RELATIONSHIP OF MANAGEMENT FACTORS TO DIFFERENCES IN PROFITABILITY AMONG VIRGINIA DAIRY FARMS

by

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INTRODUCTION

People enter the dairy business to provide income for themselves. Though dairymen have fared well in recent years, it is becoming a riskier business as inflation slows on land and cattle values, lessening a manager's ability to survive periodic cash deficits. The manager of a dairy operation must frequently make decisions on the basis of time, effort and cost associated with alternatives. Often, new management strategies are implemented without a complete evaluation of their probable financial consequences. This evaluation requires that alternatives of management decisions be quantified.

Presently information is available which tabulates production, feeding and reproductive data from DHI records. This information is descriptive, but the financial variables included are few and not necessarily current. Financial information is available independently in the form of farm record systems, which are accurate. Farm finance records do not include the production and management variables necessary for combined analysis. Records of specific management practices and facilities are necessary to determine the relationships among and effects of management conditions on previously recorded production and financial data. This information must be collected directly from farm managers.

The collection of financial and production records under different management practices yields much information on the influence of management strategies on profitability. The development of statistical models yields equations which predict probable profitability of a dairy enterprise based on the influence of several management strategies. This information will aid farmers and extension personnel in determining how to best achieve a profitable operation, while reducing the risk involved. It will also enhance the decision-making and problem-solving capabilities of researchers in dairy herd management. Financial institutions may also make note of these findings, as they provide a means of estimating debt repayment ability, although historical records from existing operations are always preferable.

OBJECTIVES

The objectives of this project were to:

1. assemble an extensive combination of production, management, and financial records from several randomly selected farms,
2. determine the relationship of these variables to four measures of profit,
3. identify prospective topics for future studies.

REVIEW OF LITERATURE

All research with dairy cattle is affected by management decisions. This review addresses the effects of differing management practices as they influence income and other variables pertinent to profitability.

It has been stated (6) that response to management practices is greater when measured by production than by income indices. This is logical as milk production is only one component of income, with costs having a great influence on net income. Production can increase at a less than cost-effective rate. To the majority of dairymen, an increase in net returns is of greater significance to herd management decisions than is increasing production. Although they were referring to genetic responses, Lin and Allaire (19) stated in this vein that continued gains over time may not always lead to continued increases in profit or net return. There is in fact a point of diminishing returns, although most dairymen probably have not reached it. That point is rather elusive, however, and changes over time.

It has also been said (9) that experimental response often exceeds response on commercial farms and it has been advocated that important results be estimated under farm conditions.

Several researchers (11, 16, 23, 29) have surveyed management practices. Data for these projects were collected by mail or from existing DHI and financial records, some from institutional or college farms. In general these studies were unable to pinpoint management factors which affected profitability per cow. They pointed out economies of scale and found that size and labor combinations caused changes in overall profitability. However these differences were size dependent. Nott et al. (23) additionally found that veterinary cost per cow and mortality rate in young stock increased as herd size increased.

Speicher and Lassiter (29) in a study of 340 farms reported that milk sold per cow explained gross income per cow but was only of tertiary importance to net farm income.

Other researchers (20, 22) have looked at the financial importance of DHI records. These studies measured differences in production between DHI and non-DHI herds and reported differences of $50 to $449 in milk sold per cow, but did not include expense items.

Bratton (5) showed a 487 kg difference between DHI and non-DHI average production for 583 New York dairy farms. It is not known how these differences relate to income. Miller et al. (22) concluded that DHI estimates of feed costs other than concentrates were of little value. Concentrate costs seemed reliable and were strongly related to income over feed costs.

Bratton (5) pointed out that many observations are necessary to isolate the effects of particular practices on dairy operations. Observations must incorporate management practices and business measures.

Dillon (9) noted a difference between statistical significance and economic significance. The dairyman is not concerned whether a 5% or less chance exists for no response. He must fit a particular practice with his own probability circumstances, and must decide if a practice is beneficial, even though its risk of failure may be 30% or so.

Blosser (4) examined the economic consequences of mastitis. He placed the cost of mastitis at $117 per cow per year, including lost production, discarded milk, increases in veterinary expense, medicines, and labor, lost cattle value and increased cost of replacements.

Andrus and McGilliard (1) found mastitis made a negative contribution to income, at the rate of $13 per year per cow per case of mastitis. This contribution was only 59% as important as milk production in describing the profit function. Appleman et al. (3) using a mail survey found that production increased in herds where all cows were dry treated, but did not state how this related to incidence of mastitis.

Appleman (2) in a study of 449 farms also showed an additivity to the effects of dry treatment, teat dipping, separate dry cow rations and cow grouping on production. Annual production increased from 250 kg per cow for herds using one practice to 887 kg for herds using all four.

Several studies (6, 11, 12, 19) have looked at the effects of age of first calving (AGECALV). Gill and Allaire (12) reported that AGECALV correlated negatively with production and a profit function. They hypothesized that individual cows calving at early ages may be associated with higher relative reproductive efficiency throughout life. Lin and Allaire (19) found a linear relationship between AGECALV and average production, reporting a gain of 138 kg milk per cow in the first lactation for each one month of younger AGECALV. Bratton (6) found a quadratic relationship between AGECALV and production, with an optimal herd average

age of 29 to 30 months. Bratton also found that herds with younger average age of first calving were younger herds on the average, with heavier culling and higher production as well.

Gill and Allaire (13) found a quadratic relationship between AGECALV and production. However they identified optimal age at 25 months. Investigating the effects of days open, they found an optimum for lifetime profit at 124 days. This was 31% of total lactation days plus dry days, with lifetime profit estimated to increase $8.50 per cow for each percentage increase. The optimal percent days open was higher for production than the 31% reported for income.

Olds et al. (24) investigated the effects of days open and found with 40 to 140 days open, first calf heifers experienced a 4.5 kg milk loss per day open and older cows experienced a 8.6 kg loss per day open beyond 40.

Bratton (5) reported that average days dry was significantly negatively related to both milk sold and operator income. Gill and Allaire (13) derived the optimal number of days dry to be 42 for maximum profit.

Income over feed cost (IOFC) has been studied by several researchers (7, 21, 22). Brown and White (7) found that linear prediction models including concentrates fed, succulents fed, dry forages fed, percent days in milk, price of grain, other feed costs, price of milk, herd size, and days on pasture accurately (R^2=.99) described IOFC. McDaniel et al. (21) found that the predictive value for IOFC could be increased by adding body weight, weight gain during lactation and forage intake for individual cows. McDaniel et al. also stated that IOFC appeared to be an accurate indicator of profitability for cow culling.

Miller et al. (22) found that on a herd basis, concentrates fed was the only measure which related to IOFC. Milk yield explained about 50% of the variation in IOFC.

It has been suggested (12, 19, 21) that individual cow culling might be best accomplished through the design of a simplified profit function which would include more variables than milk production alone, but still contain less than complete information. IOFC seems to be one accurate basis for culling cows, and age of first calving also influences profit.

Several authors (9, 14, 18) have reported variability in net worth and cash flow. These studies have a size dependency associated with their financial information. Hinman and Hutton (14) noted that as equity decreased, variation in cash operating income increased. This indicates greater cash flow instability in low equity herds.

Knoblauch (17, 18) examined the effects of available cash on debt payment ability. He reported generally that equity of greater than 50% was required to avoid periods of negative residual cash. Ratio of short term to long term debt was judged to be important to repayment ability.

The calculation of a management charge (8, 27) is a difficult concept. By deducting the owner's labor and management from net cash income, a return to capital may be calculated. Burrell and Hill (8) state that "the appropriate valuation of the contribution of the inputs of a farmer and his family is that which they would receive if exactly comparable inputs were brought in from outside." Traditionally, the management charge has been considered proportional to farm size. For simplicity, this charge has often been defined as a component of the percentage return to capital. The return used in this study of 10% on invested capital includes the effect of inflation. In the past ten years capital gains on farm land (unrealized) have exceeded net farm income (26). Inflation cannot be ignored, but there are many possibilities for calculating and interpreting it. Due to factors such as risk, an appropriate rate of return may be quite subjective. It may be appropriate to add land value increases to profit as appreciation, or charge a rate of 2-3% on invested capital which would be discounted for inflation and equivalent to the cost of borrowing money in terms of real purchasing ability (28).

Several researchers (9, 14, 17, 24) have reported the need to subjectively classify and delete data when necessary to better represent average conditions. These judgements must be made in a reasonable manner on the strength of evidence and prior information. Deletion of data risks being a manipulation of conclusions.

PROCEDURES

A personal interview was used to obtain the detailed management and financial records desired. It provided a means of insuring survey completion as well as providing uniformity, as questions would not be misinterpreted if the interviewer could clarify ambiguities. The survey was designed to provide information about the physical plant of the dairy, management practices, and financial information not available from other sources. The information collected during the survey is in Appendix II, items 1 to 124.

To sample a reasonable number of farms without exceeding time and financial constraints, the geographical area of the survey was limited. By choosing four counties which are dairy-oriented and easily accessible, it was possible to select from a population of 270 of the state's 918 DHI herds. These counties included Rockingham, Augusta, Franklin, and Bedford. Herds were grouped by size and production categories of 10th to 30th percentile, 40th to 60th percentile and 70th to 90th percentile. This categorization is illustrated in Figure 1.

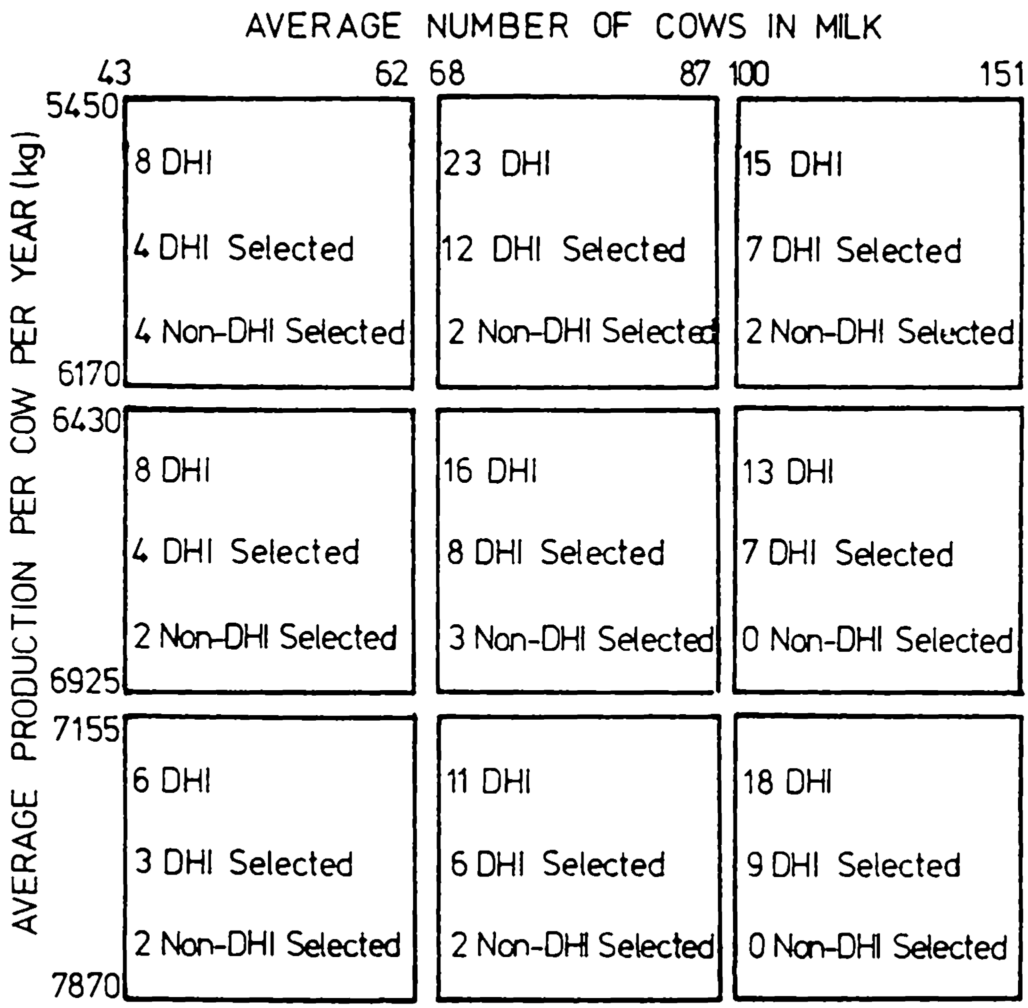

Figure 1: Number of herds by size and production percentiles.

After selecting those herds which fit the size by production categories, 118 herds remained in the sample. These herds were randomized within category and half of each group was selected. The final sample group then contained 60 randomly chosen herds in a 4-county area and 58 alternate herds, to be surveyed only if some of the 60 declined. To compare DHI and non-DHI herds, two non-DHI herds were interviewed from each category. These herds were chosen by the county agent in each county to approximate the size and production categories. Herds could not be found to approximate two of the categories (see Figure 1). This sampling of non-DHI herds was not necessarily random.

Once the samples were chosen, letters were sent to each DHI herd explaining the survey and the chance they might be contacted (see Appendix III for a copy of this letter). The letters were mailed to herds in one county at a time so that receipt would not precede the personal contact with the interviewer by more than a week. Personal contact was made with the farms by telephone approximately a week after the letters were sent. Appointments were set and directions to the farm noted. Non-DHI herds were also contacted at this time, and the study was explained to them over the phone.

Each dairy was visited personally and the survey was answered by either the owner or farm manager. The interviewer asked the questions, clarified misunderstandings, and recorded responses. While the dairyman discussed the survey, the interviewer was able to screen and verify questionable answers. Each survey took one to two hours, and all were completed between November 1980 and January 1981.

Letters of appreciation were sent to all farmers interviewed (see Appendix IV) and to the alternates not interviewed (see Appendix V). After an initial analysis of data was completed, another letter was sent to all of the involved dairymen to maintain contact and demonstrate the utility of the data they provided (see Appendix VI for a copy of this letter). At the conclusion of all surveys, data were summarized and merged with the November 1980 DHI records obtained for each farm from the Dairy Records Processing Center, Raleigh, NC. The non-DHI herds were surveyed for additional information regarding production, mastitis and size. The average number of cows reported in milk was used as the size of the non-DHI herds. Production values for these herds was computed as follows for purposes of comparison to DHI herds.

Rolling Herd Average =

$$\frac{\text{lbs. of milk shipped per day} \times 365}{\text{total no. of cows}}$$

Since DHI mastitis scores were not available for the non-DHI herds, their average somatic cell counts as determined from producer slips were recorded, or if only a WMT score was available, this was converted according to the following legend (14). Butterfat percentages were also determined from producer slips.

WMT Score	Somatic Cell Count
0 - 6	0 - 200,000
7 - 12	200,000 - 400,000
13 - 17	400,000 - 750,000
18 - 21	750,000 - 1,000,000

The financial effects of different management regimes were defined by four measures of profitability.

Net Cash Income (NTCSHINC) - this is milk sold plus beef sales plus dairy sales plus miscellaneous income, minus all cash expenses except income taxes. Interest is a cash expense, while principal payments are not.

Profit (PROFIT) - this is NTCSHINC plus changes in inventories of livestock, feed, land, buildings, machinery, and equipment, minus depreciation of 12.5% on the machinery inventory (8 years, straight-line), minus depreciation of 1.2% on the land and buildings. Since land is not depreciable, this is approximately 5% depreciation on the buildings or 20 years straight-line depreciation.

Real Profit (REALPROF) - this is PROFIT with the cash interest expense added back, minus a charge of 10% of all invested capital (including equity), minus $15,000 per year for family living expenses. This is the most complete financial measure as it compares the profitability of the dairy operation to an opportunity cost for the capital invested in the operation. A positive REALPROF indicates a rate of return on investment exceeding 10% per year. Inflation has some effect on this as has been discussed.

Cash Available (CASHAVAL) - this is NTCSHINC, minus the cash principal payment and $15,000 family living expenses. The total is multiplied by .80 for risk and uncertainty. It measures cash available for additional investment.

The definitions of other variables may be found by locating the variable in the alphabetic list in Appendix I, and cross-referencing to Appendix II.

Budgeted and realized expenses for conducting the survey are in Table 1. Expenses were close to those budgeted; $17 per herd.

The data are described in the next section, Characteristics of Data. The characteristics described are grouped into six separate sections and the results of analyses of variance are also grouped in this manner. The sections are:

Table 1. Budgeted and realized expenses for survey.

