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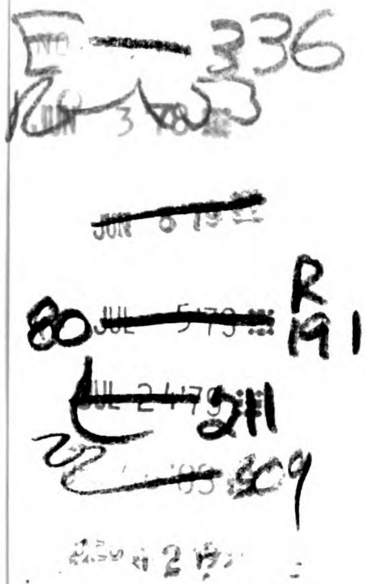
ADOPTION OF A COMPUTERIZED LEAST - COST DAIRY RATION PROGRAM BY INGHAM COUNTY, MICHIGAN DAIRYMEN

Thesis for the Degree of M. S.

MICHIGAN STATE UNIVERSITY
JAMES H. SCHOONAERT

1973



ABSTRACT

ADOPTION OF A COMPUTERIZED LEAST-COST DAIRY RATION PROGRAM BY INGHAM COUNTY, MICHIGAN DAIRYMEN

By

James H. Schoonaert

The adoption of a computerized least-cost dairy ration program by forty-eight Ingham County, Michigan dairymen was studied. The main objectives were to study the relationship of testing program (D.H.I.A. test vs. non-test), frequency of analysis (monthly vs. as needed), and herd size on adoption. Additional objectives were to study production responses attained by those herds utilizing the program and to survey herdowners for their opinions as to effectiveness, cost savings achieved, and the practicality of the program.

Adoption rate was not significantly different based on frequency of analysis or herd size ($P > .05$). However, non-test herdowners had a significantly higher adoption rate than did those herdowners participating in a D.H.I.A. testing program ($P < .05$).

No negative production responses were observed or reported by participating dairymen. Of fifteen test herdowners adopting the program, five herdowners experienced

an average increase in production amounting to 200 pounds milk per herd daily. Of the twenty-three non-test herdowners adopting the program, nine herdowners experienced an average daily increase in production of 191 pounds milk per herd.

Herdowners not experiencing an increase in production were asked to estimate savings incurred in monthly feed costs. Of herdowners on test, five estimated savings of less than $50 per month, three at $50-100, two at $100-200, and one at more than $200. Of non-test herdowners, one estimated savings at less than $50 per month, and two estimated savings between $50-100.

Seven test herdowners and eleven non-test herdowners who adopted some version of the initial analysis averaged a savings of 7¢ per cow per day. However, if all forty-eight dairymen would have adopted the initial analysis, the average savings would have been 12¢ per cow per day.

Four test herdowners and one non-test herdowner indicated they had not adopted the program when surveyed. Five test herdowners indicated adoption of the program when surveyed, but did not actually adopt the computer formulated ration as observed by the author.

A six-month post-survey period was utilized to moniter actual usage by participating dairymen. Two test and eight non-test herdowners utilized the computer program at least once during the six-month period. At the conclusion of the six-month period, twenty-four of the forty-eight

dairymen agreed to fund the touch-tone phone installation in the local extension office.

As a result of this study, it was concluded that dairymen did adopt a computerized least-cost dairy ration program because of its effectiveness, potential to reduce feed costs while maintaining milk production, and its practicality.

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A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Dairy Science

1973

G-78916

ACKNOWLEDGMENTS

The author extends his sincere appreciation to his academic advisor, Dr. John Speicher, for his excellent guidance and invaluable assistance throughout the pursuit of this advanced degree.

Excellent counsel was contributed by Dr. John Speicher, Dr. Stephen Harsh, and Dr. Donald Hillman in the development of this project, completion of this research study, and in preparation and editing of this thesis.

The author also expresses sincere thanks to Dr. John Gill for his valuable assistance in the statistical analysis of the data.

Finally, the author is especially grateful to his wife, Marcia, and his two sons, David and Brian, for their patience and understanding throughout the pursuit of this advanced degree.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

Michigan dairymen have always been concerned with feed costs and their direct relationship to returns above feed costs. As the dairy business becomes more complex, dairymen are also more concerned about total feed costs as a percent of total livestock production costs. As herds increase in size, the trend is toward more purchased feed. This is due to the lack of enough good agricultural land to raise the grain as well as the roughages required in the ration.

With the advent of computers, the formulation of balanced least-cost rations has become possible on a wide scale basis and the dairymen have considered this tool as a potential ally in combating continually rising costs of production.

