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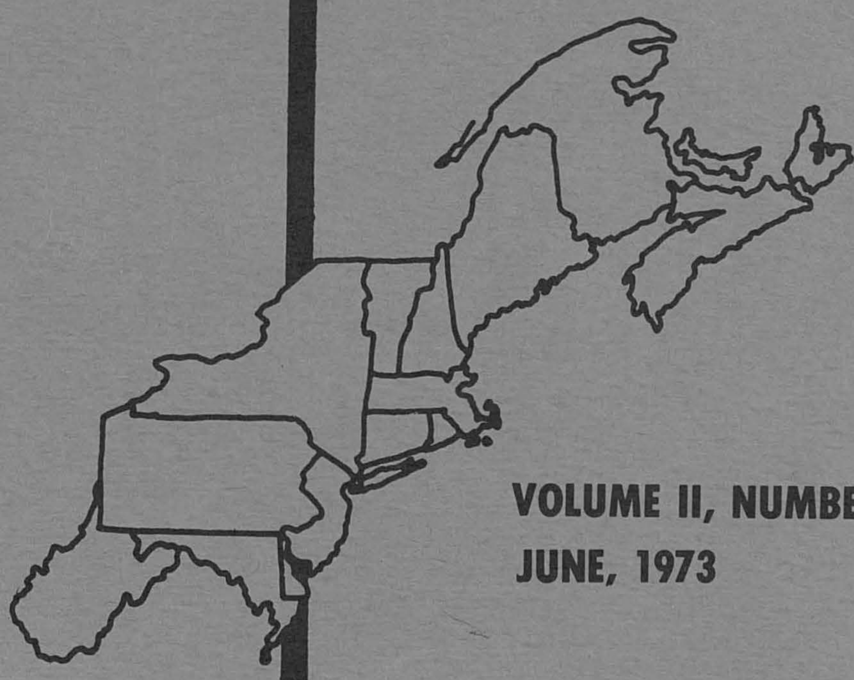

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INTERACTIVE COMPUTER COSTS FOR CALCULATING DAIRY RATIONS

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Introduction

The purpose of this study was to analyze the cost and potential for extension field application of four computer systems. Each system was designed to provide a nutritionally balanced least cost ration for feeding one dairy cow for one day given a variety of roughages and concentrates.1/

Dairy and business management specialists from the University of Maine, New Hampshire and Vermont discussed in March, 1972, the demand for and feasibility of an extension educational program for dairy farmers based on providing computerized ration suggestions. The following factors indicated demand for such a program existed: 1) A dairy ration program in the North Central Region had received a significant amount of use, [1] 2) Agway, a Northeastern farmer cooperative, had made least cost ration suggestions available on a fee basis which had been favorably received by farmers, [4] 3) feed dealers had approached the specialists for help in obtaining computerized ration calculation capability and, 4) a pilot extension project of ration calculations at the University of Maine created more farmer requests for help than the specialists were prepared to handle. The participants concluded that a need existed and agreed to move ahead with an educational program in each of the three states. The following analysis was prepared to help extension personnel judge the feasibility of utilizing currently available computer systems.

Problem Statement

Four interactive computer systems for calculating nutritionally balanced least cost dairy rations were analyzed during August, 1972. Access already existed to time sharing (interactive) computer centers. [6] Solving algorithms (computer software) were residing in each hardware system to construct and solve linear programming feeding matrices.

1/ The author conducted the research while at the University of New Hampshire.

Sufficient knowledge existed about animal nutritional requirements and feed specifications to assemble linear programming feed matrices. No additional software development was required prior to testing any of the systems. The primary objective of the analysis was to determine the cost of providing specific ration suggestions to individual dairy farmers. Secondary objectives included determining the adequacy of the suggested rations for Northern New England conditions and determining the training needs which would be required by county and area extension agents assuming they were to activate computations from field office locations.