	Amount budgeted	Amount spent
Accomodations	$400	$350
Meals	$250	$280
Postage	$ 50	$ 45
Telephone	$100	$ 50
Transportation	$500	$570
Total	$1300	$1295
Per Herd	$ 17	$ 17

1. Milking Systems and Practices
2. Reproduction and Genetics
3. Feeding Practices
4. Calf Raising Practices
5. Financial Information
6. DHI Information

ADJUSTMENTS TO DATA

In some instances, the raw form of data collected was not suitable to correlation and regression analysis. Some continuous variables were classified discretely for analytical purposes. These class variables include STAL, UNITS, CVD, CLD, CVHP and STALUNIT, fully described in the appendices. Other variables had to be changed so that the numeric value assigned would be meaningful in more than a descriptive sense. For example, STORAGE describes the type of storage used for ensiled feeds. There are eight possible responses, but only three major storage types. To compare these storage types and their combinations, a ranking was needed to differentiate them on the basis of annual cost of ownership. Bunker silos at the lowest annual cost were assigned a value of 1, oxygen-limiting units at the highest annual cost of ownership were assigned a value of 3 and combinations were assigned intermediate values. Several other variables were treated in this manner and the changes are listed in Figure 2.

Old Coding				Adjusted Coding
If STORAGE	=	4	it was changed to	1.5
		5		2.0
		6		2.5
		7		2.0
		8		1.0
If HEATDET	=	1	it was changed to	2.0
		2		1.0
		3		0.5
		4		1.5
If BREEDWHO	=	2	it was changed to	1.0
		3		2.0
		4		2.0
		5		1.0
		6		1.5
If BREDWHEN	=	2	it was changed to	1.0
		3		2.0
		4		1.0
		5		1.0
If PREGCHEX	=	2	it was changed to	1.0
		3		2.0
		4		3.0
		5		1.5
		6		1.5
		7		1.5
If MILKHOW	=	2	it was changed to	0.5
If COLOSTOR	=	3	it was changed to	1.5
	>	4		2.5
If CROPS	=	4	it was changed to	3.0
		5		2.0
		6		deleted
		7		deleted
		8		3.0
		9		3.0
If MIXRATN	>	1	it was changed to	1
If CALFAL2	=	2	it was changed to	1
		4		3
	>	6		deleted
If VET	=	0	it was changed to	deleted
If NUMBSTUD	=	0	it was changed to	deleted

Figure 2: Recoding of classified survey variables.

CHARACTERISTICS OF DATA

Milking

To understand these data it is necessary to describe the variables and investigate their underlying relationships. An alphabetic list of variable names is in Appendix I, and a description of each variable may be found in Appendix II.

All but two of the herds in the survey milked twice a day. These herds averaged an 11 hour interval between morning and evening milkings and 13 hours during the night. The milking systems averaged 9.0 stalls, 5.8 milking units, and 1.7 persons milking. The average number of cows milked per hour was 37. Forty-seven percent of the herds received Fossomatic somatic cell count (FOM) scores.

Three brands of milking systems comprised 95% of the surveyed herds, with DeLaval dominating at 64%. Fifteen percent of the herds were milked in flatbarns, 50% in side-opening parlors, 33% in herringbone parlors and one herd in a rotary parlor. Twenty-six percent had contracted for routine check-up and servicing of the milking system.

Sixty-two percent used individual paper towels to dry udders, while 29% used a common cloth towel. Twenty percent did not dip teats; the remaining group was split equally between the use of iodine-based teatdips and lanolin/glycerin-based products. Three herds in the survey used some variation of bleach as a teatdip. Forty percent of the herds did not clean teat ends with a sterile alcohol pad prior to intramammary infusions.

Thirty-three percent of the herds milked cows last with clinical mastitis, while the remainder of the herds milked these cows when they randomly arrived and then rinsed the milking unit before attaching it to the next cow. Seventy-three percent of the herds dry treated every milking animal, 19% selectively treated cows with past histories of mastitic inflammation, and 8% did not use any dry treatment.

Correlations were used initially to identify and measure relationships between variables. These relationships provide interesting information, but because they are measured independently from other factors, they are not as meaningful as regression analysis.

GOODPRAC is a count of six recommended milking management practices. The components of GOODPRAC are in Table 2 and were associated with AVGPROD and MASTALL, although significance was infrequent. GOODPRAC does relate positively

Table 2. Correlations between components of GOODPRAC and AVGPROD and MASTALL.

	TOWELS	STRIP	ALCPADS	VACOFF	DRYTRTMT
AVGPROD	.05	.13	.13	.02	.06
MASTALL	-.11	-.07	.10	.01	-.30[3]
TEATDIP	.36[1]	.13	.31[1]	.11	.32[1]
TOWELS		.03	.31[1]	.06	.28[2]
STRIP			.12	-.05	.31[1]
ALCPADS				.06	.27[2]
VACOFF					-.08

[1]Significantly different from zero (p < .01)

[2]Significantly different from zero (p < .05)

[3]Significantly different from zero (p < .10)

to AVGPROD as will be discussed later and seen in Table 3. Use of towels, teat dip, and alcohol pads generally occurred together. Dry treatment was positively related to all GOODPRAC variables except VACOFF. Dry treatment had no correlation with AVGPROD, but was associated with a decrease in mastitis. The hours of use an inflation received before replacement was highly negatively related to AVGPROD, but not to MASTALL (Table 3).

Many of the measurements made of milking systems showed relationships between the age of the system, milk line diameter, vacuum line diameter, number of milking units, vacuum pump horsepower, type of parlor, number of people milking and number of milking stalls. Most of these relationships were related as expected. For example, we find a larger number of milking stalls was associated with a larger number of milking units, a larger vacuum pump, larger milk and vacuum lines and more people milking. Chi square tests of independence are listed in Table 4 as field verification of normal logic.

Table 3. Correlations of inflation usage with MASTALL and AVGPROD.

	MASTALL	AVGPROD	HRSINFL
GOODPRAC	.11	.23[2]	-.01
MASTALL		-.07	.14
AVGPROD			-.29[1]

[1]Significantly different from zero ($p < .02$)

[2]Significantly different from zero ($p < .10$)

Table 4. Probabilities of larger chi squares testing independence of milking system variables.

Combination	Prob of > chi square[1]
CVD x NUMBSTAL	.0200
CVD x NUMBUNIT	.0001
CVHP x NUMBSTAL	.1300
CVHP x NUMBUNIT	.0001
CLD x NUMBUNIT	.0003
SYSTAGE x NUMBSTAL	.0020
SYSTAGE x NUMBUNIT	.0006
NUMBPERS x NUMBSTAL	.0400
NUMBPERS x NUMBUNIT	.0700
CVHP x CVD	.0001
CVHP x CLD	.0200
CVHP x SYSTAGE	.0002
CVHP x STALUNIT	.0006
CVHP x TYPEPARL	.0005
CVD x CLD	.0006
CVD x SYSTAGE	.0001
CVD x STALUNIT	.0700
CLD x SYSTAGE	.0001
CLD x STALUNIT	.0040
SYSTAGE x STALUNIT	.0300
SYSTAGE x TYPEPARL	.0001
NUMBPERS x TYPEPARL	.0030
NUMBPERS x STALUNIT	.0100

[1]Probabilities < .05 indicate variables were not independent.

Reproduction and Genetics

The most important aspect of a dairy breeding program is the use of artificial insemination. The herds in the survey bred an average of 87% of the milking cows and 47% of their heifers artificially. Eight percent of the herds bred all of the cows to a bull, while 36% bred all of their heifers to a bull. Thirty percent of the dairies surveyed did not maintain a breeding bull, and an additional 24% (54% total) did not use bulls for breeding cows in the milking herd.

Approximately half the herds had a technician inseminate cows and the other half had the owner or herdsman inseminate. Seventy-three percent of the herds bred cows twice a day (after each milking), 15% bred once a day at a regularly scheduled time, and the remainder bred whenever convenient. The surveyed herds observed cows for heat an average of three times per day with 2, 3 and 4 times per day predominating at 42%, 24%, and 20%. Eighty-two percent of the herds did the majority of heat detection while the cows were on a dirt surface even though 46% had some portion of their concrete barnyard grooved to reduce cow slippage.

Forty-five percent of the herds began breeding cows back by forty-five days post-partum while 30% waited until 60 or more days post-partum before breeding a cow. Only 54%

of the herds surveyed kept written records of heat dates. Sixty-five percent of the dairymen used some type of heat detection aid, with the K-Mar bubble marker most popular representing 55% of the heat detection aids. About 30% of the herds using detection aids utilized either chalk on the tail-head or a combination of chalk and the K-Mar detectors.

Seventy-five percent of the herds purchased all of their semen from one A.I. organization and only 8% bought from three or more studs. Twenty-seven percent of the herds used six or fewer bulls per year and only 10% used more than twelve bulls. On the average, 8.8 bulls were used per year. Fifty percent of the dairymen would not use semen from unproven or low-repeatability (less than 50%) bulls, although 65% stated that they would use a bull with no predicted difference for type (PDT) if his production proof satisfied their criterion. Type traits which dairymen felt needed the most selection for improvement in their own herds were, in order of frequency, feet, hind legs, and udder support.

Sixteen percent of the cows in the survey were registered. Registered herds tended to be newer and larger operations with higher sales of dairy cattle and higher sales of beef (culls and bulls). Registered herds also tended to breed a greater percentage of heifers artificially, 77% versus 42%. The registered herds were also associated with higher labor costs, greater investments in land, buildings and livestock and a larger total debt. These differences may be related to size, however. Registered herds were negatively related to all four measures of profitability, however none of these differences was significant. A comparison of some differences between registered and commercial operations may be found in Table 5.

Many of the differences were expected. Registered breeders bought semen from a greater number of studs, used more bulls per year, fewer young bulls (low repeatability) and few of them would use a bull without a calculated Predicted Difference for Type (PDT).

Registered herds also had a much higher percentage of mastitis, 21.6% versus 13.0%. The cause of this difference is not known and is unexpected given the negative relationship of mastitis to higher production, younger age, higher culling rates and a larger GOODPRAC score found in the registered herds.

Registered herds were younger, calved earlier as first calf heifers, and had lower calf mortality. However, registered herds had a lower ratio of replacements (RATIO), which may be due to somewhat longer lactations in these herds, evidenced by increased days open and days dry. They may also have sold some heifers.

Table 5. Differences between registered and commercial operations.

Variable	Herds < 50% Registered (N = 63)	Herds > 50% Registered (N = 11)
PCTREG	5.7%	77.3%
AVGNUMB	82	91
AVGPROD	6,526 kg	6,773 kg
AICOWS	88%	86%
AIHEIFER	42%	77%
NUMBSTUD	1.2	2.0
NUMBBULL	8.4	10.9
PCTYGBLS	10.5%	6.5%
NOPDTBLS	68%	54%
BRDBACK	49.8	49.1
DAYSOPEN	120	122
DAYSDRY	63	65
AVGAGE	52.2	50.6
AGECALV	29.7	28.7
TOTCULL	25.7%	29.8%
MASTALL	13.0%	21.6%
GOODPRAC	5.7	6.3
RATIO	.86	.76
MORTALTY	12.5%	10.5%
PCTEQUIT	74.3%	69.0%
LDBLDG	360,350	530,909
MACHEQP	101,983	113,181
LIVSTOCK	143,295	203,182
CAPITAL	606,350	847,273
INVESTPC	7,417	8,418
TOTDEBT	136,633	212,222
DEBTPC	1,666	2,332
LABOR	9,818	17,682
PRCHFDPC	520	521
LENGTH	7.1	5.8
NTCSHINC	60,012	63,660
NTCSHIPC	754	671
PROFITPC	823	673
REALPRPC	-42	-207
CASHAVPC	314	216

Registered herds had much larger capital assets, total debt and investment per cow than commercial herds and fared less favorably on all four measures of profitability.

Table 6 illustrates a positive relationship between the number of heat observations per day (HEATOBS) and the involvement of the owner in heat detection (HEATDET). There was also a strong positive association between HEATDET and use of a technician (BREEDWHO). This would indicate that attention to the breeding program is seen in several ways within farms. There were no significant relations, however, with SUCCESS or AVGPROD and BREEDWHO.

The use of grooving in barn areas is believed to reduce cow slippage and aid in heat detection and conception. Grooves were positively associated with both herd size (AVGNUMB) and HEATOBS, but not percentage of successful breedings. As seen elsewhere, however, an increase in heat detection observations was associated with lower breeding success.

Table 6. Correlations between breeding variables.

	HEATOBS	BREEDWHO	SUCCESS	GROOVES	AVGPROD
AVGNUMB	.06	-.09	.08	.36[1]	-.01
HEATDET	.31[1]	.35[1]	.00	-.02	.11
HEATOBS		.04	-.09	.22[2]	.06
BREEDWHO			-.02	-.18	.20[3]
SUCCESS				.04	-.11
GROOVES					.06

[1]Significantly different from zero ($p < .01$)

[2]Significantly different from zero ($p < .06$)

[3]Significantly different from zero ($p < .10$)

Feeding

Variables in feed management include storage, manner of feeding, types of rations, use of feed analysis, magnet feeders, minerals and by-product feeds. Since feed cost is the largest single expense on a dairy it ought to be a major factor in determining profitability.

Sixty-three percent of the farms in the survey fed the forage and grain portions of the ration separately. Of the remaining percentage, slightly over half (54%) fed a blended ration which had grain metered in with the forage, but not weighed. The remainder fed a ration mixed in a feed wagon with scales.

All but 6% of the farmers had their forages analyzed at least once a year. The herds surveyed fed an average of 2.5 times per day with 65% of the herds feeding twice a day. Seventy-five percent of the herds grouped their cows as milking and dry cows, 16% did not separate dry cows and 9% had two milking groups for feeding.

Eighty-three percent of the farms surveyed had outside consultation on the feed formulation for the herd, 14% did not balance their rations, and the remainder formulated rations themselves. Ninety-six percent of the farms fed minerals with the ration, and 43% fed additional supplements such as sodium bicarbonate. Twenty-five percent of the herds used magnetic feeders.

Rations based on corn silage were fed by 71% of the herds. Twelve percent used a haylage based ration, and the remainder fed a large amount of dry hay along with corn silage as the forage dry matter. Twelve percent of the dairies fed by-products such as brewer's grains but only two herds utilized these products as a major component (more than 60%) of their concentrate. Many of the farms visited had religious beliefs which prevented the use of by-product feeds. Eighteen percent of the farms fed high moisture grain, 13% using it as the major component of the concentrate mix.

Correlation coefficients provide interesting information and many of these results are summarized in Table 7. Many are similar to expected. When cows were fed more purchased grain, their production and hence milk sold increased and accordingly the net cash income increased. There was no relationship, however, between purchased grain and net cash income per cow. The use of supplements such as sodium bicarbonate is thought to maintain butterfat test during heavy lactation and thus be positively correlated with AVGPROD and SALEMKPC. We also expect to find its use associated with increased grain feeding (PRCHFDPC). What is interesting is that while we expect to find use of supplements associated with high production, it is also expected

Table 7. Correlations between feeding variables.

	PRCHFDPC	SUPPLEM	SALEMKPC	HMGRAIN	NTCSHIPC
AVGPROD	.30[2]	.27[2]	.28[2]	-.07	.16
PRCHFDPC		.21[3]	.83[1]	-.06	.01
SUPPLEM			.26[2]	-.04	.06
SALEMKPC				.20[3]	.38[1]
HMGRAIN					.27[2]

[1]Significantly different from zero (p < .001)

[2]Significantly different from zero (p < .02)

[3]Significantly different from zero (p < .10)

that their use is correlated with lower butterfat percentages. This, however, does not occur among the survey herds. The feeding of high moisture grains was positively associated with milk sold per cow (dollars) and net cash income per cow, but not with herd average production.

Many logical correlations can also be observed. For example, farms feeding rations high in dry hay tended not to use hay silage in rations. Also, farms with corn silage rations fed hay silage infrequently. Herds which used high moisture grain and used oxygen limiting storage tended not to feed in the parlor. Dairies which fed a total mixed ration (TMR) grouped the milking herd and did not feed in the parlor. The correlations between the survey data and the DHI data regarding milk sold, total feed cost and income over feed cost agree moderately well with one another (Table 8).

Calf Raising

The majority of calves (62%) in this survey were housed in unheated individual pens in a building. Fourteen percent of the farms raised calves in hutches. Seventy-five percent of the dairies first fed colostrum to newborn calves after the first scheduled milking post-partum. Only 8% of the farms routinely fed colostrum in the first hour of life,

Table 8. Correlations between selected survey and DHI variables.