The objectives of this project were to study the adoption of a computerized least-cost dairy ration program by test (D.H.I.A.) and non-test herdowners in Ingham County, Michigan. Secondly, to determine how much savings could be achieved by utilization of the program and how often the program needed to be run under local conditions. Thirdly, to study production responses of those herds

utilizing the program. Finally, to survey herdowners for their opinions as to the effectiveness, if any cost savings were achieved, and the practicality of the program.

REVIEW OF LITERATURE

History of Least-Cost Rations

During the five year period of 1967 through 1971, feed costs in Michigan have averaged 50% of total livestock costs according to Brown (4). These costs were obtained from farm records kept by Michigan Telfarm cooperators who operate specialized dairy farms in Southern Michigan. Telfarm is a computerized record-keeping project developed at Michigan State University. With feed costs representing such a high percentage of total costs, it is quite evident why computerized least-cost ration programs have been developed over the last two decades.

This development began in 1951 when Waugh (33) utilized linear programming techniques to determine the least-cost combination of feeds for dairy cattle. Waugh, an economist with limited nutritional background, was reluctant to attempt to get dairymen to accept the program as practical.

During the remainder of the fifties, agricultural economists utilized linear programming techniques to solve for minimum cost feed mix problems for the feed mill operator or feed manufacturer. Hutton, et al.(20), Hutten, et al. (21), Katzman (22), McAlexander, et al. (24), and

Swanson (32) all contributed research in the aforementioned manner.

In 1963, Coffey, et al. (8) estimated milk production functions. While not the first to do this, their findings indicated that significant differences in returns did exist between rations which were fed free-choice. They further concluded that linear programming procedures were appropriate for handling dairy feed problems.

Also in 1963, Church, et al. (7) were evaluating beef cattle fattening rations formulated with linear programming techniques. Data from their initial trial showed that linear programming procedures could be effectively used to formulate fattening rations.

In 1964, Weeks (34) developed a profit maximizing model which took into account nutritional considerations as opposed to cost minimizing models which had been applied to feed mill operating conditions. This model was developed to utilize wheat as a feed because the local price farmers received for wheat was low.

In 1969, George, et al. (12) examined the relationship between level of grain and forage feeding and milk production of dairy cows with varying inherent capacities. Their results showed that the revenue maximizing level of grain feeding increased as inherent production capability increased. Furthermore, their results implied that cows with greater potential (7,272 kg or more) could be profitably fed more than 2,954 kg of concentrates. For these high

producing cows, profitability appeared to be limited more by palatability and appetite than by milk-feed relationships.

Also during 1969, Noller, et al. (27) applied the linear programming technique for making economic comparisons of forages. This procedure permitted the determination of the maximum that could be paid for a given feed under specific conditions. Their data implies that the relative value of alfalfa as a roughage is related to both the protein and energy content. Furthermore, it is much more valuable in a ration when due consideration is given to both items simultaneously rather than individually.

Spahr (29) developed a feeding program for lactating cows using a series of computer-formulated least-cost complete feeds fed ad-libitum. This sytem was designed to consider long-term cow response in relation to the level of production and feed cost.

In 1971, McDonough (25) developed a linear programming method for solving the least-cost of gain ration. His thesis was that the conventional least-cost criterion for blending beef cattle rations would not necessarily result in the cheapest overall ration. Thus, he utilized Lofgrens concepts regarding net energy (maintenance) and net energy (production).

In 1972, Chandler, et al. (6) derived mathematical equations to predict the nutritional requirements for lactating dairy cows based on the 1971 National Research

Council (NRC) requirements. These equations were then programmed into the computer to generate nutrient specifications for use in least-cost dairy rations.

Consequently, utilization of computer programs became more widespread as the seventies approached. Candler, et al. (5) suggested that computer "software" (programs) for farm management extension should meet three specific criteria. First of all, information obtained from the farmer and the results returned to him must be easily understood, i.e., clarity. Secondly, a minimum delay should exist between data input and availability of an answer, i.e., speed. Finally, unreliable "software" is high cost. Thus, a reliable fixed structure, the "software" must be available to assure the extension worker and the farmer of a reliable answer.

Research Studies Measuring Responses to Adoption of Computerized Least-Cost Ration Programs

In 1968, Howard, et al. (17) reported results of their least-cost complete ration experiment. Two least-cost linear programmed computer formulated rations were compared to a conventionally formulated ration in a 20-week continuous trial. One of the computerized rations was reformulated bi-weekly (LCV) while the other computer formulated ration remained constant (LCC).

Ration treatment did not significantly affect dry matter consumption per 100 kg bodyweight, actual milk

production, fat-corrected milk production, milk fat and solids-not-fat, and body weight gains. Abrupt ration changes under the conditions of their research did not significantly affect animal performance. Daily feed costs were significantly reduced for both computerized rations when compared to the control. Also, there were no significant differences in health disorders.