Systems Tested

Dr. Calvin Walker of the University of Maine provided a linear programming feed matrix (the Maine matrix) with animal nutritive requirements developed to meet locally indicated needs. It included 16 different feeds and their ingredient levels. System A involved solving the Maine matrix on the University of New Hampshire's Call/360 time share system in Durham, New Hampshire. Three separate software packages were required but could be chained together. The final answer resembled an income statement format. System B involved solving the Maine matrix on the Computerized Management Network (CMN) which is a regional time share network supported by the Extension Service, U.S.D.A., and serviced by personnel located at Virginia Polytechnic Institute. [7] Only one software package was needed for modifying and solving the matrix. The answer format was a standard listing of activities in solution, but readability was enhanced by the capability of using up to 20 alphameric characters for row and column identification. System C involved using the Michigan Telplan network and their library program Number 31 which was specifically for calculating dairy rations. The hardware was located at Ann Arbor, Michigan; the software was serviced by personnel at Michigan State University. The final answer was in numerical code which required the user to make a written translation for clientele consumption. System D involved using the Computerized Management Network's library program entitled "DAIRY". This program is specifically for calculating dairy rations, but the output format is like System B. Both Systems B and D enable the New England user to access the system through a Wellesely, Massachusetts, telephone exchange.

Costs

Table 1 presents the variable and fixed costs required to obtain three different rations on each of the four systems analyzed, assuming the users were located in Woodsville, New Hampshire. For System A, the total variable cost was $11.45; the two significant factors would be the central processor units (cpu) and the telephone charges. System B variable cost was only $8.56. The low cost reflects the existence of an enterprise telephone number which was available to all New England users of CMN except those in the State of Maine. However, higher connect charges partially offset this advantage. The variable cost of Systems C and D were $11.31 and $18.16, respectively. The telephone and connect charges are a function of user training, problem complexity and amount of workload on the computer. The time data reported in Table 1 consisted of one observation by the author of his own performance during midafternoon. He was moderately familiar with all four systems and the problems were not complex. An extension field agent would incur more telephone and connect charges when beginning. However, a trained person specializing in one system might attain better times than those reported. Using any of the time sharing computer systems during midafternoon resulted in relatively slow turnaround or computer response reaction time due, apparently, to a large number of simultaneous users. Turnaround times were quicker in the early morning or late evening. All four of the systems tested could be accessed with a teletype terminal. The director of the University of New Hampshire computer center obtained what he felt was an optimal contract with a Boston, Massachusetts, firm for leasing several teletypes with acoustic couplers and maintenance agreements. The rental costs were about $75 per month or a minimum of $900 for a year per terminal. However, System C could also be accessed using a touch-tone telephone as a terminal due to an audio response unit attached to the Ann Arbor hardware. The telephone equipment was rented for about $15.00 per month or $180 per year.

The assumptions in Table 1 call for running each program three times. In field use on special problems, the extension agent would probably have to run three solutions to give the dairyman an adequate answer. The first answer would duplicate the farmer's current feeding programs and the other two solutions would provide information on more nutritionally sound and/or economically advantageous rations. On most dairy farms rations fed are a function of milk production level. When considering alternative rations, the astute manager will demand specific suggestions for higher levels of production, for lower levels, and possibly for an intermediate level. It would require two, and perhaps three, solutions to provide this information. Field experience has convinced the author that New England dairymen are reluctant to accept a single answer; they prefer two or three alternatives from which to make a managerial decision. These considerations indicate that extension agents should be prepared to calculate three rations per farm if the educational program is to be successfully accepted. The need to calculate three answers (as was done to get the costs in Table 1) was found to be significant in comparing the four systems. In Systems A and C the second and third slightly modified solutions could be obtained with less connect time than was required for the first solution. In System C an adjusted analysis often required changing only one or two lines of data. System A contained software which enabled the user to sequentially create adjusted data files which reduced time. Systems B and D required three full runs to get three different answers; existing software allowed no shortcuts. This was a factor in System D having the highest variable cost.