	MKSOLDPC*	YRIOFC*	MYIOFC	YRAVGTOT*	TOTFDPC
SALEMKPC	.35[1]	.33[1]	.67[1]	.14	.46[1]
MKSOLDPC*		.86[1]	.26[2]	.30[2]	.11
YRIOFC*			.35[1]	.19	-.01
MYIOFC				-.09	-.34[1]
YRAVGTOT*					.26[2]
AVGPROD	.95[1]	.78[1]	.30[2]	.32[2]	.24[2]

*DHI measure

[1]Significantly different from zero ($p < .01$)

[2]Significantly different from zero ($p < .05$)

although most allowed the calf to remain with the dam until the scheduled milking. This allows unsupervised suckling by the calf. All of the farms surveyed fed colostrum for at least two days, but only 19% fed colostrum beyond five days. Seventy-five percent fed the colostrum fresh, and the remainder either fermented or froze the colostrum. At birth of a calf, 47% of the dairies provided no preventative care for the calf. Of the remainder, most dipped the calf navel cord in iodine, and some used anti-scour vaccines and vitamin shots at birth.

Thirty-seven percent of the herds fed whole milk to their calves, 47% fed a milk-protein replacer, and the remainder fed either a vegetable protein milk replacer or a combination of items. Sixty-five percent of the farms fed calves with a nipple and the remainder had calves drink milk from a pail, generally by one week of age or earlier. Thirty-seven percent of the herds fed some of their withheld mastitic or antibiotic milk to calves.

Calves were raised in groups after weaning on all farms and these groups averaged 9.0 calves. Weaning age averaged 7.5 weeks.

Reported mortality on all live-born calves averaged 12.2% through freshening. During the survey process it was noted that many dairymen forget they were only raising half of the animals born. A dairyman with 80 cows would have about 100 calves born per year. He would raise 50 heifers and sell 50 bull calves. If 5 heifers die, mortality is 10%. A dairyman thinking of 100 calvings and 5 deaths may report 5%. Clarification of this point was made during several interviews.

The farms had an average of .85 heifers (newborns through springing heifers) for every cow in the milking herd. As can be seen in Table 9, RATIO, this measure of herd replacements, was correlated with AVGPROD, which was negatively related to the average age at first calving (AGECALV). This would indicate that having more available replacements was associated with a younger age of first calving, although this direct relationship was not significant. RATIO was significantly correlated with MORTALTY, which verifies that as the rate of calf mortality increases, the number of heifers decreases relative to the number of milking cows. NTCSHIPC was also seen to be related to RATIO. This is logical as NTCSHIPC was tied to AVGPROD, although the relationship was not statistically significant.

The relationship of MILKHOW and AVGNUMB indicates an association between increasing herd size and changing from nipple-feeding to pail-feeding calves.

Table 9. Correlations between selected calf raising variables.

	AVGNUMB	RATIO	AGECALV	MILKHOW	MORTALTY	NTCSHIPC
AVGPROD	-.01	.30[1]	-.30[2]	.11	-.18	.16
AVGNUMB		-.10	-.14	-.21[3]	.01	.19
RATIO			.20	.13	-.28[2]	.22[3]
AGECALV				-.15	.10	-.04
MILKHOW					.05	.09
MORTALTY						-.05

[1]Significantly different from zero ($p < .01$)

[2]Significantly different from zero ($p < .05$)

[3]Significantly different from zero ($p < .10$)

Financial

The average dairy in the survey had been operating approximately 14 years and owned 40,500 kg of monthly milk marketing base. About 38% of this base was issued by the Virginia State Milk Commission and the remainder by the milk marketing cooperative.

Fourteen percent had refinanced during the year preceding the survey and 35% used a short-term operating loan during this time period. The average values for the financial information are most interesting and can be found in Table 10. When possible, the totals NETINC and NETEXP were compared with figures from IRS Schedule F or Virginia Agribusiness Management Association (VAMA) reports. These figures were within two percent of one another in those instances when compared. Most of the individual income and expense items correlated highly with one another due to their size dependency.

A comparison of the surveyed herds to the averages for 75 Grade A dairies that were members of VAMA in 1980 (10) shows that the per cow net incomes are almost identical (VAMA herds were $13 higher), but there were major differences in expenses, investments and equity position. The VAMA herds spent $507 more per cow. These higher expenses were mainly in labor, purchased feed, taxes, insurance and

Table 10. Means and standard deviations of major financial variables.[1]

VARIABLE	MEAN	S.D.
SALEMILK	$ 145,412	$ 84,004
SALEMKPC	1,759	282
BEEF	14,436	17,919
DAIRY	2,897	7,619
MISCINC	4,151	23,796
NETINC	168,035	114,722
PURCHFD	43,352	30,241
PRCHFDPC	520	202
PRODCOST	18,561	16,109
TOTFDPC	746	224
VETEXP	2,328	2,315
LABOR	11,036	15,521
INTPYMT	11,023	18,424
MISCEXP	7,428	6,797
ENERGEXP	9,014	11,722
RENTS	4,003	6,676
NETEXP	106,572	93,410
NTCSHINC	60,540	40,299
LDBLDG	386,774	374,829
MACHEQP	103,718	101,836
LIVSTOCK	152,445	103,359
CAPITAL	643,677	540,518
INVESTPC	7,574	3,427
PCTEQUIT	73%	19%
EQUITYPC	5,815	3,234
PRINCPMT	12,151	18,211
INVLVSTK	6,194	18,629
INVFEED	-8,000	14,129
INVLDBLDG	13,854	39,790
TOTDEBT	148,362	154,716
PCTCDEBT	6.4%	19%
PCTIDEBT	49.2%	48%
PCTLTDET	44.4%	46%
AVGINTRT	9.6%	5.6%
NTCSHIPC	742	348
PROFITPC	801	689
REALPRPC	-66	809
CASHAVPC	300	338

[1]Definitions in Appendix II, PC indicates per cow.

miscellaneous expenses. It is possible that VAMA herds have considerably less family labor than the herds in this survey. VAMA records reported an average of 3.95 full-time employees and reported $130 per cow more labor expense than surveyed herds. Survey herds averaged a total of 2.70 employees, when the manager and family labor was included and five parttime employees were equivalent to one fulltime employee. Survey herds averaged 205,240 kg milk sold per man and 31 milking cows per man.

While VAMA herds spent $125 more for purchased feed per cow, they also had investments in land which were $1500 less per cow than the surveyed herds. It is possible that the VAMA herds had less land and grew a smaller percentage of their feed. However, the surveyed herds had feed production costs only $30 higher per cow than the VAMA farms.

Differences in taxes and insurance may be somewhat influenced by several of the farms in the survey being members of a religious community which did not believe in insurance and in some instances purchased land for church members. The tax consequences of church involvement in land holdings is not known.

The VAMA herds paid more interest per cow, had $300 higher debt per cow, and an average equity of 64% versus 77% for the surveyed herds. Investments in livestock were the same. VAMA herds had less land investment and much less machinery and equipment ($665 less per cow). VAMA herds milked 25 more cows. The total investment per cow was approximately $2200 less in VAMA herds than the surveyed herds. VAMA herds had considerably more non-cash income than the surveyed herds in the form of increases in inventory.

As seen in Table 11, as the number of cows increased there was no effect on production but NTCSHINC, INTPYMT, and PRINCPMT increased. Note that these are not per cow. None of these financial measures was related to AVGPROD. The strong relationship between INTPYMT and PRINCPMT demonstrates repayment (retirement) of debt is accompanied by payment of interest. The negative relationship between INTPYMT and PCTEQUIT is also very logical, for as equity grows, the amount of borrowed capital and associated cash interest charges are necessarily reduced. PCTEQUIT and LENGTH were very positively related, as one would expect both debt retirement and asset appreciation to increase percent equity over time.

Table 12 illustrates the high degree of agreement between all measures of profit. It is interesting to note that while the total amount of capital was positively correlated to NTCSHINC, PROFIT and CASHAVAL, when a charge was

Table 11. Correlations between major financial variables.

	AVGPROD	NTCSHINC	INTPYMT	PRINCPMT	PCTEQUIT	LENGTH
AVGNUMB	.01	.76[1]	.20[3]	.31[1]	.17	.10
AVGPROD		.14	.05	-.06	.17	.15
NTCSHINC			.22[3]	.26[2]	.29[2]	.34[1]
INTPYMT				.55[1]	-.22[3]	-.06
PRINCPMT					-.12	-.13
PCTEQUIT						.51[1]

[1]Significantly different from zero ($p < .01$)

[2]Significantly different from zero ($p < .05$)

[3]Significantly different from zero ($p < .10$)

Table 12. Correlations between profit measures, production and invested capital.

	PROFIT	REALPROF	CASHAVAL	CAPITAL	AVGPROD
NTCSHINC	.70[1]	.39[1]	.89[1]	.52[1]	.08
PROFIT		.84[1]	.58[1]	.28[1]	-.11
REALPROF			.37[1]	-.26[2]	-.19
CASHAVAL				.27[2]	.10
CAPITAL					.10

[1]Significantly different from zero ($p < .01$)

[2]Significantly different from zero ($p < .05$)

made for owning this capital (opportunity cost), REALPROF was not dependent on the amount of invested capital. AVGPROD was not related to any of the profit measures. The two cash measures, NTCSHINC and CASHAVAL, were highly correlated as were the two profit measures.

On a per cow basis (Table 13) there is still a very high degree of relationship between the profit measures. As expected, as average interest rate (AVGINTRT) increased, the profitability of the farm decreased, but this trend was significant only for CASHAVPC. As INVESTPC increased the two cash flow measures were not significantly affected, but the two profit measures decreased. PROFITPC was negatively affected by large INVESTPC due to greater depreciation associated with a larger investment. REALPRPC was affected much more than PROFITPC because the interest on investment additionally reduced REALPRPC as INVESTPC increased.

Also of interest is the response seen to changes in EQUITYPC. Neither NTCSHIPC, PROFITPC or CASHAVALPC were significantly correlated with EQUITYPC. However, when an interest charge on all capital, including equity, was deducted from the profitability measure (REALPROF), the trend was reversed to a significantly negative relationship.

Once again, while the dairy may have a satisfactory cash flow, the cost of owning farm assets did not compete

Table 13. Correlations between per cow profit measures and selected variables.

	PROFITPC	REALPRPC	CASHAVPC	AVGINTRT	EQUITYPC	INVESTPC
NTCSHIPC	.57[1]	.47[1]	.92[1]	-.18	.10[2]	.01
PROFITPC		.90[1]	.52[1]	-.18	.12[2]	-.12
REALPRPC			.41[1]	-.14	-.50[1]	-.50[1]
CASHAVPC				-.26[2]	.08	-.06
AVGINTRT					.05	-.06
EQUITYPC						.93[1]

[1]Significantly different from zero ($p < .0001$)

[2]Significantly different from zero ($p < .05$)

favorably with the opportunity cost of the capital invested in the dairy operation. Inflation of land values has traditionally provided compensation for this deficit. The financial institutions apparently recognize this situation as there was a correlation of .93 between INVESTPC and EQUITYPC, which means as the investment per cow increased so did the equity per cow. The institutions are not financing operations to high levels of investment per cow. Rather, the farmer is re-investing in his operation or gaining equity through inflation.

Dairy Herd Improvement Information

The DHI information was used to investigate relationships between the survey data and production measurements. DHI data were from the December herd summaries provided by the Dairy Records Processing Center, Raleigh, NC. This coincides as closely as possible to the date of the survey, and the year average variables represent the same time period as surveyed.

The surveyed herds averaged 83 cows producing 6511 kg of milk and 239 kg of fat per year. Sampling stratification for production and size has excluded extremes. The means for the DHIA variables are in Table 14. The variable names are interpreted in Appendix II, items 125 to 168.

Table 14. Means and standard deviations for DHI variables.[1]

VARIABLE	MEAN	S.D.
AVGNUMB	83	46
CONC ($/d)	1.43	.40
IOFC ($/d)	2.99	.70
BLEND ($)	13.05	.70
YRBLEND ($/45 kg)	12.51	.58
AVGAGE (mo)	51.0	5.5
AGECALV (mo)	29.5	2.6
AVGPROD (kg)	6,511	1,150
SILAGLBS (kg/d)	18.5	6.4
FAT (kg/d)	.65	.08
CONCLBS (kg/d)	6.6	1.8
BTRFTPCT (%)	3.49	.17
YRAVGMLK (kg)	6,823	593
YRFAT (kg)	18,843	7,496
YRAVGFAT (kg)	239	21.9
YRBFPCT (%)	3.54	.13
SUCCESS (%)	57.7	12.1
DAYSDRY (days)	63.3	8.0
DAYSOPEN (days)	120.4	18.9
MAST2 (%)	9.6	9.4
MAST4 (%)	2.7	3.0
MAST8 (%)	2.3	3.7
MASTALL (%)	14.6	14.2
YRSILLBS (kg)	482,807	257,952
YRDRYFOR (kg)	60,617	38,215
YEARCONC (kg)	194,966	93,016
PRODVALU ($)	149,111	59,173
YRCONC ($)	36,264	16,692
YRFDCOST ($)	59,443	24,418
YRAVGTOT ($)	997	444
YRIOFC ($)	1,085	232
CULLDAIR (%)	1.7	4.2
CULLPROD (%)	7.5	11.2
CULREPRO (%)	9.4	6.4
CULLDIS (%)	5.0	4.2
CULLDIED (%)	3.0	2.2
MEHEFMLK (kg)	6,976	684
MEHEFFAT (kg)	236	26.1
MESECMLK (kg)	7,284	663
MESECFAT (kg)	243	25.5
MEALLMLK (kg)	7,193	644
MEALLFAT (kg)	242	24.8

[1]Definitions are in Appendix II.

Comparing the surveyed herds to 883 herds summarized for Virginia DHIA in 1980 (25), the surveyed herds are very similar to the state average. The surveyed herds averaged 10 fewer cows and were 127 kg lower in production, however, total feed costs were $38 less per cow and the income over feed cost per cow was only $23 less than the state average.

Table 15 associates selected DHIA variables. The total incidence of mastitis (MASTALL) did not relate to the other variables. MASTALL will be discussed in greater depth in the milking results.

The overall culling rate (TOTCULL) was negatively related to average herd age (AVGAGE). As the amount of culling increased, AVGAGE became younger. TOTCULL had a positive association with SUCCESS, probably due to increased reproductive culling (CULREPRO), which is a component of TOTCULL. Increased reproductive culling removes difficult breeders and therefore increases success. As expected, AVGAGE and SUCCESS were negatively associated, although this was not significant. Older cows bred back less successfully.

YRIOFC was very strongly associated with AVGPROD, indicating that, in general, higher production may be more profitable, even though larger feed costs might be incurred. AVGPROD and NTCSHIFC are also seen to be modestly positively

Table 15. Correlations between selected DHIA variables and net cash income per cow.

	TOTCULL	YRIOFC	AVGAGE	SUCCESS	AVGPROD	NTCSHIPC
AVGNUMB	-.05	-.41[1]	-.13	.08	-.01	.19
MASTALL	-.19	.01	.43[2]	-.04	-.07	-.06
TOTCULL		-.12	-.47[1]	.22[3]	-.13	-.03
YRIOFC			.00	-.26[2]	.73[1]	.21
AVGAGE				-.16	.13	.06
SUCCESS					.28[2]	.16
AVGPROD						.16

[1]Significantly different from zero ($p < .01$)

[2]Significantly different from zero ($p < .05$)

[3]Significantly different from zero ($p < .10$)

associated with one another. Herd size (AVGNUMB) was negatively related to YRIOFC, indicating a loss of efficiency or inability to feed cows to their individual needs in larger herds.

RESULTS

Milking

Data regarding milking systems allow a review of the types of systems used and the relationships between milking system variables, mastitis and profit measures. Differences are significant at $p \leq .10$ unless otherwise noted. Different intensities of mastitis and a combined mastitis score created from these DHI measurements showed a high degree of agreement within herds (Table 16). Regression models which used milking system variables such as line diameters, system age, vacuum pump horsepower, etc. did not significantly explain differences in percentages of mastitis or production between herds.

Regression of AVGPROD on classifications of SYSTAGE and TYPEPARL as well as linear and quadratic COWSPRHR and NUMBPERS showed type of parlor to have a major effect on production. There was little difference between farms which milked using herringbone parlors and those using side-opening parlors. The significant difference was between these two parlors and flat barns (stanchions), with herds using

Table 16. Correlations between mastitis measures.