Bath, et al. (1) reported results from four feeding trials involving 251 dairy cows. The trials compared the performance of cows fed commercial concentrate mixes with cows fed least-cost concentrate mixes. Double-reversal designs were used in three of the trials while the fourth was a 300 day trial. The cows in the double-reversal trials did not appear to have any digestive, physiological, or palatability problems when switched abruptly from one mix to the other.

In one trial, an increase in milk production offset a decrease in fat test, both statistically significant at the 1% and 5% level respectively. While in the other three trials, there were no significant differences. Results of these trials indicate that savings can be made in feed costs by utilizing computerized least-cost rations. While at the same time, equal milk production can be maintained. Savings ranging from $1.05 to $4.49 per metric ton of feed resulted in these trials.

Dean, et al. (11) extended the least-cost ration formulation to the next logical step of profit maximization.

They utilized an L.P. model which simultaneously selected concentrate and roughage components of the ration, the roughage-concentrate ratio, level of feeding per cow, and quantity of milk production maximizing income over feed costs.

This linear programming model was applied to typical production situations in Northern and Southern California. Optimum milk production in Northern California was 23.59 kg per day with a daily income above feed cost of $1.49 per cow. Whereas in Southern California, optimum milk production was 24.04 kg per day with a daily income above feed costs of $1.66 per cow. This was due to prices of feed inputs which are affected by local availability and also to a higher blend price for milk usually received in Southern California.

Bath, et al.(2) conducted a complete lactation field trial on a 180-cow dairy herd. Their objective was to test a computer program designed to formulate rations which result in maximum income over feed costs from lactating dairy cows. This computer program was the one described by Dean, et al. (11).

The mean mature equivalent milk production was 8,602 kg for cows fed the computer formulated ration compared with 8,504 kg from the control group. Cows fed the computer formulated rations returned $15 to $21 more income over feed costs per year than cows fed the control ration which was formulated in the conventional manner.

Only one negative production response has been reported in the literature. That involved a 135-day trial conducted by Hawkins (14). Twelve cows received a control blended ration throughout the trial. Another 12 cows were switched abruptly from the control ration to a least-cost blend ration 1 (LCBR 1) for 28 days to LCBR 2 for 35 days and then to LCBR 3 for the remainder of the trial. Cows were adversely affected by frequent changes in the computer formulated ration as indicated by a significant depression in milk yield of 2.6 kg daily.

Empirical Results Regarding the Use of Least-Cost Ration Programs

White, et al. (35) conducted a computer-formulated least-cost ration demonstration for 52 weeks with a 40-cow Holstein herd in Texas. DHIA production increased 413.6 kg of milk and 12.3 kg butterfat in one year. Savings of the least-cost ration mix compared to the original herd ration varied from $5.08 to $12.82 per metric ton. The dairy averaged savings of $9.21 per metric ton, or since 2.74 metric tons of concentrate were purchased per week, a savings of $1315 during the year.

Hutjens, et al. (19) conducted a pilot program in eight Minnesota counties utilizing a least-cost ration program developed by Harsh, et al. (13). A forage testing program was also implemented to estimate forage quality to input into the program. Rations were balanced in the presence of the dairymen and they received output from

three to seven balanced rations (varying production levels, feed costs, feed quality, and feeds available).

County agents were surveyed to evaluate time expenditure, intentions with regard to future use, and effectiveness of the total program as an educational tool. Farmers were surveyed concerning ration changes, effects on production and feed costs.

Of the fifty dairymen involved in the initial trial, twenty-eight responded to the survey. Twenty-three of the twenty-eight responding plan to continue to use the computer program. The average computer cost was $3.00 while the long-distance phone call amounted to $10.40.

A Winona County dairyman reported savings of 40¢ per cow per day, while a Dakota dairyman obtained a 10 lb. per cow per day increase in milk production. No negative production responses were reported.

Minnesota extension personnel projected that 297 dairymen would utilize the program in 1972-73.

Future Methods of Feeding Dairy Cattle

As modern dairy farms expand in size, technological advancement has made substantial progress to improve the milking facilities and equipment. This has become necessary to combat rising labor costs associated with the handling, housing and milking of dairy herds in the traditional manner. However, as technology is developed to solve some of these new problems, additional problems were created. For example, milking parlors reduced milking time required

for these larger herds. But at the same time, the amount of time that the dairy cow spends in the parlor is inadequate if a high producing cow is to receive enough concentrates to meet her requirements. Thus the dairymen is faced with overfeeding the bottom end of the herd or underfeeding the top cows in early stages of lactation.

