ($)	0.72	2.47	1.64	0.28

[1]Hay Equivalents = Hay (lbs.) + (Silage (lbs.) ÷ 3).

[2]Expected Profit = Value of Product ($) - (2 x Feed Cost ($)).

TABLE 23. Minimums, maximums, means, and standard deviations of herd factors on a per cow basis for 201 Michigan Holstein herds on DHIA in 1971.

Factor	Minimum	Maximum	Mean	Std. Dev.
Milk Produced (lbs.)	9,487	19,473	13,923	1,648
Fat Produced (lbs.)	355	730	510	61
Butterfat (%)	3.29	4.04	3.67	0.14
Number of Cows	24	218	72	35
Days in Milk (%)	70.8	96.3	87.4	3.1
Silage (lbs.)	----	21,448	10,616	4,371
Hay (lbs.)	----	11,001	2,929	1,994
Hay Equivalents (lbs.)[1]	731	15,397	6,468	2,376
Grain (lbs.)	2,101	8,612	5,142	1,154
Days on Pasture	----	200	34	57
Value of Product ($)	602	1,169	818	100
Grain Cost ($)	53	269	128	36
Forage Cost ($)	52	205	115	25
Total Feed Cost ($)	107	388	243	45
Return Over Grain ($)	458	939	690	94
Return Over Forage ($)	481	1,037	703	99
Return Over Feed ($)	226	829	575	98
Expected Profit ($)[2]	85	654	332	110
Milk Price/Cwt. ($)	5.19	6.51	5.88	0.22
Grain Price/Cwt. ($)	1.42	3.86	2.50	0.46
Grain Cost/Cwt. Milk ($)	0.35	1.53	0.92	0.24
Feed Cost/Cwt. Milk ($)	0.78	2.67	1.76	0.32

[1]Hay Equivalents = Hay (lbs.) + (Silage (lbs.) ÷ 3).

[2]Expected Profit = Value of Product ($) - (2 x Feed Cost ($)).

TABLE 24. Minimums, maximums, means, and standard deviations of herd factors on a per cow basis for 201 Michigan Holstein herds on DHIA in 1972.

Factor	Minimum	Maximum	Mean	Std. Dev.
Milk Produced (lbs.)	10,508	18,519	14,175	1,579
Fat Produced (lbs.)	378	694	529	59
Butterfat (%)	3.35	4.20	3.74	0.15
Number of Cows	23	218	76	37
Days in Milk (%)	76.7	96.3	87.5	2.7
Silage (lbs.)	----	21,952	11,672	4,447
Hay (lbs.)	----	8,962	2,919	2,019
Hay Equivalents (lbs.)[1]	868	13,151	6,810	2,401
Grain (lbs.)	2,465	10,233	5,410	1,112
Days on Pasture	----	177	34	55
Value of Product ($)	602	1,129	853	101
Grain Cost ($)	56	270	141	37
Forage Cost ($)	52	278	124	26
Total Feed Cost ($)	108	446	265	48
Return Over Grain ($)	431	969	712	96
Return Over Forage ($)	460	993	729	95
Return Over Feed ($)	333	842	588	93
Expected Profit ($)[2]	25	633	323	107
Milk Price/Cwt. ($)	5.25	6.55	6.02	0.26
Grain Price/Cwt. ($)	1.66	4.08	2.61	0.45
Grain Cost/Cwt. Milk ($)	0.35	1.93	1.00	0.25
Feed Cost/Cwt. Milk ($)	0.78	2.85	1.88	0.31

[1]Hay Equivalents = Hay (lbs.) + (Silage (lbs.) ÷ 3).

[2]Expected Profit = Value of Product ($) - (2 x Feed Cost ($)).

TABLE 25. Minimums, maximums, means, and standard deviations of herd factors on a per cow basis for 201 Michigan Holstein herds on Telfarm in 1968.

Factor	Minimum	Maximum	Mean	Std. Dev.
Cows	19	165	59	28
Calves Born	----	161	57	29
Calves Died	----	49	8	7
Calves Per Cow	----	0.99	0.98	0.18
Calf Loss (%)	----	70	14	12
Milk Sold (lbs.)	5,353	19,580	12,674	1,738
Milk Sales ($)	333	1,147	728	97
Cattle Sales ($)	-123	376	106	63
Gross Income ($)	355	1,285	834	122
Feed Cost ($)	----	705	390	90
Return Over Feed ($)	----	816	444	123
Total Dairy Investment($)	----	1,818	883	250
Land Investment ($)	----	226	25	31
Machinery Investment($)	----	443	131	64
Building Investment($)	----	1,151	293	171
Cattle Investment ($)	----	910	433	115
Milk Price/Cwt. ($)	4.75	7.40	5.76	0.31
Net Cost/Cwt. ($)	3.49	9.17	5.44	1.08
Excess Base (%)	0	30.0	4.4	5.2

TABLE 26. Minimums, maximums, means, and standard deviations of herd factors on a per cow basis for 201 Michigan Holstein herds on Telfarm in 1969.