	MAST4	MAST8	MASTALL
MAST2	.50[1]	.93[1]	.96[1]
MAST4		.46[1]	.68[1]
MAST8			.95[1]

[1]Significantly different from zero ($p < .006$).

flat barns averaging 680 kg less milk per cow per year than herds milking in parlors. Although parlor type had a significant effect on production, this difference in production did not have a significant effect on any of the profitability measures.

The type of parlor was also associated with differences in the average number of milking cows. Flatbarns were associated with the smallest herds, side opening parlors with mid-sized herds and herringbones with the largest herds. Each of these differences was significant.

The different types of parlors were also noticeably different in their labor requirements. The side opening parlors in this study usually were operated by one man, while flatbarns and herringbones required greater manpower than the side-openings. System age was also highly related to type of parlor with flatbarns being oldest, side opening parlors next oldest and herringbones newest.

The model of SYSTAGE, TYPEPARL, COWSPRHR, and NUMBPERS which affected AVGPROD also explained differences in MASTALL. TYPEPARL was most important in this model, with flatbarns having levels of mastitis 1.7 times higher than either type of parlor. These variables were confounded with others which were not included in the model. After investigating the milking system, the next consideration was the milking practices on each farm and how the combinations of practices affect production, mastitis and profits.

GOODPRAC is a count of the number of good practices used by the herd. Good practices include use of teatdip, use of paper towels for drying udders, pre-stripping each quarter, use of alcohol pads prior to intramammary infusions, release of vacuum prior to removal of milking machines and dry treatment for cows. A half point is awarded for selective dry treatment of cows and a full point for dry treatment of all milking cows.

A classification model to predict mastitis and profit measures from good practices (GOODPRAC) failed to yield any significant relationships. The regression model with linear and quadratic GOODPRAC provided an even poorer fit. AVGPROD increased an average of 246 kg per each additional good practice performed and indicates that more good practices in the milking program lead to higher production (Figure 3). A model including receipt of FOM scores as a good practice showed similar response. The receipt of FOM scores was quite important. Herds using Foss-O-Matic cell counts produced 474 kg more milk per cow and had associated advantages in profit. Net cash income per cow was $118 greater for herds receiving FOM. The only difference seen between herds receiving FOM scores and those who did not was the use of

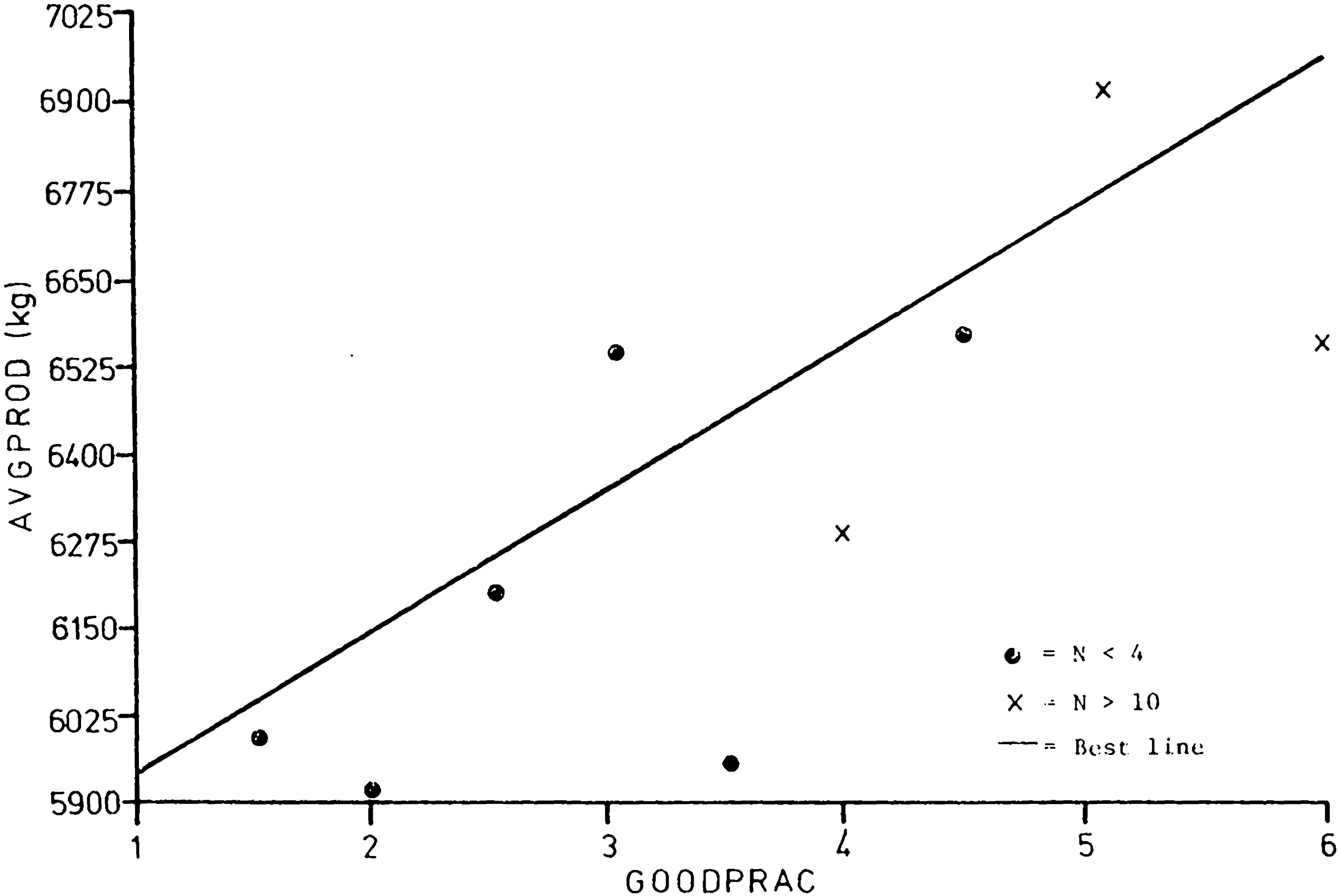

Figure 3: Effect of good milking practices (GOODPRAC) on average production (AVGPROD).

individual paper towels for udder drying (TOWELS), with herds receiving FOM scores also using individual towels. This indicates overall concern with sanitation and cell counts. Good practices were also associated with type of parlor; persons milking in flatbarns have had lower GOODPRAC scores than those in either herringbone or side-opening parlors.

One notable observation made during the survey was that while many farms decreased grain fed and number of milkings, generally for a period of 3 to 7 days prior to drying off cows, none of them reduced water intake. A cow deprived of grain can produce a substantial amount of milk from body reserves, but deprived of water for 24 hours, lactation is greatly reduced and drying off made easier. Facilities may not be especially suited to this procedure however.

The number of cows milked per hour is a measure of labor efficiency. It also holds practical consideration as a measure of time spent by cows waiting to be milked and the time spent milking the herd.

Cows milked per hour was significantly (R^2=.75) affected by combinations of ATO, TYPEPARL, STALUNIT and NUMBPERS. STALUNIT was the most important variable in determining cows milked per hour. STALUNIT is a combination of numbers of stalls and units and is described in Appendix

II, items 169 to 171. A good fit (R^2=.69) was obtained for cows milked per hour (COWSPRHR) with a model containing TYPEPARL, ATO, linear and quadratic NUMBSTAL, NUMBPERS and the products of NUMBSTAL with NUMBPERS, NUMBSTAL with TYPEPARL and NUMBPERS with TYPEPARL. The most influential component of this model was the NUMBSTAL by TYPEPARL product, which means that cows milked per hour in different milking facilities (flatbarn, herringbone, side-opening) were affected differently by changes in number of stalls. The herringbone parlor gained the most cows per hour by adding additional stalls, 3.4 more COWSPRHR than a flatbarn would achieve by adding a stall and 0.8 COWSPRHR more (p=.45) than a side-opening. Use of automatic take-offs across all facilities increased cow flow by 1.65 COWSPRHR (p=.50). Adding a second milker was estimated to slow milking by 3.8 COWSPRHR (p=.55). On the average, each additional stall increased cows milked per hour by 2.7, and as the number of stalls increased, the number of people milking also tended to increase.

Reproduction and Genetics

To evaluate reproductive efficiency, many variables were examined for their effects on days open. No significant relationships could be found between days open and variables describing use of veterinarian for pre-breeding examinations, use of pregnancy checks, time of earliest breeding back, number of observations for heat, person performing heat detection, veterinary expense per cow or use of heat detection aids. The use of any type of heat detection aid reduced days open by an average of 11 days. This decrease in days open was not related to profit or production functions.

The simultaneous influence of days open and days dry provides interesting relationships to both production and profit. Figure 4 demonstrates the relationship of average production, at constant NTCSHIPC, to days open and days dry. Production appears to be largely controlled by the number of days open. Beyond about 53 days dry, the response was not affected by increases in days dry. Differences in production between herds seem to be more dependent on the number of days open, with more production from fewer days open. Herds with fewer days open would have a longer percentage of cows in peak lactation. The number of herds found at each extreme was small, five or six herds.

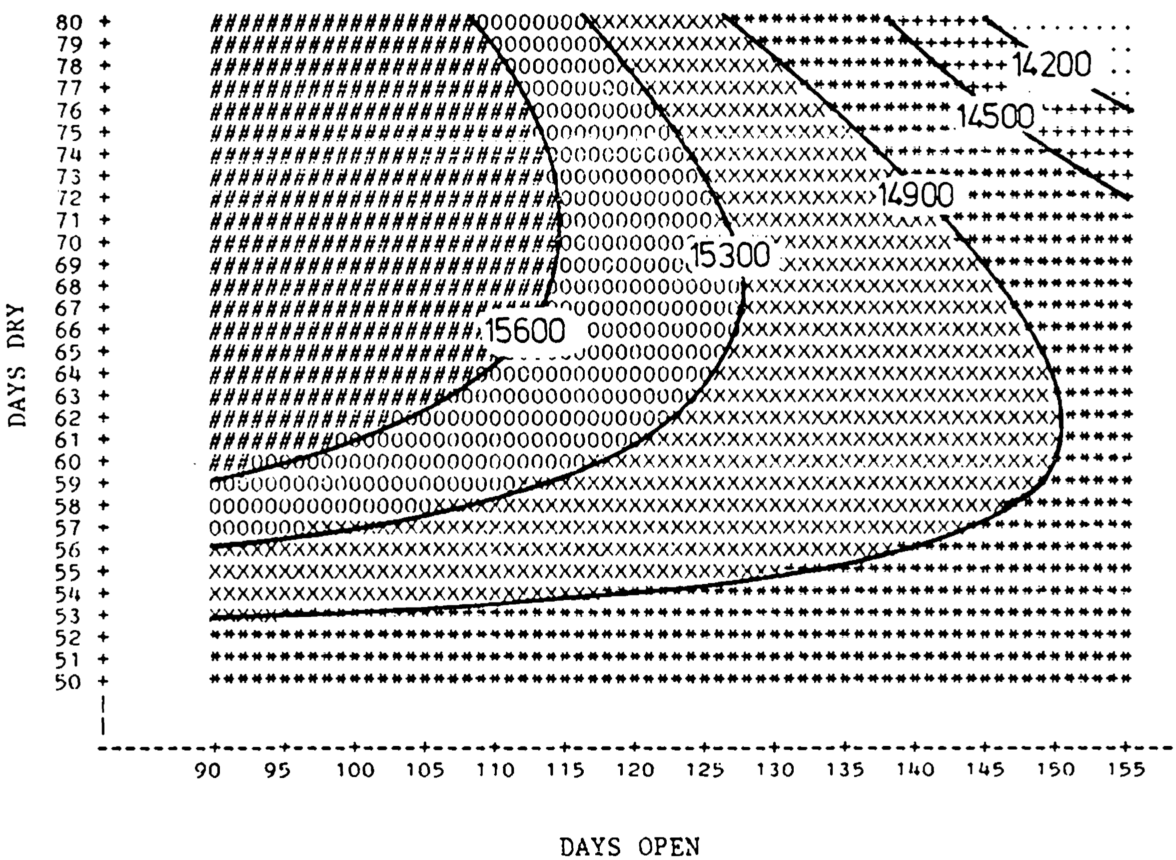

Figure 4: Relationship of days open and days dry to average production per cow (AVGPROD) with net cash income held constant.

Figure 5 illustrates the relationship of NTCSHIPC, at a constant level of production, to days open and days dry. The relationship was most strongly controlled by the number of days dry, especially above 110 days open. Below 110 days open, days dry had no influence on net income. Above 110 days open, lower days dry were more profitable. This appears to be a further indication that responses to a given situation may be quite different for production and income. While decisions must be made regarding the goal to be maximized, relationships within herds over time are probably different from relationships among herds at one point in time. It is possible that keeping days open to a minimum and increasing days dry will increase NTCSHIPC for a given herd while number of milking cows is held constant.

The success rate of conception was not related to herd production or profitability. The number of units of semen required to obtain a milking heifer can be calculated by adjusting the rate of conception for sex ratio, calf mortality, heifer steriity, and loss due to cows culled while pregnant. The formula used is in Appendix II, Item 227. Due to the potential lack of accuracy of the effects entering this variable, it was not related to production, profitability, days open or success rate. The surveyed herds required an average of 6.5 units of semen for each heifer

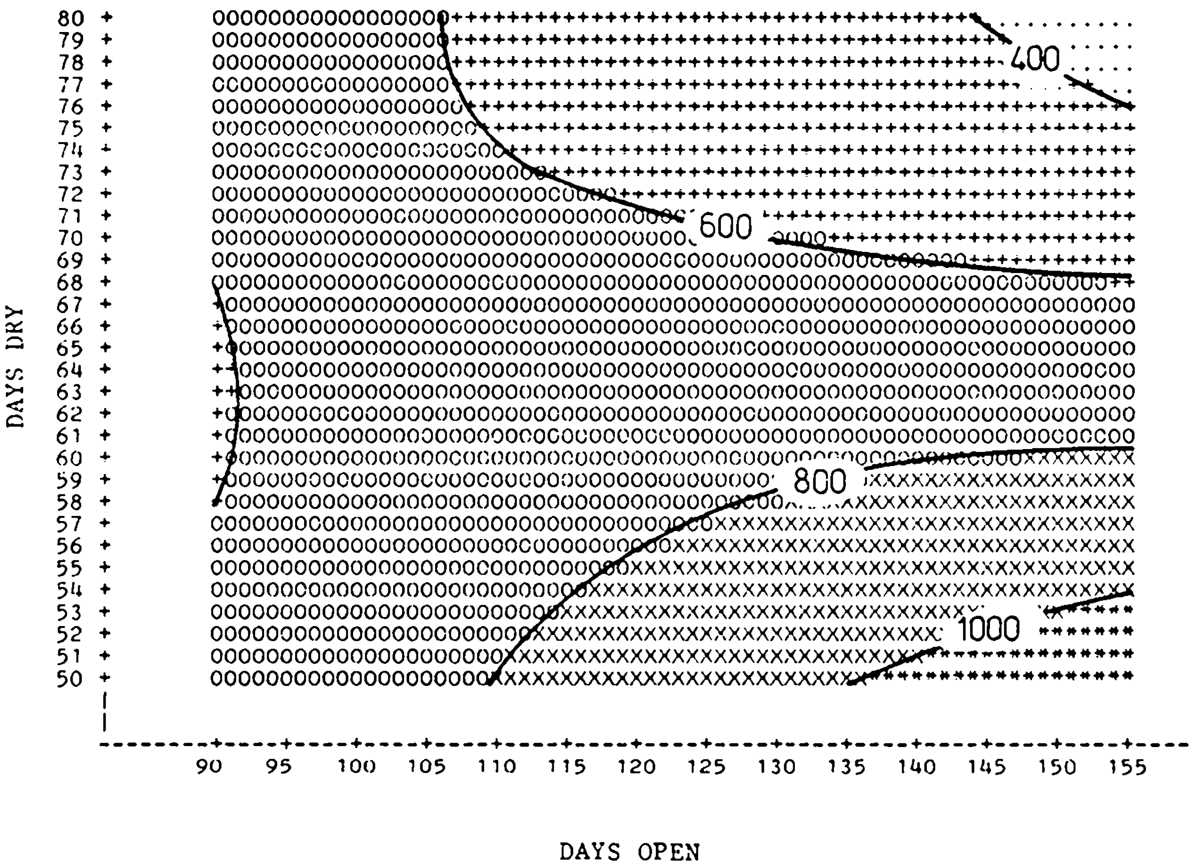

Figure 5: Relationship of days open and days dry to NTSCHIPC with production per cow held constant.

entering the milking string, with a median of 5.5 units. This distribution was not symmetric, as several herds were more than three standard deviations beyond the mean. This variable has limited meaning when not measured over several years.