Table 1
Costs of Doing Three Calculations on Each of Four Systems
User Located in Woodsville, New Hampshire[1/]

Cost Item	System A	System B	System C	System D
Variable Costs:				
Telephone	25 min	22 min	20 min	36 min
	$ 5.33	free	$ 6.71	free
Computer				
CPU[2/]	$ 5.60	$ 6.00	$ 4.60[4/]	$12.15
Connect[3/]	.42	2.46	0	5.91
Paper	.10	.10	0	.10
Total Variable Cost:	$11.45	$ 8.56	$11.31	$18.16
Fixed Cost				
Annual Rent for Terminal	$900.00	$900.00	$180.00	$900.00

1/ Assumptions: a direct dial call during business hours, three least cost solutions obtained, teletype speed 10 characters per second.

2/ Indicates amount of central hardware usage.

3/ Minutes and seconds from sign on to sign off multiplied by an hourly charge.

4/ Fixed charge of $3.00 for the first answer and $.80 for each adjusted answer.

Recommended Rations

Table 2 presents the nutritionally balanced least cost ration solutions obtained from the systems. The rations were for feeding one 1,100 pound cow producing 30 pounds of 4.0 percent fat milk for one day. In the first two columns the answers were identical down to the information on feed costs per hundredweight of milk. System B obtained the same answers as would be obtained from any system which had a program for solving linear programming and which used the Maine matrix as the data input. System C recommended less corn silage and more soybean oil meal and high moisture ear corn than did Systems A or B. However, System C considered salt and magnesium oxide requirements but provided only a daily feed cost statistic along with an indication of whether or not excess energy or excess protein existed in the ration. Variations from specifications were not given by System C. The fourth column of Table 2 presents the least cost ration obtained from using System D.

The same size of cow and milk production level were provided, but the ration suggested was quite different. It consisted of less corn silage, more soybean oil meal and more high moisture ear corn. Consequently, the daily ration cost was the highest despite the fact the feed prices were set equal. Other information on the given solution and variations from specifications are available.

Table 2
Least Cost Ration Solutions Provided by Four Systems
1,100 lb. Cow, 30 lbs. of 4.0% Milk Per Day

Feed		System A	System B	System C	System D
Corn Silage	lbs.	82.90	82.90	76.50	64.03
SBOM	lbs.	3.10	3.10	3.60	4.91
Ground Limestone	lbs.	.11	.11	.10	.25
Dicalcium Phosphate	lbs.	.02	.02	.00	.26
HMEC	lbs.	.00	.00	.60	12.74
Salt	lbs.	N/A	N/A	.10	.34
Magnesium Oxide	lbs.	N/A	N/A	.00	.01
Other Available Information:					
Daily Feed Cost		$0.60	$0.60	$0.61	$0.89
Excess energy		0.00	0.00	0.00	2.9
Excess protein		0.3[1/]	0.3[1/]	0.00	0.00
Income over feed cost		$1.27	$1.27	N/A	N/A
Feed Cost/cwt. Milk		$2.01	N/A	N/A	N/A
All other ingredients: variations from specifications and shadow prices		Available	Available	N/A	Available

1/ Digestible. N/A = Not Available

<u>Animal Nutritive Specifications</u>. The nutritive specifications per cow per day must be known prior to solving for the least cost ration. In Systems A and B, these values given in the data matrix provided for two levels (30 and 60 pounds) of milk production. If the user desired rations for a production level or fat level other than the two given, or a cow size other than 1,100 pounds, then the user would have to find the new coefficients and insert them into the matrix. This is a significant drawback. In Systems C and D, the user provides the cow's weight, the milk production level and the butterfat percentage; the software then calculates the nutritive specifications for the given animal. The user can tailor the animal feed requirements (and

hence the final ration) to an individual herd situation. The documentation to System C indicates nutritive specifications required. [1] Complete documentation of the way nutritive specifications were set in System D was available. [2] The nutritive requirements of System D were basically those of the National Research Council's presented in Nutrient Requirements of Dairy Cattle (Fourth Revised Edition, 1971). System C requirements were basically those of the second revised edition. Inasmuch as the fourth edition requirements were higher, it was not surprising that the daily ration cost computed by System D is larger. Table 3 below presents the nutritive requirements set for the test runs. The minimum energy and protein requirements may be set by the user in System C; this was done in the analysis so as to reduce variability of results.