In Michigan, many milking parlors have been constructed without means of regulating the amount of concentrates cows can receive in the parlor. Thus cows at the tail-end of lactation are overfed and fresh cows, because of the time element, are underfed. A redistribution of this concentrate has the potential to attain a higher level of production with the same amount of concentrates. At the same time, this would reduce many of the health problems observed by Hillman and Newman (15) in Michigan.

There is a substantial amount of research that indicates that feeding some type of complete feed can overcome the feed intake problems created with the advent of milking parlors. Muller, et al. (26) concluded that lactating cows can efficiently utilize a group fed, complete mixture of corn silage and concentrates.

Stoddard (31) observed that cows not being fed grain in the parlor stood quieter and appeared more contented. This observation has also been made by Michigan dairymen who have discontinued the practice of feeding grain in the milking parlor.

A symposium prepared by Rakes (28) cautions that while complete feeds are advisable in some management situations, certain cow health problems can be encountered with ad libitum feeding of a single ration to the entire herd. However, these difficulties seem to be more related to physical form and roughage content rather than to the actual blending of the ingredients.

Huff, et al. (18) obtained no significant difference between two feeding regimes for milk production and composition, body weight changes and cow health. One group received a complete feed, while the other received a traditional ration of concentrates and roughages separately.

Similar results were obtained by Hooven, et al. (16) when comparing a complete feed to a traditional ration.

A switchback trial was conducted by Coppock, et al. (9) to compare the effect of individual versus group feeding on feed intake and milk production. Again, no significant differences in milk production, fat test, or body weight changes occurred. However, group fed cows consumed 7.1% more dry matter daily. This was attributed to an increased maintenance-activity factor.

Martz, et al.(23) studied the frequency of feeding of a complete ration. Results indicated that 2X day feeding versus 4X day feeding had no significant benefit with regard to daily fat-corrected-milk production, milk composition, body weight changes, and ration intake. The ration

consisted of a blended corn silage-concentrate ration containing a pelleted urea-alfalfa supplement.

Baxter, et al. (3) reported that milk production was significantly greater for cows fed a 22% crude protein concentrate individually than for cows receiving the same concentrate blended with corn silage. In addition, birds were a nuisance in the lot where the complete ration was fed.

Spahr and Harshbarger (30) fed a complete ration of corn silage and concentrates mixed to form low, medium, and high energy complete feeds. These were fed for 8-week periods as the only source of energy and protein to grcups of cows producing low, medium, and high daily amounts of milk. At the end of each 8-week period, cows were regrouped, fresh cows were added, and cows due to go dry were removed from the experiment. The complete feeds used in this trial met the general desired requirements of approaching maximum production performance for the production level with which they were matched without causing any metabolic disturbances.

Coppock, et al. (10) found that as concentrate portion of complete feeds was increased, occurrence of displaced abomasum also increased. However, this trial included prepartum ad libitum intake of one of four complete feeds: a) 75:25; b) 60:40; c) 45:55; and d) 30:70 forage to concentrate ratios. The authors concluded that there seems to be little reason to continue the practice of lead feeding prepartum if cows are in good condition at drying off.

There is enough evidence in the literature that substantiates that properly managed complete feeds can be effectively utilized to maximize production in large modern dairy facilities. This practice would overcome many production problems as well as herd health problems now encountered in local Michigan dairy herds.

EXPERIMENTAL PROCEDURE

Sample Selection

A total of 48 Ingham County dairymen participated in the trial. Dairymen were divided into those herds on a D.H.I.A. testing program and non-test herds. A further subdivision was made on the basis of herd size: a) less than 35 cows; b) 35-75 cows; and c) more than 75 cows. Eight herds were then randomly selected within each of the six sub-groups. One-half or four herds were randomly assigned to have their ration computed on a monthly basis, if necessary, and the remainder as often as the herdowner believed the ration should be recomputed. Final selection criteria was that the randomly selected dairymen must be willing to cooperate with the author. This amounted to a commitment of time prior to the initial computer run for an explanation of the computer program and the initial run via the touch-tone telephone.

Initial Explanation of Program to Herdowners

Approximately one hour and fifteen minutes was spent with each of the 48 dairymen prior to the initial run. At this time, the dairymen were informed that the computer

balanced the ration in a manner similar to that a person would using a pencil and the traditional method of ration balancing. The computer offered the additional dimension of meeting the nutrient requirements by including the least-cost combination of feeds in the ration.

A brief explanation was made of the constraints built into the computer program. Among these were a review of the feed tables prepared by Harsh, et al. (13), the minimum fiber level being set at 15%, the maximum NPN level as a percent of crude protein equivalent (30%), the maximum urea level in the grain ration (1.5%), and that the nutrient requirements for cows were based on National Research Council standards for maintenance, milk production and butterfat test.