The use of a veterinarian for comprehensive reproductive health programs provided a benefit of 448 kg of production and $151 of net cash income per cow over use of a veterinarian for problems only. This relationship was significant for production, but not significant (p = .18) for net cash income. Interactions between use of a veterinarian (VET) and number of heat observations per day (HEATOBS) indicate that larger numbers of heat observations when using the veterinarian only for problem cows had a 473 kg advantage over more heat observations in herds where the veterinarian visits regularly and has probably maintained a working knowledge of herd reproductive health. Interaction of VET with the minimum number of days between calving and breeding (BRDBACK) showed little effect in herds with complete reproductive health programs. But in other herds, each additional day decreased production and profits significantly. This loss in profitability amounted to $10 per cow in net cash income for each day of waiting, and 53 kg in production. The advantage is less for herds with reproductive health programs because the veterinarian has identified individual cows according to their readiness for breeding. Later breeders are then more by design than accident, and early breeders are ready.

Regressions of production and profits on linear and quadratic age of first calving (AGECALV) demonstrated a quadratic relationship. For maximization of herd production, optimal AGECALV was 35 months, but for maximum net cash income (NTCSHIPC), optimal age of first calving was 29 months. Maximum PROFITPC occurred at 26 months, while REALPRPC never reached a maximum but continued to increase as age at calving decreased. Although the production optimum of 35 months is higher than normally recommended, the reduced ages for income and profit seem to be moving in a reasonable direction. It obviously can be costly to hold non-productive heifers for extended periods of time.

Genetic herd indices which were two times the USDA Cow Index herd average for cows calving in the previous two years were added to the data of 36 herds. To qualify, a herd had to have 50% of its cows with sire identification. Examining the regression of herd average milk production on average genetic ability failed to show a significant relationship between genetic potential and phenotypic expression. In fact, 99% of the differences in herd production were unexplained by average cow index. This is probably because genetically superior A.I. sires have been readily available to all dairymen, and hence the variation in genetic quality among the sample herds is less than the 10% commonly expected.

The percentage of young, low repeatability bulls used (PCTYGBLS) was related to genetic index, with the genetic index for dollars of milk (GDOL) increasing $2.85 for each 1% increase in low repeatability bulls. This is roughly equivalent to 12.3 kg of milk. Genetic indices were higher for registered herds by $28.70, or roughly 104 kg of genetic potential over commercial herds. There was no significant advantage to registered herds in actual production or profitability.

PCTYGBLS also had a significant effect on production of 18.5 kg per 1% increase. PCTYGBLS did not significantly affect profit measures.

The use of bulls with no Predicted Difference for Type (NOPDTBLS) was associated with less production ($p = .14$) and described significant decreases in profitability. When PCTYGBLS and NOPDTBLS were considered simultaneously, the increased use of young bulls increased the genetic index, while herds using more fully proven bulls (those with PDT's) were less dramatically superior in production and profitability.

The number of artificial insemination organizations from which semen is purchased showed a 355 kg decrease (p = .14) in production for herds using more than one organization and $203 per cow less net cash income. Herds were grouped by either one organization or more than one organization. This difference may be caused by herds which are buying semen from more than one stud selecting for traits other than Predicted Difference for income (PD$). These results were variable though. Using the actual number of studs yielded similar, though less accurate results.

Feeding

Feeding information encompasses types of feeds, feeding practices, DHI measures and financial information.

Traditionally, purchased feed per cow (PRCHFDPC), income over feed cost (YRIOFC, IOFC, MYIOFC) and feed cost as a percentage of total expenses (PRCFDPCT, TOTFDPCT, DHIFDPCT) have been used as feed cost control measures. Analysis of variance showed a significant positive relationship between PRCHFDPC and three of the profit measures. Each dollar (-$1.00) increase in PRCHFDPC was associated with -$.59, -$.98, -$.48 change in NTCSHIPC, REALPRPC and CASHAVPC. PROFITPC was not described by PRCHFDPC. YRIOFC was positively associated with AVGPROD, but not with any of the profit measures. MYIOFC, which was determined from the dairymen's financial records, was positively related to AVGPROD and all four measures of profitability. For every dollar MYIOFC increased, NTCSHIPC increased $.88, PROFITPC $.77, REALPRPC $.94 and CASHAVPC increased $.74. Average production was 1.02 kg higher for every dollar of MYIOFC.

TOTFDPCT described three of the profit measures, but did not explain REALPRPC. As previously discussed, REALPRPC contains large non-cash charges and was not expected to relate to cost variables but to amount of investment and financial situation. PRCFDPCT did not relate to any of the profit measures, nor did DHIFDPCT.

Regressing AVGPROD on MYIOFC and TOTFDPC provided a good fit (R^2 = .40, and regressions 5.27 and 7.06). A more accurate model was one which described the effects of MYIOFC and TOTFDPCT on NTCSHIPC and CASHAVPC. Spending a larger percentage of expenses on feed increased income greatly as did increased income over feed cost as measured by the survey. Models containing DHI variables IOFC, YRIOFC and YRAVGTOT did not explain differences in profitability. The mean and standard deviation for YRIOFC were 1095 and 212, for MYIOFC they were 1014 and 264. While there is not an apparent difference between these figures, they correlate by only 35%, not as highly as expected.

Several class variables described one or more of the profit measures. Among these were MAGNETS, HMGRAIN, MAINFOR, BALANCE, CROPS, MIXRATN, NUMBGRPS and SUPPLEM. The effects of MAINFOR and CROPS were the most influential. Least squares means indicated that feeding hay silage as the main forage produces $83 more net cash income per cow (NTCSHIPC) than corn silage. Both of these forages were over $400 per cow more profitable than feeding dry hay as the main forage. CROPS was highly related to three measures of profit, but not REALPRPC. The relationship between NTCSHIPC and CROPS is illustrated in Figure 6. The relationship between degree of crop analysis and net cash income is very linear and quite dramatic. The use of rumen buffers (SUPPLEM) was related to AVGPROD, but not to any of the profit measures. SUPPLEM was associated with increased production per cow of 471 kg. It is thought that these products are associated with high producing herds to aid in the maintenance of butterfat test. However, no lower than average fat percentages were detected. This may be due to the feeding of SUPPLEM. Use of high moisture grains (HMGRAIN) was positively related to all four measures of profit. This is largely due to a great decrease ($196) in PRCHFDPC associated with HMGRAIN.

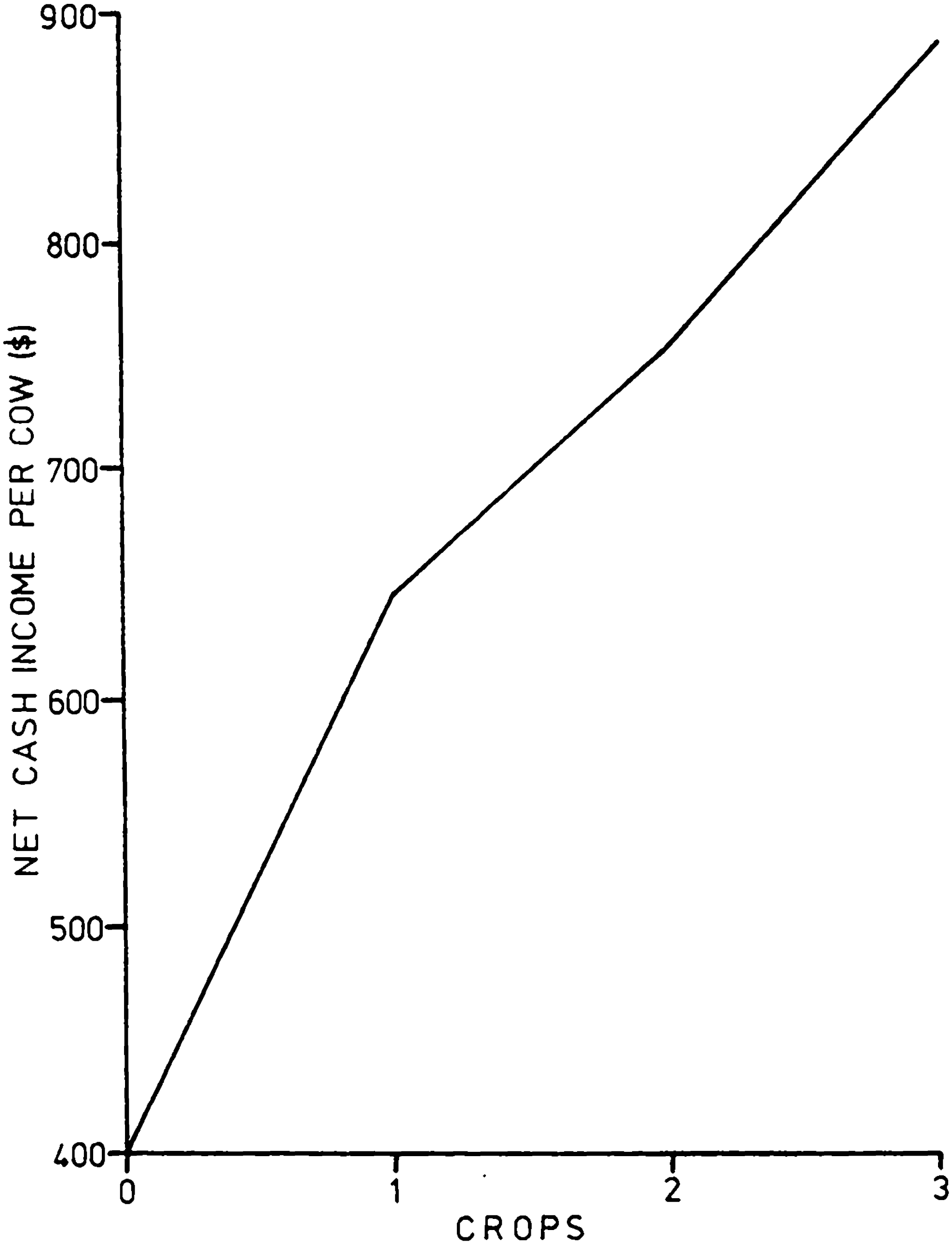

Figure 6: Relationship of Net Cash Income per cow (NTCSHIPC) and degree of crops submitted for feed analysis.

The effects of magnetic or challenge feeders (MAGNETS) were particularly pronounced, although not statistically significant. Table 17 indicates that herds utilizing these feeders had 312 kg higher production, higher purchased and total feed costs and higher income over feed costs. These herds also had more invested per cow, a higher percentage of equity, more registered cows and higher incomes per cow as defined by all four profit measures. A model containing MAINFOR, CROPS, MAGNETS and HMGRAIN described differences in NTCSHIPC and CASHAVPC. MAINFOR, HMGRAIN and CROPS, however, were the most important variables. R^2 for this model was .46.

Differences were also found in machinery and equipment investment per cow (MACHEQPC) for different forages. Herds feeding corn silage as the major forage had a $76 per cow lower investment than herds feeding hay silage and a $319 per cow lower investment in machinery than herds feeding dry hay as the main forage. These differences were not statistically significant.

No relationship was found between MAINFOR and VETEXPPC, failing to verify a prevalent concept that feeding dry hay results in fewer displaced abomasa and metabolic disorders.

A combination of MYIOFC, PRCHFDPC and TOTFDPCT with class variables MAINFOR, CROPS, BALANCE, and MAGNETS

Table 17. Differences for farms utilizing magnetic or challenge feeders.

Variable	Without Feeders (N = 54)	With Feeders (N = 19)
AVGPROD	6,473 kg	6,785 kg
AVGNUMB	80	76
YRIOFC	$ 1,091	$ 1,118
MYIOFC	993	1,080
PRCHFDPC	505	558
TOTFDPC	725	792
INVESTPC	7,446	7,816
PCTEQUIT	70%	81%
PCTREG	12%	28%
NTCSHIPC	$ 724	$ 815
PROFITPC	753	933
REALPRPC	-98	10
CASHAVPC	270	391

explained differences between farms in both NTCSHIPC and CASHAVPC extremely well ($R^2 > .83$). Table 18 describes this model more fully. All variables are individually significant. The least squares means are interesting but difficult to interpret. Note that corn silage means are higher than hay silage means. These are computed at average values of other variables in the model, which may not be reasonable in some circumstances. No analysis of crops, for instance, is not likely to exist with an average degree of ration balancing. These means also are adjusted to identical average feed costs and income over feed cost.

Calf Raising

The enterprise of calf raising does not produce income and therefore was not expected to directly relate to profitability. Low variability in calf-raising expenses further reduces the importance of calf raising to profit measures. However, the indirect effects of calves as herd replacements may cause differences in profits among management regimes.

The number of days colostrum was fed (COLOSDYS), manner of colostrum storage (COLOSTOR), and form of milk fed after colostrum (REPLACER) were not related to production, profitability, calf mortality (MORTALTY) or the difference in mature equivalent production between first calf heifers and older herdmates (IMPROVE).

Table 18. Least squares means of feeding variables used to predict net cash income and cash available.

Source		NTCSHIPC LS Mean	NTCSHIPC S.E.	CASHAVPC LS Mean	CASHAVPC S.E.
MYIOFC		$ .866[a]		$ .713[a]	
PRCHFDPC		-.6558[a]		-.7495[a]	
TOTFDPC		18.644[a]		20.144[a]	
CROPS					
No analysis	0	947.5	86.9	463.9	111.0
	1	890.1	67.2	355.5	85.9
	2	780.1	49.8	369.6	63.6
Extensive	3	887.7	56.6	443.3	72.3
BALANCE					
None	0	568.4	60.9	119.1	77.7
Commercial	1	1047.1	136.6	604.0	174.4
Extension	3	689.8	32.7	250.8	41.8
Combinations	4	1053.2	95.2	572.1	121.6
Special	5	709.5	136.7	240.8	174.5
MAINFOR					
Corn Silage	0	896.6	48.0	434.9	61.4
Hay Silage	1	816.1	62.0	358.0	79.2
Dry Hay	2	728.0	83.0	279.2	106.0
MAGNETS					
No	0	767.9	57.0	299.2	72.8
Yes	1	859.3	56.2	415.5	71.7

[a]Regression Coefficient

Feeding of mastitic or antibiotic milk to calves (MASTMILK), with MASTALL as a covariate, showed a 708 kg decrease in herd average relative to not feeding mastitic milk.

A model containing the variables MORTALTY, RATIO, AGECALV and LDBLDGPC showed that decreased AGECALV and increased RATIO were most important to higher production. TOTCULL as a dependent variable was most affected by rate of mortality, with culling increasing .79% for every 1% increase in mortality, not as expected. This model did not describe IMPROVE or profitability.

Age in weeks at weaning (WEANING) was related to AVGPROD and IMPROVE, but not to MORTALTY or profitability. For each week increase in weaning age, average production decreased 99 kg and the production of first calf heifers was 58 kg further from the older cows. Grouping weaning ages into two classes (CLASWEAN), above and below eight weeks, showed no group differences in MORTALTY, IMPROVE, AVGPROD or profits.

The type of facility for raising calves influenced MORTALTY. Calves raised in hutches had the lowest rate of mortality (9.3%), while calves raised in groups from birth (in cold pens) had a mortality rate 8.1% higher (17.4%).

Combining CLASWEAN and CALFACL2, it was noted that earlier weaning was associated with approximately 2% lower mortality. Hutches were associated with approximately 3% lower mortality, with cold housing for groups and individuals essentially equal in mortality. The interactions are very interesting. Calves raised in cold housing, individually, with early weaning had 3.8% lower than average mortality. Calves raised in cold housing, grouped from birth, with early weaning incurred losses 8.3% higher than average. All other combinations were not different from average.

Financial

Financial information has been used in all sections of this study to evaluate dollar consequences of different management conditions. NETINCPC, NETEXPPC and their interaction provided a good fit for all four profit measures and average production. The individual components of income and expense are also very interesting. NETINCPC is composed of SALEMKPC, BEEFPC, DAIRYPC and MISCINPC. Milk sold per cow accounted for 51% of the variation in income and was twice as important as any other component of net income. BEEFPC was next in importance, being 1.5 times as important as DAIRYPC for net income. However, when cash available was considered, DAIRYPC was 1.4 times as important as BEEFPC.