Table 3
Nutritive Requirements Set Up in Various Ration Calculations
1,100 lb. Cow Producing 30 lbs. of 4% Milk Per Day

Nutrient	Systems A and B	System C1/	System D2/
	Pounds (unless otherwise noted) Required		
Crude Protein			
Max.	None	None	None
Min.	3.59	3.60	4.76
Fiber			
Max.	8.50	None	5.31
Min.	5.00	15%	4.65
Calcium			
Max.	0.19		0.22
Min.	0.11	.085 to .089	0.18
Phosphorous			
Max.	None		None
Min.	0.08	.065 to .069	0.15
Energy - MCAL			
Max.	None		None
Min.	17.40 (net)	17.40 (net)	37.44 (Metabol.)
Dry Matter			
Max.	35.00	4/	None
Min.	None		33.21
Dry Matter From Roughage		5/	5/
Max.	26.00		
Min.	None		

See footnotes at the end of the table.

Table 3
Continued

Nutrient	Systems A and B	System C 1/	System D 2/
	Pounds (unless otherwise noted) Required		
Urea			
Max.	0.40	30% of Crude Protein 3/	0.33
Min.	0.00	0.00	0.00
Magnesium	5/		
Max.			None
Min.		.042 to .051	0.07
Salt	5/		
Max.			4/
Min.		.084 to .102	
Magnesium Oxide	5/		
Max.			
Min.		4/	4/
Sodium	5/	5/	
Max.			0.17
Min.			0.08
Sulpher	5/	5/	
Max.			0.08
Min.			0.05
Methionine	5/	5/	
Min.			0.05
Fat	5/	5/	
Max.			1.99
Wheat	5/	5/	
Max.			2.66

1/ Michigan documentation provides coefficients used at selected cow weights and production levels. Actual solution was based on a point within the given range.

2/ Feeding for body maintenance, heifer growth, late pregnancy during the winter.

3/ Also limited to 1.5% of grain ration. If urea exceeds 0.8% of grain, molasses must be added (up to 10% maximum) for palatability.

4/ A limit exists but level not known.

5/ Nutrient not considered in the computation.

Nutrients in the Feeds. Prices for the same feed in all systems were set equal. The rations presented in Table 2 could vary due to unequal amounts of specific nutrients in the available feeds. The nutrient levels were set equal where possible so as to reduce variability in the final answer. Every nutrient factor could be modified in each individual feed in Systems A, B and C. In System D the dry matter, crude protein and crude fiber could be modified. In all systems, then, forage test results could be incorporated. However, energy could not be modified and high moisture ear corn was not an available feed in System D. For test purposes, corn and cob meal was modified where possible to be like high moisture ear corn in System D. It was suspected that the assumed energy level for this feed was higher in System D than in the other three systems. This could explain the higher recommended feeding level for high moisture ear corn in System D. All four systems had ways to control the utilization of urea. In order to reduce variability in answers, urea was not considered as an available feed in this analysis. Table 4 summarizes the nutrients supplied by corn silage, high moisture ear corn and soybean oil meal. The documentation for System D indicated average composition values of the listed feeds were utilized although the exact statistics were not given. [3]

Adequacy of the Rations. Dr. James Holter, animal nutritionist at the University of New Hampshire, reviewed the rations as presented in Table 2. He felt that the amount of corn silage recommended by Systems A and B were more than the typical 1,100 pound cow would eat. However, when used by trained extension agents he felt any of the systems could be safely utilized in the field. The author's training precludes him from passing judgement on ration adequacy. The learned nutritionists who created the systems all believed their systems were adequate for field use and could provide the reader with successful case studies.