Following this, the author discussed the individual's feeding program including feedstuff availability, prices, how roughages and concentrates were fed, production level for which the ration was to be balanced, batch size and associated costs. From this discussion, necessary information was determined to complete the input form for Telplan Program 31 developed by Harsh, et al. (13).

The dairyman's ration was computed in his presence via touch-tone telephone linked to a computer at the University of Michigan, Ann Arbor. A basic analysis and 3 to 5 adjusted analyses were computed to give him alternative feeding programs to consider and also to demonstrate the flexibility of the computer program. The dairyman

indicated which ration was acceptable, if any, and was then advised that the answer obtained was only as good as his estimate of forage quality and estimated feed intake levels.

Follow-Up Procedures

Within seven to ten days, the author visited the dairymen to see if any changes were made in their feeding program. The author was also interested in any problems encountered by the dairymen and the effect the adoption of the program had on production.

During the following year, visits were made monthly to those herds so designated and the rations were recomputed if any major changes occurred in the roughage program or level of production. The herds designated "as needed" were recomputed whenever the dairyman requested that they be recomputed. Results of each visit were recorded including production responses, if any, and any cost savings encountered by the dairyman. The dairyman did not need to be present each time the ration was recomputed. Results of the recomputed ration were given to the dairyman via the telephone or a personal visit.

Survey Instrument

At the conclusion of one year, dairymen were surveyed concerning their opinions with regard to effectiveness, optimum frequency of analysis, what constituted sufficient reason for another ration formulation, their intentions with regard to future use, production responses observed,

and if any cost savings were achieved. The Least-Cost Dairy Ration Survey is included under Appendix.

Post-Survey Observation

At the conclusion of the survey, dairymen who continued to utilize the computer program were required to pay for the long-distance telephone call to the computer. For Ingham County dairymen, this amounted to 20¢ per minute. The time required to compute a basic analysis and several adjusted analyses was 20-30 minutes. Thus, the dairyman must be willing to spend $4-$6 for a long-distance telephone call. Since intentions to use and actual use are not one in the same, the author conducted a six-month post-survey to ascertain a better estimate of adoption practices of Ingham County dairymen.

RESULTS AND DISCUSSION

Difference in Cost of Original Ration Vs. Least-Cost Ration

The greatest opportunity to reduce feed cost per cow per day occurred on the initial analysis. Once a herdowner adopted the least-cost ration, additional cost reductions were of a reduced magnitude. The range in potential savings was from 1¢ per cow per day to 61¢ per cow per day. The wide range in potential savings can be explained in several different ways.

First of all, home grown feeds were more abundant on those farms which could have encountered lesser savings. As potential savings increased, more purchased feed was utilized including some rather expensive commercial protein supplements. In the monthly-test group, the average savings of 32¢ was high because two of the herdowners in the group were overfeeding relative to requirements for their level of production. The difference between test and non-test can also be attributed to the personal feeding biases of the herdowners on test. Table 1 shows the average savings offered by the least-cost ration versus the original ration (per cow per day).

TABLE 1.--Potential savings per cow per day to Ingham County dairymen through the use of least-cost rations.

	All Herds	Monthly		As Needed	
		Test	Non-Test	Test	Non-Test
Less than 35 cows	$.15	$.33	$.04	$.14	$.05
35-75 cows	.11	.17	.08	.07	.16
More than 75 cows	.11	.13	.06	.12	.13
Mean	.12	.21	.06	.11	.11

Each value in Table 1 is the average of the four herds in that group. Under the conditions of this trial, 20¢ per minute for a 25 minute long-distance phone call and approximately the same for the computer charge, would result in a cost of $10 to the dairyman. A 30-cow herd with an average reduction in feed costs of only 4¢ per cow per day would recover the cost of the phone call and the computer charge in nine days. For a 30-cow dairy herd achieving a 33¢ per cow per day average reduction in feed costs, only one day would be required to recover costs of the phone call and the computer charge.

In large dairy herds--more than 75 cows--the average savings ranged from 6¢ to 13¢ per cow per day. Thus to recover the same $10 fee for phone and computer

charges, a 75-cow dairy would need only three days and one day respectively.

The 48 herds in this study would have averaged savings of 12¢ per cow per day if all herdowners would have adopted the initial least-cost ration analysis.

Adoption

Follow-up visits with cooperating dairymen shortly after the initial run provided the number of dairymen adopting some version of the least-cost ration program. As shown in Table 2, a total of 18 herds adopted some version of the program initially and experienced an average savings of 7¢ per cow per day.