Dairy sales are indeed "the cream" of secondary receipts in providing additional cash. MISCINPC accounted for only 7% of the variation in income, low as expected from herds chosen as dairy farms.

On a cash available basis BEEFPC returned only $.52 for each dollar received. This indicates that selling more beef was unprofitable to the dairymen and suggests it was better not to raise steers for additional cash. This may vary with changes in the relationship of feed and beef prices.

The components of NETEXPPC are ENERGPC, INTPDPC, LABORPC, PRODCSPC, RENTPC, PRCHFDPC, VETEXPPC and MISCEXPC. Total feed costs per cow (PRODCSPC plus PRCHFDPC) accounted for 40% of the variation in expense, 2.7 times more important than any other component of net expense. However, total feed costs averaged 61% of expenses, lower than other studies have indicated. Fuel, labor, storage costs and machinery depreciation were not included in feed cost calculations, nor was cost of ownership. This suggests that feed management and costs were fairly well controlled on the surveyed farms. It also indicates, from the 40%, that feed costs are not as important to differences between farms as normally thought relative to other expenses. ENERGPC, INTPDPC and LABORPC contributed equally 13 to 15% of the total variation in expenses. RENTPC contributed 10%, MISCEXPC contributed 6% and VETEXPPC contributed 3% of the total variation in cash expenses. The importance of these components changed with each definition of profitability.

All profits except NTCSHIPC were regressed on all expenses and receipts. Coefficients were known to be exactly 1.0 or -1.0 for NTCSHIPC, and on the surface would be expected to be that for the other profits. On all measures except CASHAVPC, ENERGEXP cost about $2.40 of profit for each dollar spent. RENTPC was insignificant for all measures except REALPRPC. When measured against an opportunity cost for owning land, each $1.00 spent on rented land returned $2.00 in profit.

On a cash available basis, VETEXPPC was the only expense item with a positive return, returning $.81 for each dollar spent. Expenditures measured by LABORPC and PRCHFDPC were both economical on a cash available basis. They returned -$.75 and -$.85 per dollar spent, both significantly higher than -$1.00. INTPDPC was costly in terms of cash available, reducing cash by $1.58 for every $1.00 paid. This is a logical consequence of dairymen paying higher interest also paying more in principal. Interest as a percent of expenses (INTPCTEX) also described CASHAVPC. CASHAVPC decreased $18.36 for every 1% increase in INTPCTEX.

Multiple regression on NETINCPC, INVESTPC, DEBTPC, AVGINTRT and the products of DEBTPC with NETINCPC and DEBTPC with AVGINTRT significantly explained average production and all profit measures (R^2 = .29 to .52).

DEBTPC and EQUITYPC were calculated independently. To verify the fit of the data, DEBTPC, EQUITYPC and their product were regressed on INVESTPC and yielded an R^2 of .98. They explained all variation in investment, as expected.

CASHAVPC is particularly interesting because it can be used to determine the debt carrying capacity of the farm. This debt capacity was calculated on a per cow basis and named DETCAPPC (Table 19). It was computed by adding the amount of debt CASHAVPC would service (FUTDETPC) for 5 years at 16% interest (CASHAVPC * 3.2744) to the present amount of debt per cow (DEBTPC). Under this definition, CASHAVPC would service $965 and DETCAPPC was $2519. If the new debt were computed in the same manner for a 20 year period DETCAPPC would have been $3461. It appears that the rule of thumb, $3000 per cow, is a reasonable guideline. DETCAPPC will vary according to structure of current and future debt over time, as well as changes in interest rates.

Table 19. Debt capacities per cow.

Debt Variable	Mean	Standard Deviation	Maximum	Minimum
DEBTPC	$1712	1345	5225	94
FUTDETPC[1]	965	1121	3634	-1926
DETCAPPC	2519	1565	6177	-710

[1]Cash available per cow (CASHAVPC) amortized at 16% interest for 5 years.

Dairy Herd Improvement Herds

Effects of Dairy Herd Improvement (DHI) measures on production and profit have been reported under applicable subsections of milking, feeding, calf raising and breeding. This section will therefore be devoted to differences between DHI and non-DHI herds in the survey. The small number (N=17) of non-DHI herds makes it difficult to achieve statistical significance, however several differences are noteworthy. Remember that the randomness of non-DHI herds is unknown. The sources of non-DHI measures are described in the procedures, page 14 and 15 and Appendix II, items 121 to 124.

As seen in Table 20, DHI herds produced an average of 483 kg more milk per cow and milked 15 more cows than non-DHI herds. This higher production resulted in greater net cash income per cow (NTCSHIPC). Comparing the other profit measures, non-DHI herds experienced losses due to inventory changes and depreciation, while DHI herds gained $104 per cow. When an opportunity cost for investment is added (REALPRPC), the difference in profitability becomes even greater. Investment per cow and equity per cow were higher in the non-DHI herds, which had been operating one year longer and held 9% more equity as well.

Table 20. Means of selected variables for DHI and non-DHI farms.

Variable	DHI Farms (N=57)	Non-DHI Farms (N=17)
AVGPROD	6,669 kg	6,186 kg
AVGNUMB	87	72
AICOWS	90%	77%
AIHEIFER	53%	29%
PCTREG	20%	3%
NUMBULLS	9.3	6.9
PRCHFDPC	530	480
TOTFDPC	761	684
MYIOFC	1,052	861
ANALYSIS	4.6	3.0
SUPPLEM	52%	19%
MAGNETS	33%	0%
COLOSDYS	8.6	9.1
MILKHOW	31%[1]	50%[1]
MORTALTY	12.3%	11.9%
RATIIO	.86	.80
VETEXPPC	30	17
PCTEQUIT	72%	81%
EQUITYPC	5,653	6,453
INVESTPC	7,494	7,892
LDBLDG	405,982	308,571
MACHEQP	106,965	90,500
LIVSTOCK	159,228	126,667
CAPITAL	672,175	527,643
LENGTH	6.8	7.3
NTCSHINC	63,027	50,771
NTCSHIPC	758	677
PROFITPC	862	567
REALPRPC	24	-412
CASHAVPC	314	244

[1]Indicates percentage of calves fed with a nipple (as opposed to pail-feeding).

DHI herds used artificial insemination more extensively, 90% versus 77% for milking cows and 53% versus 29% for breeding heifers. Non-DHI herds had fewer registered cows, used a smaller number of bulls and had much lower veterinary expenses, $17 per cow versus $30 per cow.

DHI herds fed more purchased grain and incurred higher total feed costs per cow, however their income over feed cost (MYIOFC) exceeded the non-DHI herds by $191, primarily due to higher milk receipts.

DHI herds analyzed feed more often, an average of 4.6 times per year versus 3.0 times for non-DHI herds.

Non-DHI farms had 63% fewer farms using rumen buffering supplements (SUPPLEM) and had no magnetic or challenge feeders, while one-third of the DHI farms utilized one of these devices.

Calf mortality and days feeding colostrum were essentially identical for both groups of herds, but those on DHI maintained a higher ratio of replacements than the non-DHI herds. This higher ratio could be due to a shorter calving interval for DHI herds, but information of this type was unavailable for the non-DHI herds.

Fifty percent of the non-DHI herds fed calves with a nipple while 31% of the DHI herds fed in this manner, the remainder teaching calves to drink from a pail. No connection could be found between this practice and mortality rate. Analyses of variance showed no significant differences between DHI and non-DHI herds for number of cows, production, levels of mastitis, cows milked per hour or any of the four profit measures.

Size and Production Comparisons

Comparing per cow net cash incomes (Table 21) demonstrated that differences existed for operations of different sizes and productions. Variables in Table 21 were those significantly affected by size, production, or the interaction in a least squares analysis. Small operations (coded 11, 12, and 13) increased in per cow income as production increased. Mid-size operations (coded 21, 22 and 23) steadily declined in per cow income as production increased and large herds (coded 31, 32 and 33) had lowest per cow income at moderate production, with low and high production being more profitable.

Differences in per cow profitability for different herd sizes indicated that scale of operation was important to efficient use of resources. Mid-size herds (68-87 cows) had higher per cow expenses for both labor and energy which accounted for the majority of the differences in net cash income per cow.

Table 21. Least squares means of per cow profitability and expenses for size and production categories.[1]

CATEGORY Size Prod	NTCSHIPC X	NTCSHIPC S.E.	LABORPC X	LABORPC S.E.	ENERGPC X	ENERGPC S.E.	PRODCSPC X	PRODCSPC S.E.
11	$ 471	98	$ 89	31	$ 91	34	$ 187	37
12	736	113	74	36	101	39	355	40
13	870	160	108	51	87	55	291	60
21	821	113	62	33	104	36	264	40
22	732	124	144	39	81	43	188	48
23	308	160	280	51	319	55	213	60
31	889	139	99	39	94	43	184	47
32	778	105	126	33	85	36	202	40
33	1185	160	97	51	79	55	163	60

[1]Categories are 10th to 30th, 40th to 60th and 70th to 90th percenetiles for size and productiion.

SIZES (cows): 1 = (43 to 62) 2 = (68 to 87) 3 = (100 to 151)
PROD (kg): 1 = (5450 to 6170) 2 = (6430 to 6925) 3 = (7155 to 7870)

Per cow costs of producing feed showed significant changes with production level. The smallest and largest herds had higher per cow production costs at median (Code 2) milk production, while the mid-size herds had lowest feed production costs associated with median milk production.

Percentile Comparisons

There were many differences between farms. Perhaps the most important concept was that production cannot be used as a simplified profit function. Expense items must be considered to determine profitability.

Table 22 shows a difference of $961 per cow per year for net cash income between herds above the 80th percentile and herds below the 20th percentile. Milk production differed by only 469 kg, which would only account for approximately $140 additional income per cow. The remainder of the difference was due to variation in expenses.

Cows milked per hour were higher by 14 cows for the most profitable herds. This was likely due to increased milking automation. More profitable herds also had greater availability of replacements as measured by RATIO.

Herds with higher incomes were in operation for an average of 3.6 years longer than low income herds and had attained 17% more equity in their operations, averaging 81% equity.

Table 22. Differences between the high and low twenty percent of herds for net cash income per cow (NTCSHIPC).

Variable	Mean above 80th percentile (N = 14)	Mean below 20th percentile (N = 20)	Difference (High-Low)
NTCSHIPC	1226	265	+961[1]
PROFITPC	1286	166	+1120[1]
REALPRPC	411	-568	+979[1]
CASHAVPC	754	-128	+539[1]
AVGPROD	6780 kg	6311 kg	+469kg
AVGNUMB	86.2	91.2	-5.0
COWSPRHR	46.0	31.9	14.1[1]
HRSINFL	311	212	+99[3]
AICOWS	98%	89%	+9%
AIHEIFER	68%	44%	+24%
IMPROVE	1206	406	+800[3]
NUMBULLS	10.0	10.5	-0.5
PCTYGBLS	8.4%	6.6%	+1.8%
WEANING	7.4	8.4	-1.0
RATIO	.92	.76	+.16[2]
MORTALTY	10.8%	13.9%	-3.1%
PCTREG	5.7%	23.0%	-17.3%[3]
PCTEQUIT	81.4%	64.4%	+17.0%[2]
DAYSOPEN	118.5	121.8	-3.3
DAYSDRY	60.7	65.7	-5.0
SUCCESS	61%	58%	+3%
MASTALL	11.3%	17.1%	-5.8%
AVGINTRT	7.1%	10.9%	-3.8%
INVESTPC	7470	6734	+736
LENGTH	15.9 yrs.	12.3 yrs.	+3.6 yrs.[3]

[1]Significantly different (p = .001)

[2]Significantly different (p = .05)

[3]Significantly different (p = .10)

Longer use of inflations by almost 50% was seen in highly profitable herds, although 311 hours does not exceed the recommendation of 2000 cow-milkings per inflation. Interestingly, the average for all 77 herds was 325 hours of inflation usage.

Low profit herds had less difference in mature equivalent (M.E.) production between mature cows and first calf heifers. The average M.E. for first calf heifers was equivalent and the difference was caused by higher production from the older cows. These herds also had over four times the number of registered cows. The causes of differences in profitability between registered and grade herds were not determinable (see Table 5).

Table 23 shows that high and low production does not affect profitability. In fact the lowest production herds had higher PROFITPC and REALPRPC than the highest production herds and their NTCSHIPC and CASHAVPC were only $71 and $20 lower.

Herds with highest production had much greater availability of herd replacements with less than half the calf mortality of low production herds and a large increase in ratio of young stock to milking cows (RATIO), 1.00 versus 0.71.

Table 23. Differences between the high and low twenty percent of herds for average milk production per cow (AVGPROD).

Variable	Mean above 80th percentile (N = 15)	Mean below 20th percentile (N = 15)	Difference (High-Low)
AVGPROD	7630 kg	5218 kg	+2412 kg[1]
AVGNUMB	73.7	89.1	-15.4
NTCSHIPC	749	678	+71
PROFITPC	627	896	-269
REALPRPC	-461	52	-513[3]
CASHAVPC	273	253	+20
COWSPRHR	33.6	40.5	-6.9
HRSINFL	223	465	-242
AICOWS	81%	77%	+4%
AIHEIFER	44%	33%	+11%
IMPROVE	1041	1164	-123
NUMBULLS	7.7	6.7	+1.0
PCTYGBLS	11.9%	5.3%	+6.6%
WEANING	7.1	7.9	-0.8
RATIO	1.00	.71	+.29[1]
MORTALTY	7.9%	16.9%	-9.0%[2]
PCTREG	22.7%	15.3%	+7.4%
PCTEQUIT	80.0%	68.5%	+11.5%
DAYSOPEN	112.9	123.5	-10.6
DAYSDRY	62.0	62.0	+0
SUCCESS	53.4%	62.5%	-9.1%[2]
MASTALL	9.2%	11.9%	-2.7%
AVGINTRT	9.5%	8.9%	+0.6%
INVESTPC	9599	7160	+2539[2]
LENGTH	15.3 yrs.	11.5 yrs.	+3.8 yrs.[3]

[1]Significantly different (p = .01)

[2]Significantly different (p = .05)

[3]Significantly different (p = .10)

Low production herds had $2539 less investment per cow. Although these herds had slightly lower cash flow than high production herds, when a charge for invested capital was added, the low production herds were significantly more profitable by $513 per cow.

Success rate in breeding was lower for high production herds. Although increased success rate should lead to higher production, high productiion in cows is biologically competitive with high conception rates and seems to be more influential.

CONCLUSIONS

This project demonstrated that it is possible to obtain large amounts of data from dairymen by use of a personal survey. Management surveys in the past have typically been conducted through the mail, making randomness of returns questionable, leaving ambiguities unclarified, and allowing a large number of non-returns. Through personal surveying these problems were minimized and complete records were obtained for 97% of the farms surveyed.

The relationships of many variables were investigated. Relation to profitability was most strongly demonstrated by variables relating to feed cost, the major expense on dairy farms.

Examining all statistically significant variables from each subsection, and attempting to maximize the R^2 of models describing profitability showed the best overall model consisted of cash income per cow (NETINCPC), income minus feed cost per cow (MYIOFC), purchased feed cost per cow (PRCHFDPC) and total feed cost as a percent of expenses (TOTFDPCT). NETINCPC and PRCHFDPC describe all of the income and 26% of the variation in the expenses. PRCHFDPC and TOTFDPCT are cost control measures. This model provided an R^2 of .86 for NTCSHIPC, .75 for CASHAVPC, .26 for PROFITPC and .18 for REALPRPC. DEBTPC was quite important to PROFITPC and REALPRPC. Once again it was reinforced that although production is the main contributor to gross income, it is not possible to predict profitability accurately without measures of related expenses.

The variable with next greatest importance, although not included in the model, was average age of herd (AVGAGE), with younger herds more profitable.

Several characteristics of this study require careful interpretation. These were herd records, in contrast with data from individual cows under controlled experimental conditions. The relationships in this study are therefore less precisely defined and have been influenced by a multitude of management conditions. Many variables are confounded with quality of management. These records also were obtained for only one year. The differences analyzed then represent variation among herds and cannot be interpreted as an indication of future consequences from changing the management within a single herd. It only delineates differences among dairy herds at one point in time.

Since feed costs have proven most important in determining profitability and because there exists a distinct negative relationship between feed grown and feed purchased, further research involving cropping and fertilizing programs, acreages and soil quality measures must be added to financial measures. With the continuing high opportunity cost associated with land ownership, the balance between home grown and purchased feeds will be more critical in years to come.