Factor	Minimum	Maximum	Mean	Std. Dev.
Cows	25	189	63	31
Calves Born	----	203	63	33
Calves Died	----	65	9	10
Calves Per Cow	----	1.22	1.00	0.19
Calf Loss (%)	----	80	14	11
Milk Sold (lbs.)	8,228	17,052	12,776	1,608
Milk Sales ($)	462	992	739	95
Cattle Sales ($)	-75	320	115	60
Gross Income ($)	585	1,140	854	118
Feed Cost ($)	----	678	403	94
Return Over Feed ($)	----	896	451	125
Total Dairy Investment($)	323	1,965	932	275
Land Investment ($)	----	127	21	25
Machinery Investment($)	24	444	141	73
Building Investment($)	----	1,186	308	187
Cattle Investment ($)	180	1,004	462	113
Milk Price/Cwt. ($)	3.49	6.68	5.78	0.25
Net Cost/Cwt. ($)	3.26	8.33	5.59	0.91
Excess Base (%)	0	37.0	5.1	5.6

TABLE 27. Minimums, maximums, means, and standard deviations of herd factors on a per cow basis for 201 Michigan Holstein herds on Telfarm in 1970.

Factor	Minimum	Maximum	Mean	Std. Dev.
Cows	25	283	67	36
Calves Born	----	232	66	37
Calves Died	----	64	10	10
Calves Per Cow	----	0.96	0.99	0.20
Calf Loss (%)	----	94	15	12
Milk Sold (lbs.)	8,777	18,211	12,876	1,668
Milk Sales ($)	534	1,060	767	99
Cattle Sales ($)	-151	647	128	84
Gross Income ($)	490	1,393	895	145
Feed Cost ($)	----	888	418	132
Return Over Feed ($)	----	999	477	157
Total Dairy Investment($)	323	2,580	970	286
Land Investment ($)	----	133	20	24
Machinery Investment($)	21	534	151	77
Building Investment($)	----	1,372	321	195
Cattle Investment ($)	179	853	478	119
Milk Price/Cwt. ($)	5.41	6.97	5.96	0.20
Net Cost/Cwt. ($)	1.79	9.81	5.75	1.19
Excess Base (%)	0	34.0	6.1	6.2

TABLE 28. Minimums, maximums, means, and standard deviations of herd factors on a per cow basis for 201 Michigan Holstein herds on Telfarm in 1971.

Factor	Minimum	Maximum	Mean	Std. Dev.
Cows	24	335	71	39
Calves Born	----	315	70	40
Calves Died	----	126	12	14
Calves Per Cow	----	0.98	0.99	0.21
Calf Loss (%)	----	140	17	14
Milk Sold (lbs.)	9,107	18,225	13,193	1,578
Milk Sales ($)	539	1,134	806	99
Cattle Sales ($)	-611	864	144	112
Gross Income ($)	335	1,627	950	154
Feed Cost ($)	----	858	448	125
Return Over Feed ($)	----	1,185	502	161
Total Dairy Investment($)	347	2,750	1,035	362
Land Investment ($)	----	125	18	22
Machinery Investment($)	16	790	170	106
Building Investment($)	----	1,339	336	220
Cattle Investment ($)	200	1,031	511	138
Milk Price/Cwt. ($)	5.14	7.37	6.11	0.19
Net Cost/Cwt. ($)	1.18	9.92	5.88	1.16
Excess Base (%)	0	27.0	6.5	5.9

TABLE 29. Minimums, maximums, means, and standard deviations of herd factors on a per cow basis for 201 Michigan Holstein herds on Telfarm in 1972.

Factor	Minimum	Maximum	Mean	Std. Dev.
Cows	23	342	74	41
Calves Born	----	372	73	45
Calves Died	----	73	11	11
Calves Per Cow	----	1.10	0.99	0.21
Calf Loss (%)	----	290	15	15
Milk Sold (lbs.)	9,632	17,667	13,421	1,672
Milk Sales ($)	537	1,134	845	105
Cattle Sales ($)	-270	744	160	106
Gross Income ($)	266	1,632	1,005	168
Feed Cost ($)	----	990	442	139
Return Over Feed ($)	----	1,106	563	180
Total Dairy Investment($)	306	2,510	1,092	351
Land Investment ($)	----	140	17	23
Machinery Investment($)	22	998	186	112
Building Investment($)	----	1,222	341	213
Cattle Investment ($)	190	1,120	549	154
Milk Price/Cwt. ($)	5.57	7.37	6.30	0.21
Net Cost/Cwt. ($)	1.79	10.23	5.81	1.19
Excess Base (%)	0	25.0	5.2	5.6