No negative production responses were encountered by any of the eighteen herdowners. The range in savings was from 2¢ to 15¢ per cow per day. Thus a 30-cow herd would recover costs of the program in eighteen days and three days respectively.

Over the period of one year, 38 of the 48 dairymen adopted the program. Of the 38, 15 were test herds and the remaining 23 were non-test herds. A 3-criterion chi-square analysis was made to test if the adoption of the computer program was independent of herd size and whether or not the herdowner participated in a D.H.I.A. testing program. Adoption was not independent of herd size and testing program ($P < .05$).

TABLE 2.--Savings achieved (per cow per day) by Ingham County dairymen initially adopting some version of the least-cost ration program.

	All Herds	Monthly		As Needed	
		Test	Non-Test	Test	Non-Test
Less than 35 cows	$.07 (6 herds)	$.11 (1 herd)	$.02 (1 herd)	$.09 (2 herds)	$.06 (2 herds)
35-75 cows	.06 (7 herds)	.-- (0 herds)	.05 (3 herds)	.04 (2 herds)	.10 (2 herds)
More than 75 cows	.08 (5 herds)	.10 (2 herds)	.08 (1 herd)	.-- (0 herds)	.06 (2 herds)
Mean	.07 (18 herds)	.10 (3 herds)	.05 (5 herds)	.07 (4 herds)	.07 (6 herds)

Thus a 2-criterion chi-square analysis was made of adoption and herd size, adoption and testing program, and adoption and frequency of analysis (monthly vs. as needed). There was no significant difference in adoption rate based on herd size or frequency of analysis ($P > .05$). However, non-test herds had a significantly higher adoption rate than did those herds on a testing program ($P < .05$). One thinks of dairymen who participate in D.H.I.A. programs as more progressive and on the average, better dairymen. It was expected that test herdowners would adopt the least-cost dairy ration program at least as readily as non-test herdowners. But the opposite occurred as non-test herdowners more readily adopted the program. The difference may have been due to less bias toward the composition of rations on the part of the non-test herdowners; or because more of the non-test herdowners were originally feeding rations that were not properly balanced. This is verified by the greater number of positive production responses observed in non-test herds discussed in another section of this thesis.

Frequency of Analysis

The average number of ration analyses computed per year are shown in Table 3.

Herds assigned to the monthly group only required an average of 2.66 analyses per year. However, in the "as needed" group of herds, 3.08 analyses were computed. The

TABLE 3.--Average number of least-cost ration analyses computed per year by Ingham County dairymen.

	All Herds	Monthly		As Needed	
		Test	Non-Test	Test	Non-Test
Less than 35 cows	2.56	2.00	2.50	3.25	2.50
35-75 cows	2.94	3.00	3.00	2.75	3.00
More than 75 cows	3.12	3.00	2.50	3.25	3.75
Mean	2.87	2.66	2.66	3.08	3.08

range in number of analyses was from 1 to 6. The 48 herds averaged 2.87 analyses per year. It appears that the number of times the program needs to be run is dependent on the individual dairyman's feeding situation. Dairymen who raise all of their roughage and grain would require fewer analyses than those who raise only a portion of their roughage, raise only limited quantities of alfalfa, or purchase most or all of their grain. This is consistent with the results obtained in surveying the participating dairymen.

Production Responses Observed

Production increases were observed in 14 of the 48 herds. The mean increase was 195 lbs. per herd per day.

The net increase in feed costs for these 14 herds amounted to $27.67 per day. Increased milk sales per day amounted to $163.56 assuming the price of milk at $6.00 per cwt.

When surveyed, these fourteen dairymen thought that their production response was greater than it actually was as their estimate averaged 238 lbs. per herd. No negative production responses were observed or reported by cooperating dairymen.

Adoption--Survey Vs. Observed

When surveyed, 20 test herdowners indicated that they had adopted the results of the computer program. Twenty-three non-test herdowners gave a similar response. As shown in Table 4, 15 test herds and 23 non-test herds adopted the least-cost ration program sometime during the one-year trial.

Of the 20 test herds, nine herdowners thought that they had experienced a daily increase in production amounting to 2,350 lbs. additional milk per day or 260 lbs. per herd. However, by observation of milk weights, the author determined that only five test herds experienced an increase in production amounting to 200 lbs. per herd per day. Of the nine who thought they had received an increase in production, seven indicated that they were underfeeding protein and three that they were also overfeeding energy at the same time. The remaining two indicated that they were underfeeding energy. In reality, the five herds experiencing increased milk production were underfeeding protein while

TABLE 4.--Adoption of least-cost ration results by Ingham County dairymen--Survey (Sur.) versus Observed (Obs.).