More information is needed to describe the amount of labor involved in the dairy operation. The type of ownership and mechanization can greatly affect the amount of labor expense recorded. Future studies might determine if operations are sole proprietorships or corporations and should define labor inputs in terms of man-hours as well as cash expense.

Several topics deserve more concentrated efforts in the future. Of particular interest is the relationship between production and profitability. The development of a measure to stabilize quality of management while investigating the unique contributions of individual management practices would be of great value. Some innovative methods must be found to separate the effects of particular practices and strategies from the overall quality of management. Records on the same herds over several years seem most promising.

SUMMARY

Seventy-seven randomly chosen herds were personally surveyed for management information. Dairymen were questioned for 1.5 hours about milking systems and practices, feeding, reproductive and genetic aspects of breeding, calf raising and finances. Seventeen non-DHI herds were included.

Objectives of the study were to assemble data that described farm management practices not found in DHI records and to relate these data to net cash income, profit, real profit, and cash available for investment.

Type of milking system accounted for production differences of 680 kg less milk for herds milking in flatbarns in contrast to parlors. Parlor type had no effect. Individual milking practices except dry treatment, had no effect on percentages of mastitis, production per cow, or profits. Use of dry treatment reduced mastitis. A count of recommended milking practices showed an annual increase of 246 kg milk per cow per practice implemented.

Reproductive variables such as use of pregnancy checks and number of heat observations per day did not describe

days open, production or profit measures. Days open were 11 days fewer in herds using heat detection aids. Optimal ages at first calving were found for average production, net cash income per cow and profit per cow. These were 35, 29 and 26 months, respectively.

Interactions of days open and days dry demonstrated that increasing days open, once beyond 53 days dry, decreased production. However, net cash income per cow was largely increased by fewer days dry, beyond 110 days open. Below 110 days open, days dry had no influence on income and fewer days open was more profitable.

Feeding programs accounted for the largest portion of expenses and were important to profitability and production. Income over feed cost and feed cost as a percentage of total expense were most important in describing profitability and production. The major forage fed, the degree of crop analysis and the amount of purchased feed per cow all had significant effects on profits. Feeding high moisture grains was associated with dramatic reductions in purchased feed and was positively related to all four measures of profit. Use of electronic or magnetic feeders demonstrated positive trends in profitability, though not statistically significant.

Age of calves at weaning was related to production, but not profits or mortality. Calf mortality was influenced most by type of facility with calves in hutches having the lowest rate of mortality and calves raised in groups in pens having the highest rate. An interaction of weaning age and type of housing was shown to explain rate of mortality in youngstock, with individually raised and early weaned calves having 8% lower mortality than calves raised in groups and weaned early.

Standardized partial regression coefficients showed that milk sales accounted for 51% of the variation in total income, and beef sales accounted for 25%. Total feed costs accounted for 40% of the variation in expenses, with labor, energy expenses and interest paid contributing equally at 13 to 15%. Models using investment per cow, debt per cow, average interest rate and net income per cow were good predictors of profitability (R^2 = .29 to .52). Debt capacity per cow, averaged across herds, fell between $2500 and $3500, depending on the debt structure of financing and interest rates.

DHI herds were 383 kg superior to non-DHI herds in annual milk per cow, had 15 more cows and $81 more net cash income per cow. These differences, however, were not significant. Registered herds had 247 kg higher production than commercial herds, but lower profitability in all four measures. None of these differences was significant.

Least squares means for production and size categories indicate decreased per cow profitability in mid-size herds (68-87 cows). This was due to significantly higher per cow labor and energy expenses. Higher production per cow led to more net cash income per cow except for medium-sized herds.

Separation of herds into 20th and 80th percentiles for production and net cash income per cow demonstrated large ranges for many variables.

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APPENDICES

APPENDIX I. Alphabetic index of variable names.

Variable Name	Appendix II Item No.	Variable Name	Appendix II Item No.
ENERGPC	210	MAINFOR	203
EQUITYPC	182	MAST2	156
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FOM	32	MAST8	158
FUTDETPC	222	MASTALL	179
GDOL	226	MASTCOWS	28
GMILK	225	MASTDRUG	27
GOODPRAC	180	MASTMILK	80
GROOVES	47	MASTRTMT	25
GROUPS	55	MEALLFAT	165
HAYLAGE	69	MEALLMLK	164
HEATAIDS	49	MEHEFFAT	161
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HEATLOC	46	MESECFAT	163
HEATOBS	41	MESECMLK	162
HEATREC	48A	MILKFEED	76
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HEFMAST4	167	MILKINT1	3
HEFMAST8	168	MILKINT2	3
HMGRAIN	71	MILKINT3	3
HOWGRPD	56	MILKTIME	77
HRSINFL	19	MINERAL	63
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INTPYMT	107	MISCINC	102
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INVFEED	115	MIXRATN	50
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INVLVSTK	114	MORTALTY	83
INVMACH	91	MYIOFC	196
IOFC	130	NETEXP	189
LABOR	106	NETEXPPC	209
LABORPC	213	NETINC	188
LABORPCT	221	NETINCPC	208
LDBLDG	111	NTCSHIPC	175
LDBLDGPC	218	NONCOWN	122
LENGTH	89	NONRHA	121
LINE	6	NOPDTBLS	44
LINEDIAM	13	NPN	62
LIVSTOCK	113	NUMBCALV	81
LPS	61	NUMBFDRS	54
MACHEQP	112	NUMBGRPS	55
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Variable Name	Appendix II Item No.	Variable Name	Appendix II Item No.
NUMBREG	16	STORAGE	66
NUMBSTAL	8	STRIP	21
NUMBSTUD	42	STUDY30	88
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NUMBUNIT	9	SUPPLEM	64
OPLOANS	90	SYSTAGE	17
OPLNWHY	96	TEATDIP	24
PARLRFED	51	TIMESFED	53
PCTCDEBT	118	TIMESFIX	18A
PCTCOOP	90A	TIMESMIL	2
PCTEQUIT	98	TOTCULL	199
PCTIDEBT	119	TOTDEBT	117
PCTLTDET	120	TOTFDPCT	205
PCTREG	97	TOTFDPC	195
PCTVSMC	90B	TOWELS	22
PCTYGBLS	43	TURNOVER	191
PRCFDPCT	206	TYPEATO	184
PRCHFDPC	192	TYPEPARL	5
PREGCHEX	36	TYPETRT1	45
PRINCPC	212	TYPETRT2	45
PRINCPMT	92	UDDWASH	87
PROD	186	UNIT	170
PRODCOST	104	UNITSREQ	227
PRODCSPC	214	VACDIAM	14
PRODVALU	143	VACHP	15
PROFITPC	176	VACOFF	23
PURCHFD	103	VET	34
RATIO	84	VETEXP	105
REALPRPC	177	VETEXPPC	200
REFINANC	93	WEANING	82
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REG	220	YEARCONC	142
RENTPC	215	YRAVGFAT	136
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APPENDIX II. Description of variables in item number order.

Item Nos.	Subject
1-32	Milking systems and practices
33-49	Breeding program
50-71	Feeding program
72-88	Calf Raising program
89-120	Financial information
121-124	Non-DHI herd information
125-168	DHI variables
169-174	Classification variables
175-227	Analytic variables

1. DHI herd Code Number; (non-DHI herds designated by 99 in state code)
2. Number of times milking per day;
3. Intervals between milkings; (xx.x hrs.)
4. Manufacturer of milking system;

   1 = DeLaval

   2 = Boumatic

   3 = Surge

   4 = Bodmin

   5 = Jamesway

   6 = Universal
5. Type of milking system;

1 = Stanchion

2 = Herringbone

3 = Side-opening

4 = 2 & 3 one on each side

5 = Rotary

6. High or low line;

1 = Low

2 = High

7. Milk weighing devices;

0 = none

1 = jar

2 = meter

3 = bucket and scale

4 = jar, daily

5 = meter, daily

6 = bucket & scale, daily

8. Number of milking stalls;

9. Number of milking units;

10. Number of persons milking;

11. Automatic take-offs;

0 = No

1 = Yes

2 = Yes, but cows are rechecked by milker

12. Cows milked per hour;

13. Milk line size, in inches with two decimal points

(x.xx);

14. Pulsator line size, in inches with two decimal points (x.xx);

15. Total horsepower of vacuum pumps used (x.x);

16. Vacuum regulators;

number of regulators

A. manufactuer of regulator

1-3 = Sizes of Sentinel

4 = Westfalia (small)

5 = Surge Equalizer II

6-7 = Sizes of De-Laval

8 = All sliding weight types

9 = Boumatic

10 = Westfalia (large)

11 = DeLaval Servo (2 linked units)

12 = Starite

17. Age of system;

1 = <2 yrs

2 = 2-5 yrs

3 = 6-10 yrs

4 = >10 yrs

18. Frequency of system maintenance;

1 or 5

1 = only when breaks

5 = contract agreement

A. number of times per year service is required;

19. Number of hours between inflation changes;

20. Type of claw;

1 = solid, vented

2 = clear, vented

3 = solid, unvented

4 = clear, unvented

21. Cow's foremilk stripped & checked;

0 = No

1 = Yes

22. Use of single service towels;

0 = not used

1 = used dry

2 = used wet

3 = 1 & 2 both

4 = individual cloth towels

23. Vacuum released before removing machine;

0 = No

1 = Yes

24. Teats dipped;

0 = No

1 = Iodine dip

2 = Glycerin/lanolin dip

3 = Clorox

25. Mastitis treatments;

0 = No treatments

1 = Treat based on cell count (DHI)

2 = Treat clinical mastitis at detection

3 = Treat clinical mastitis 1 or more milkings after first detection

4 = 1 & 3

5 = 2 & 3

6 = 1, 2, & 3

7 = 1 & 2

26. Alcohol pads used prior to intra-mammary infusions;

0 = No

1 = Yes

27. Main product used for mastitis treatment;

0 = Gallamycin

1 = Hetacin K

2 = Dariclox

3 = Today

4 = I.V. treatment

5 = Cephalac

6 = Forte 1700

7 = Albacillin

8 = vet mix (Jenocin)

9 = Mastaid

28. When mastitic cows are milked;

0 = anytime

1 = last

2 = thorough sanitizing after mastitic cows

29. Drying off;

1 = abrupt

2 = reduced milkings

3 = reduced feed

4 = 1 & 3

5 = 2 & 3

6 = 1 & 2 (50/50)

30. Dry cow treatments;

0 = no treatment

1 = selective treat

2 = all cows treated

31. Main product used for dry treatment;

0 = Drymast

1 = Orbenin DC

2 = Quartermaster

3 = Biodry

4 = Dryclox

5 = Novamast

6 = GoDry

7 = Tomorrow

8 = Cephadry

9 = Drygard

32. Receive Foss-o-Matic somatic cell counts;

0 = No

1 = Yes

33. Percent artificial breeding (cows); (no decimal)

34. Veterinary exams;

0 = none

1 = problems only

2 = complete reproductive program

35. Percent artificial breeding of heifers; (no decimal)

36. Pregnancy checks;

0 = not done

1 = owner does

2 = hired labor does

3 = technician does

4 = veterinarian does

5 = 1 & 4 (30/70)

6 = 2 & 3 (50/50)

7 = 1 & 3 (50/50)

37. Breeding cows;

0 = not done (bull does)

1 = owner does

2 = hired labor does

3 = techician does

4 = veterinarian does

5 = 1 & 2 (50/50)

6 = 2 & 3 (50/50)

38. When breed;

0 = whenever convenient

1 = once daily AM

2 = once daily PM

3 = twice daily

4 = once daily, noon

5 = 1 or 2, but not both in one day

39. Who detects heats;

0 = not done

1 = owner does

2 = hired labor does

3 = technician does

4 = 1 & 2

40. Who breeds heifers;

0 = not done (bull does)

1 = owner does

2 = hired labor does

3 = technician does

4 = 0 & 1

41. Heat detection; number of times checks are made daily (9=continuous observation)

42. Number of stud organizations and bulls used;

Number of studs (9=any or all available)

A. Number of different bulls used per year

43. Percent young (rpt < 50%) bulls used; (no decimal)

44. Use bulls with no PDT;

0 = no

1 = yes

45. Most severe descriptive trait problem in herd; (choice of two traits)

1 = US (Udder Support)

2 = RU (Rear Udder)

3 = FU (Fore Udder)

4 = TT (Teats)

5 = HL (Hind Legs)

6 = FT (Feet)

46. Predominant location for heat detection;

1 = inside

2 = on concrete

3 = on dirt

4 = 2 & 3 (50/50)

5 = 2 & 3 (30/70)

9 = 1, 2, & 3 equally

47. Concrete lots grooved;

0 = no

1 = holding area only

2 = entire barn

3 = alleys but not holding area

5 = slatted floor barn

48. Begin breeding back; (days post-partum)

A. Heat records;

0 = no

1 = yes

2 = only after number of days stated in item 48.

49. Heat detection aids;

0 = no

1 = K-Mar

2 = chalk

3 = testosterone treated heifer

4 = altered bull

5 = 1 & 2

6 = 2 & 3

7 = 2 & 4

8 = 1 & 4

9 = 1 & 3

50. Total mixed ration;

0 = no

1 = mixer wagon

2 = mixer wagon with scales

3 = conveyor feeder

51. Parlor feeding;

0 = no

1 = yes

52. Feed analysis;

Number of times per year

A. Crops analyzed;

0 = not done

1 = silage

2 = hay

3 = mix

4 = 1, 2, 3, & concentrates

5 = 1 & 2

6 = 1 & 3 & concentrates

7 = 1 & concentrates

8 = 1 & 2 & concentrates

9 = 1 & 2 & 3

53. Feeding routine; Number of times cows are fed per day (9 = self-feeding bunker);

54. Feeding routine; Number of different people who do feeding;

55. Number of feeding groups (including dry group);

56. Determination of grouping (if any);

0 = random

1 = production level

2 = reproductive status

3 = production with modifications

4 = 1 & 2

5 = 2 & 3

57. Ration balancing;

0 = none

1 = done by feed mill or salesman (includes those who do not follow other recommendations)

2 = done by hired labor

3 = done off the farm

4 = 1 & 3

5 = done by farmer

58. Dry cow feeding;

0 = left in herd

1 = separated

59. Dry cow feeding;

0 = no grain restrictions

1 = restricted grain

60. Distance to nearest waterer in winter months;

(see 60A)

60A. Distance to nearest waterer in summer months;

1 = <50 ft.

2 = 50-200 ft.

3 = 201-500 ft.

4 = > 500 ft.