	All Herds				Monthly				As Needed			
	Test		Non-Test		Test		Non-Test		Test		Non-Test	
	Sur.	Obs.	Sur.	Obs.	Sur.	Obs.	Sur.	Obs.	Sur.	Obs.	Sur.	Obs.
Less than 35 cows	6	4	8	8	3	1	4	4	3	3	4	4
35-75 cows	7	7	8	8	3	3	4	4	4	4	4	4
More than 75 cows	7	4	7	7	4	2	3	3	3	2	4	4
	20	15	23	23	10	6	11	11	10	9	12	12

at the same time, three were feeding too much energy because of high corn silage rations.

Only one test herd was overfeeding protein. A daily cash savings of $6.00 resulted when protein levels were reduced to those indicated in the computer result.

Eleven herdowners expressed the opinion that while no difference could be observed in production, a savings in monthly feed costs did occur. Five herdowners estimated monthly savings at less than $50, three at $50-100, two at $100-200, and one at more than $200.

Of the twenty-three non-test herds adopting the program, twenty thought that they had experienced increased milk production totaling 5,170 lbs. per day or 258 lbs. per herd. In reality, only nine herds averaged 191 lbs. daily increase in production as determined by observation of milk weight slips in the milkhouse. Of the remaining herdowners who could not observe any difference in milk production, one estimated savings of less than $50 per month, while the remaining two estimated $50-100 savings per month.

Eighteen of the twenty herdowners who thought that a positive production response was encountered, believed that their herds were not receiving enough protein. The remaining herdowners both thought their problem was a lack of energy. Of the nine herdowners actually experiencing increased milk production, the increase could be attributed to a correction for insufficient protein in the ration. Several were also overfeeding energy.

Four test herdowners and one non-test herdowner indicated that they had not adopted the program when surveyed. Two of those non-adopters stated that the cost of the computer ration was not enough different from their own ration. Two others stated that the program did not fit their feeding situation. The fifth herdowner could not believe the ration the computer had calculated for his herd.

Herdowners were asked to estimate the minimum number of times per year that they would have to rebalance their ration. Only one test herdowner estimated four times per year, eight estimated three times, eleven estimated twice, and the remaining herdowners estimated only once. The average for these twenty-four test herdowners was 2.25 times per year. The same question was asked of non-test herdowners. Seven responded three times per year, sixteen estimated twice, and the remaining herdowner only once. These twenty-four herdowners estimated an average of 2.25 times per year also.

All herdowners were asked what conditions made it desirable for them to rebalance their ration. Responses were as follows:

a) major changes in kind of roughage 44
b) changes in price of feed inputs 9
c) substantial changes in level of production . 13
d) changes in quality of the same roughage . . 22
e) other 5

Herdowners were also asked to respond to two general questions about computers. The first was if they believed computers could be a valuable tool to assist them in making management decisions on their farm. Forty-four herdowners responded yes. One herdowner gave a negative response and the remaining herdowners indicated no opinion.

The final question in the survey asked for any reservations the herdowner had about using the computer to assist him in making management decisions. Herdowners could respond to more than one alternative. Seven herdowners indicated that the computer gave them more information than they needed or understood. Only one herdowner stated that the opposite was true, the computer did not give him enough information. Sixteen herdowners were not sure about the assumptions that the computer works on. Only one herdowner believed that computers can and do make mistakes. Thirty-five herdowners had no reservations about using the computer and further indicated that the person inputting the information into the computer and not the computer was responsible for any mistakes.

Post-Survey Observation

A six-month post-survey period (March through August) was utilized to compare actual use of the program to those dairymen who indicated an intention to use the program. When surveyed, 22 of 24 test herdowners indicated an intention to use the program in the future. During the

six-month time period, only two test herdowners actually utilized the program to rebalance their ration.

Twenty-one of the twenty-four non-test herdowners gave a positive response to the same question. At the conclusion of six months, 8 of the 21 had utilized the program at least once. This can be explained in several ways. Under local conditions, the average dairy herd experiences declining production during this six-month period as most cows are bred to freshen during the base milk marketing period--August through December. Consequently, the transition from winter feeding to a summer feeding program is less critical than the opposite switch during the base setting months. Secondly, as indicated earlier, the greatest savings can be encountered when making the initial adoption. Any subsequent savings are of a lesser magnitude.

At the conclusion of the six-month post-survey period, a new source of funding had to be obtained to keep the touch-tone phone installed in the local extension office. Twenty-four of the forty-eight herdowners in the project provided the necessary funding to maintain the phone for the following year. In addition, they were required to pay for the long-distance phone call as well. This is a more accurate indication of the adoption of the least-cost dairy ration program by Ingham County dairymen.