61. Use of Liquid Protein Supplements (LPS);

0 = no

1 = yes

2 = dry cows only

3 = heifers only

4 = 2 & 3 only

62. Use of Non-Protein Nitrogen (NPN); (urea);

0 = no

1 = yes

63. Use of mineral supplements;

0 = no

1 = yes

64. Use of other supplements (rumen buffers);

0 = no

1 = yes

65. Use of magnetic or challenge feeders;

0 = no

1 = yes

66. Storage facilities for ensiled forages;

1 = bulk/trench

2 = concrete upright

3 = sealed upright

4 = 1 & 2

5 = 1 & 3

6 = 2 & 3

7 = all 3

8 = all metal

67. Corn silage based ration; (>60% DM intake)

0 = no

1 = yes

68. Use of hay;

0 = none

1 = <5 lbs per day

2 = 5-10 lbs/day

3 = >10 lbs/day

69. Use of hay silage;

0 = none

1 = part

2 = main roughage (>50% DM intake)

70. Use of byproducts;

0 = none

1 = part

2 = main roughage

71. Use of high moisture grains; (>60% of concentrate)

0 = none

1 = part

2 = major grain %

72. Where are calves raised? (choice of two types of facility);

1 = cold building (pens)

2 = warmed building (pens)

3 = cold building (individual)

4 = warmed building (individual)

5 = hutches

6 = counterslope

7 = elevated stalls

8 = run loose until 30 days of age

9 = contract out heifer raising

73. Time from calving to first colostrum feeding (in hours);

74. How long colostrum is fed; (in days)

75. Form of colostrum;

1 = fresh

2 = fermented

3 = frozen

4 = 1 & 2

5 = 1 & 3

6 = 1, 2, & 3

76. Milk feeding;

1 = individually fed

2 = group fed

77. Milk feeding;

Number of times per day (9 = free access)

78. Milk feeding procedure;

1 = nipple bottle

2 = pail

3 = automated feeder

4 = foster mother

79. Milk feeding constituents;

1 = all milk

2 = mixed milk/replacer

3 = replacer (milk protein)

4 = 1 & 3 alternately

5 = 2 & 3 as available

80. Mastitic milk fed;

0 = no

1 = yes

2 = bull calves only

81. Groups; Average number of calves per group (after weaning)

82. Weaning; age in weeks

83. Percent mortality; (no decimals)

84. Ratio heifers:cows; in decimal form (x.xx).

85. Births, where calved;

1 = calving area

2 = in barn

3 = on pasture

4 = 1 & 2

5 = 1 & 3

6 = 2 & 3

86. Births, administrations;

1 = navels dipped

2 = vitamins

3 = prophylactic antibiotics

4 = anti-scour vaccine

5 = 1 & 2

6 = 1 & 3

7 = 1 & 4

8 = 2 & 3

9 = 2 & 4

10 = 3 & 4

11 = 1 & 2 & 3

12 = 1 & 2 & 4

13 = 1 & 3 & 4

14 = 1, 2, 3 & 4

15 = 2, 3 & 4

87. If calves are allowed to nurse, teats washed prior to suckling;

0 = no

1 = yes

88. Co-operator with VPI; (i.e., participating in 30-herd study or similar)

0 = no

1 = yes

89. How long in business;

1-9 in 2-year intervals

9 = 18+ years

90. Milk base;

Pounds of base per month

A. Percent co-op issued base

B. Percent Virginia State Milk Commission issued base

91. Inventory change in machinery and equipment;

92. Principal payments;

93. Refinanced recently;

0 = no

1 = ≤50%

2 = ≥50%

94. Refinancing details;

1 = within family change of ownership

2 = previously debt-free

3 = disaster loan (drought)

4 = major capital addition

5 = refinanced to Long Term

95. Operating loans used;

0 = no

1 = <10% of annual operating expense

2 = ≥10% of annual operating expense

96. Operating loan details;

1 = fertilizer/seed

2 = no specific purchases

3 = fertilizer & shell corn

4 = new operation

5 = new equipment on short term

97. Percent of cattle registered;

98. Percent equity;

99. Net milk sales;

100. Beef & veal;

101. Livestock for dairy purposes;

102. Miscellaneous income;

103. Purchased feed;

104. Other feed production costs (fert., lime, seed, custom);

105. Vet. & Medicine;

106. Hired labor;

107. Interest paid;

108. Misc. (Insurance, taxes, breeding, supplies);

109. Fuel, oil, gas, elec.;

110. Rents and leases;

A. Number of acres rented

111. Investment: Land and buildings;

112. Investment: Machinery and equipment;

113. Investment: Livestock;

114. Inventory change: Livestock;

115. Inventory change: Feed;

116. Capital changes;

117. Total debt;

118. Current debt (<1 yr); (percentage, no decimals)

119. Intermediate debt (1-10 yrs); (percentage, no decimals)

120. Long-term debt (10+ yrs); (percentage, no decimals)

121. Non-DHI approximate production; (pounds per cow per year)

122. Non-DHI approximate number of cows;

123. Non-DHI approximate butterfat percent; (x.x)

124. Non-DHI approximate cell count;

125. Average number of cows in herd (DHI);

126. Fat per cow per day (DHI);

127. Pounds of silage per cow per day (DHI);

128. Pounds of concentrate per cow per day (DHI);

129. Cost of concentrates per cow per day (DHI);

130. Income over feed cost per cow per day (DHI);

131. Blend price received at last test date (DHI);

132. Percent butterfat at last test date (DHI); (herd average)

133. Average production per cow per year (DHI);

134. DHI rolling herd average (DHI);

135. Total herd fat production per year (DHI);

136. Pounds of fat per cow per year (DHI);

137. Average age of herd in months (DHI);

138. Average age at first calving in months (DHI);

139. Average percent butterfat per year (DHI);

140. Pounds of silage per herd per year (DHI);

141. Pounds of dry forage per herd per year (DHI);

142. Pounds of concentrate per herd per year (DHI);

143. Value of product per herd per year in dollars (DHI);

144. Cost of concentrate per herd per year in dollars (DHI);

145. Total feed cost per herd per year in dollars (DHI);

146. Average feed cost per cow per year (DHI);

147. Average income over feed cost per cow per year (DHI);

148. Average blend price for year (DHI);

149. Average days dry (DHI);

150. Average days open (DHI);

151. Percent culled for dairy purposes (DHI);

152. Percent culled for low production (DHI);

153. Percent culled for poor reproduction (DHI);

154. Percent culled for disease (DHI);

155. Percent culled due to death (DHI);

156. Percent of total herd with somatic cell counts of 200,000 to 400,000 (DHI);

157. Percent of total herd with somatic cell counts of 400,001 to 800,000 (DHI);

158. Percent of total herd with somatic cell counts greater than 800,000 (DHI);

159. Percent successful breedings for year (DHI);

160. Mature equivalent milk production for first calf heifers (DHI);

161. Mature equivalent fat production for first calf heifers (DHI);

162. Mature equivalent milk production for second calf and older cows (DHI);

163. Mature equivalent fat production for second calf and older cows (DHI);

164. Mature equivalent milk production for all cows in herd (DHI);

165. Mature equivalent fat production for all cows in herd (DHI);

166. Percent of first calf heifers with somatic cell counts of 200,000 to 400,000. (DHI);

167. Percent of first calf heifers with somatic cell counts of 400,001 to 800,000 (DHI);

168. Percent of first calf heifers with somatic cell counts greater than 800,000 (DHI);

```
169. If number of milking stalls <8   then STAL = 1
                                = >8 and <10    = 2
                                = >10           = 3;
170. If number of milking units = <6  then UNITS = 1
                                 = >6 and <8      = 2
                                 = >8             = 3;
171. STALUNIT = STAL * 10 + UNITS;
172. If VACHP <3 then CVHP = 1
            = >3 and <5    = 2
            = 5            = 3;
              >5 and <9    = 4
            = >9           = 5;
173. If LINEDIAM <2  then CLD = 1
                = 2           = 2
                 >2           = 3;
174. If VACDIAM <1.5  then CVD = 1
```

= 1.5 = 2

>1.5 = 3;

175. NTCSHIPC = (NTCSHINC/AVGNUMB);

176. PROFITPC = PROFIT/AVGNUMB;

177. REALPRPC = REALPROF/AVGNUMB;

178. CASHAVPC = CASHAVAL/AVGNUMB;

179. MASTALL = MAST2 + MAST4 + MAST8;

180. GOODPRAC = TEATDIP + TOWELS + STRIP + ALCPADS + VACOFF + DRYTRTMT;

181. Average interest rate = (INTPYMT/TOTDEBT) * 100;

182. Equity Per Cow = (CAPITAL * PCTEQUIT * .01)/AVGNUMB;

183. Investment Per Cow = (CAPITAL/AVGNUMB);

184. TYPEATO = TYPEPARL * 10 + ATO;

185. SIZE = (see pages 12 & 13 for description)

186. PROD = (of these two variables)

187. CAT = SIZE * 10 + PROD;

188. NETINC = SALEMILK + BEEF + DAIRY + MISCINC;

189. NETEXP = PURCHFD + PRODCOST + VETEXP + LABOR + INTPYMT + MISCEXP + ENERGEXP + RENTS;

190. CAPITAL = LDBLDG + MACHEQP + LIVSTOCK;

191. TURNOVER = NETINC/CAPITAL;

192. PRCHFDPC = PURCHFD/AVGNUMB;

193. SALEMKPC = SALEMILK/AVGNUMB;

194. CONCEPT = (1/SUCCESS) * 100 = (number of services/conception);

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195.  TOTFDPC = PRCHFDPC + (PRODCOST/AVGNUMB);
196.  MYIOFC = SALEMKPC - TOTFDPC;
197.  MKSOLDPC = PRODVALU/AVGNUMB;
198.  BEEFPC = BEEF/AVGNUMB;
199.  TOTCULL = CULLDAIR + CULLDIED + CULLDIS + CULLPROD
      CULREPRO;
200.  VETEXPPC = VETEXP/AVGNUMB;
201.  DAIRYPC = DAIRY/AVGNUMB;
202.  DEBTPC = TOTDEBT/AVGNUMB;
203.  MAINFOR = 0 = no one major forage
                1 = corn silage main forage
                2 = haylage as main forage
                3 = at least 5 lbs. dry hay in ration;
204.  IMPROVE = MESECMLK - MEHEFMLK;
205.  TOTFDPCT = TOTFDPC/NETEXPPC;
206.  PRCFDPCT = PRCHFDPC/NETEXPPC;
207.  DHIFDPCT = YRAVGTOT/NETEXPPC;
208.  NETINCPC = NETINC/AVGNUMB;
209.  NETEXPPC = NETEXP/AVGNUMB;
210.  ENERGPC = ENERGEXP/AVGNUMB;
211.  INTPDPC = INTPYMT/AVGNUMB;
212.  PRINCPC = PRINCPMT/AVGNUMB;
213.  LABORPC = LABOR/AVGNUMB;
214.  PRODCSPC = PRODCOST/AVGNUMB;
215.  RENTPC = RENTS/AVGNUMB;
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216. MISCEXPC = MISCEXP/AVGNUMB;

217. MISCINPC = MISCINC/AVGNUMB;

218. LDBLDGPC = LDBLDG/AVGNUMB;

219. MACHEQPC = MACHEQP/AVGNUMB;

220. REG = If PCTREG < 50 = 0, if PCTREG > 50 = 1;

221. LABORPCT = LABORPC/NETEXPPC;

222. FUTDETPC = CASHAVPC multiplied by amortization factor;

223. DETCAPPC = DEBTPC + FUTDETPC

224. CLASWEAN = If WEANING < 8= 0, if WEANING > 8 = 1;

225. GMILK = (USDA Cow Index herd average) * 2;

226. GDOL = (USDA Cow Index herd average) * 2;

227. UNITSREQ = (CONCEPT * 2/((90 - MORTALTY)/100)) * (1/((100 - (TOTCULL - CULREPRO))/100));

APPENDIX III. Letter of initial contact.

COLLEGE OF AGRICULTURE AND LIFE SCIENCES

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

DEPARTMENT OF DAIRY SCIENCE (703) 961-6331

Oct. 28,1980

Dear

I am a graduate student at VPI&SU in the department of Dairy Science. I am working on a degree in dairy herd management with Dr. Mike McGilliard in cooperation with Dr. Dave Kohl, Ag Economics.

We are looking at many different management practices in an attempt to identify practices associated with changes in profit. To do this we need to gather information from herds who are willing to visit with us one time for about an hour. The information obtained from this study will not be associated with any particular herd and no records from any individual dairyman will ever be identified. The records will be computerized and all farm identification will be scratched.

Once the results have been summarized, all cooperating dairymen will receive a copy.

During the next month or so, I will phone you to discuss whether you would be willing to participate in this study by sharing with us some of the management practices you use on your farm. We would arrange a time which would not interfere with your work. Your assistance is greatly appreciated.

Sincerely,

William Zweigbaum
Research Assistant

APPENDIX IV. Letter of thanks to participating herds.

COLLEGE OF AGRICULTURE AND LIFE SCIENCES

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

DEPARTMENT OF DAIRY SCIENCE (703) 961-6331

Dear

I have completed the management survey which you participated in.

The response from dairymen around the state was exceptional and therefore it was not necessary to interview all of the dairymen originally contacted. All dairymen will receive a summary and interpretation of the results as soon as available.

As mentioned, dairymen were most cooperative, with over 90% providing all of the requested information. This close working relationship between dairymen and their state university is very gratifying and allows us to produce quality research in the field of dairy management. This will benefit the Virginia dairy industry. Thank you again for your assistance in these efforts.

Sincerely,

William Zweigbaum
Research Assistant

APPENDIX V. Letter of thanks to alternate herds.

COLLEGE OF AGRICULTURE AND LIFE SCIENCES

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

DEPARTMENT OF DAIRY SCIENCE (703) 961-6331

Dear

I have completed the management survey which you received a letter about some time ago.

The response from dairymen around the state was exceptional and therefore it was not necessary to interview all of the dairymen originally contacted. All dairymen who were not interviewed will still receive a summary and interpretation of the results as soon as available.

The survey covered in detail the areas of milking systems, milking practices, breeding programs, feeding programs, calf-raising programs, housing, facilities and financial situations.

As mentioned, dairymen were most cooperative, with over 90% providing all of the requested information. This close working relationship between dairymen and their state university is very gratifying and allows us to produce quality research in the field of dairy management. This will benefit the Virginia dairy industry. Thank you again for your assistance in these efforts.

Sincerely,

William Zweigbaum
Research Assistant

APPENDIX VI. Letter to all herds with summary of initial results.

COLLEGE OF AGRICULTURE AND LIFE SCIENCES

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

DEPARTMENT OF DAIRY SCIENCE (703) 961-6331

September 8, 1981

Dear

The data from the farm management survey have been compiled and while there is still a great deal to analyze, I do have a lot of interesting information to report. The findings, though not completed, are already too numerous to list, so instead I have prepared a summary of items. Mike McGilliard, Dave Kohl and I will continue to analyze these data through the fall.

The average dairyman in this survey milks about 81 cows, with an interval of 11.0 hours between morning and evening milkings and 13.0 hours during the night. Parlors were the most common type of milking system and accounted for 84% of the systems. Herringbone parlors were more prevalent and accounted for about 60% of the parlors, while side-openings accounted for about 40%. Double-3, double-4 and double-6 were the most common sizes and were found about equally. The dairies averaged 6 milking units, as many of the farms use one unit for two animals in parlor milking. Milking labor averaged 1.7 employees during each milking and milked an average of 37 cows per hour. The farms also averaged 325 hours of milking between inflation changes. This corresponds very well to recommendations that inflations be changed approximately every 2000 cow-milkings.

The dairies in the survey bred 83% of their cows and 49% of their heifers artificially. They checked cows for heat an average of 3 times a day and generally were not breeding any cows until 50 days after calving.

Eight-five percent of the herds parlor-fed grain to the milking herd and fed forages an average of 2.5 times per day.

Calves were weaned at an average of eight weeks. The mortality rate for young stock was 12% and there were 86 heifers and female calves for each 100 milking and dry cows. This indicates strong opportunities for herd improvement through culling.

Total farm assets averaged $665,000 for the farms in the survey. This represents assets (investment) of over $8000 per cow. This is considerably higher than the "rule of thumb" we have followed in the past and represents a tremendous non-cash expense to dairymen in the form of interest which could be made if this money were invested elsewhere.

Approximately $400,000 of this investment is in land and buildings. Another $110,000 is invested in machinery and equipment to run the dairy and $155,000 is the average value of livestock and base.

In approximately one month a revised Dairy Guideline "Let Your Budget Be Your Guide" will be available. This guideline incorporates more of the survey's information regarding the income and expenses of a dairy operation.

The survey also included information collected from 18 non-DHI herds. These herds averaged five fewer cows and production per cow was approximately 1600 pounds lower than the DHIA herds. At this time we have not attempted to identify the sources of these differences.

If you have any questions regarding this study or if I can be of any assistance to you, please feel free to contact me.

Sincerely,

William Zweigbaum

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RELATIONSHIP OF MANAGEMENT FACTORS TO DIFFERENCES IN PROFITABILITY AMONG VIRGINIA DAIRY FARMS

by

William Herman Zweigbaum

(ABSTRACT)

Seventy-seven randomly chosen herds were personally surveyed for management information. Dairymen were questioned for 1.5 hours about milking systems and practices, feeding, reproductive and genetic aspects of breeding, calf raising and finances. Seventeen non-DHI herds were included.

Objectives of the study were to assemble data that described farm management practices not found in DHI records and to relate these data to four measures of profitability.

Type of milking system accounted for production differences of 680 kg less milk for herds milking in flatbarns in contrast to parlors. Parlor type had no effect. Dry cow treatment reduced mastitis. A count of six recommended milking practices showed an annual increase of 246 kg milk per cow per practice implemented.

Optimal ages of first calving were found for average production, net cash income per cow and profit per cow. These were 35,29 and 26 months, respectively.

Genetic indices failed to explain differences in production or profitability. Feeding programs accounted for the largest portion of expenses and were of great importance

to profitability and production. Income over feed cost and feed cost as a percentage of total expense were most important, with major forage fed and degree of crop analysis having significant effects on profits.

Models using investment per cow, debt per cow, average interest rate and net income per cow were good predictors of profitability (R^2 = .29 to .52).

DHI herds were 383 kg superior to non-DHI herds in annual milk per cow, had 15 more cows and $81 more net cash income per cow, none significant. Higher production per cow led to more net cash income per cow except for medium-sized herds.