SUMMARY AND CONCLUSIONS

Adoption of a computerized least-cost dairy ration program by forty-eight Ingham County, Michigan dairymen was studied in this project. Objectives were to compare the results in D.H.I.A. tested herds with non-tested herds (test vs. non-test), frequency of analysis (monthly vs. as needed), and herd size on adoption. Additional objectives were to study production responses achieved by those herds utilizing the program and to survey herdowners for their opinion as to effectiveness, cost savings possibilities, and practicality of the program.

There was no significant difference in adoption rate based on frequency of analysis or herd size ($P > .05$). However, non-test herdowners had a significantly higher adoption rate than did those herdowners participating in a D.H.I.A. testing program ($P < .05$).

No negative production responses were observed or reported by participating dairymen. Of fifteen D.H.I.A. test herdowners adopting the program, five herdowners experienced an increase in production amounting to 200 lbs. per herd daily. Of the twenty-three non-test herdowners adopting the program, nine herdowners experienced a daily

increase in production averaging 191 lbs. of milk per herd.

Four test and one non-test herdowners indicated they had not adopted the program when surveyed. Five test herdowners indicated adoption of the program when surveyed, but did not actually adopt the computer formulated rations according to the observations by the author.

A six-month post-survey period was utilized to moniter actual usage by participating dairymen. Two test herdowners and eight non-test herdowners utilized the computer program at least once during the six-month period. At the conclusion of this six-month period, twenty-four of the forty-eight dairymen agreed to fund the touch-tone phone installation in the local extension office.

Herdowners not experiencing an increase in production were asked to estimate savings incurred in monthly feed costs. Of herdowners on test, five estimated savings of less than $50 per month, three at $50-100, two at $100-200 and one at more than $200. Of non-test herdowners, one estimated savings of less than $50 per month, and two estimated savings at $50-100. No herdowner adopting the program experienced zero savings.

Seven test herdowners and eleven non-test herdowners who adopted some version of the initial analysis averaged a savings of 7¢ per cow per day. However, if all forty-eight dairymen would have adopted the initial analysis, the average savings would have been 12¢ per cow per day.

Thus it was concluded that dairymen did adopt a computerized least-cost dairy ration program because of its effectiveness, potential to reduce feed costs while maintaining milk production, and practicality.

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APPENDIX

LEAST-COST DAIRY RATION SURVEY

1. Name_____

2. No. of cows (milking and dry)_____

3. Did you use the results obtained when the program was run for your feeding situation? yes_____ no_____

If no, please indicate why not.

a) I couldn't believe the answer_____

b) My ration would have changed too much_____

c) The cost wasn't enough different_____

d) The program doesn't fit my situation_____

e) Other_____

If yes, did you get a response?

a) Increase in production_____

b) Decrease in production_____

c) I couldn't observe any difference_____

If an increase, please circle those that you believe apply to your situation.

a) I was underfeeding protein

b) I was overfeeding protein

c) I was underfeeding energy

d) I was overfeeding energy

e) Other (please describe)_____

_____

How much additional production per day?_____lbs. no cows._____

If decrease in production, why (please circle)

a) Improper assumptions with regard to feed quality.

b) Didn't balance ration for sufficient level of production

c) other (please elaborate)_____

_____

_____

If you couldn't observe any change in production, did using "Synthia's" answer save you any money? yes_____ no_____

If yes, how many dollars would you estimate per month?

_____a) less than $50

_____b) $50-$100

_____c) $100-$200

_____d) more than $200

4. Keeping in mind that you will have to pay approximately $8-$10 each time you would use this program, do you intend to utilize this program in the future?

yes_____ no_____

If yes to question 4,

5. Please estimate the minimum number of times per year you would need to balance your ration?

a) monthly b) 6 times per yr. c) 4 times per yr.

d) 3 times per yr. e) 2 times per year

f) other (please specify)_____

6. Under what conditions would it be desirable for you to balance the ration.

   a) major changes in kind of roughage

   b) changes in price of feed inputs

   c) substantial changes in level of production

   d) changes in quality of the same roughage

   e) other (please specify)_____

   _____

7. In general, do you believe computers can be a valuable tool to assist you with management decisions on your farm?

   a) yes_____ b) no_____ c) no opinion_____

8. What reservations do you have about using the computer to assist you in making management decisions?

   a) It gives me more information than I need or understand

   b) It doesn't give me enough information

   c) I'm not sure about the assumptions that the computer works on.

   d) I believe that computers can make mistakes.

   e) I have no reservations about using the computer. The computer doesn't make mistakes, the person inputting the information makes the mistakes.

   f) other_____

   _____

   _____

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