Northern New England dairy farmers typically purchase their concentrate as a premixed feed with some minimum guaranteed level of protein. In this situation, an educational service which would provide nutritionally balanced least cost dairy rations should include the capability of handling this type of mixed grain if answers are to be accepted in the field. System C could handle one mixed protein supplement. Systems A and B could handle two mixed concentrates simultaneously. System D could not consider a premixed concentrate. The author would not recommend the field use of System D due to this factor.

Training Required

The training needed by extension personnel prior to using any of the computer systems could be divided among three areas: 1) understanding dairy cow nutrition and related terminology, 2) understanding the implications of a linear programming data matrix and 3) understanding the mechanics of terminal operation. None of the systems required the user to know anything about computer programming.

Table 4
Nutrients Supplied by the Feeds Considered
Coefficients in Ration Calculations[1/]

Item	Systems A and B	System C	System D[2/]
Crude Protein			
Corn Silage	s	s	s
HMEC	s	s	s
SBOM	.49	.46	
Crude Fiber			
Corn Silage	s	s	s
HMEC	s	s	s
SBOM	.035	.054	
Dry Matter			
Corn Silage	s	s	s
HMEC	s	s	s
SBOM	.90	.90	
Digestible Protein		3/	
Corn Silage	.014		
HMEC	.052		
SBOM	.450		
Calcium			
Corn Silage	.0007	.0007	
HMEC	.0003	.0002	
SBOM	.0029	.0026	
Phosphorous			
Corn Silage	.0007	.0007	
HMEC	.0018	.0014	
SBOM	.0060	.0057	
Energy			
Corn Silage	.18	.18	
HMEC	.57	.57	
SBOM	.80	.80	
Magnesium	4/		
Corn Silage		.16	
HMEC		.11	
SBOM		.28	

1/ Feed values were set equal where possible - indicated by s.

2/ Nutrients not set equal to the other systems are unknown.

3/ Not known.

4/ Nutrient not considered in the computation.

<u>Nutrition Training</u>. An educational program in Northern New England set up to provide nutritionally balanced least cost dairy rations could be initiated with little, if any, additional training for extension personnel on the first point. Most county agricultural and area dairy agents who currently work with dairy farmers already have nutritional training sufficient to use any of the four systems tested. System D probably required the least knowledge, closely followed by System C. Safeguards are built into these programs which make it nearly impossible to get dangerously incorrect ration suggestions. The ultimate guard in System C was to provide no answer unless it was an acceptable answer; an understanding of nutrition and linear programming was sometimes useful in determining why no answer was presented. Systems A and B would require nutritional knowledge to make up for lack of built-in safeguards, and to set up the data to compute rations for production levels other than the two which were built into the matrix by the Maine specialists. State specialists could provide the coefficients for various production levels should either System A or B be activated. Nutritional training prior to using any of the systems would be of a review nature as opposed to the presentation of new material.

<u>Linear Programming</u>. A thorough understanding of linear programming matrix generation would be needed by individuals utilizing either System A or B. This would be required to manipulate the availability of various feeds and to modify the production level being solved for, both of which must be done to meet varied field situations. At the current time, few, if any, of the extension field agents in Northern New England who might have need for this type of computational aid have an adequate understanding of linear programming. It is estimated that 12 to 16 hours of classroom instruction would be required to develop a level of understanding which would enable agents to comfortably utilize either System A or B. An understanding of linear programming would facilitate the potential user's understanding of the total process used in Systems C and D. It would also enable an agent to more completely analyze the implications of various solutions. However, adequate understanding of solutions obtained from Systems C and D require little or no understanding of linear programming procedures.

<u>Terminal Operation</u>. Most extension personnel who would use nutritionally balanced least cost dairy rations in their activities would have no experience in operating either a teletype or a touch-tone telephone terminal. A low level of mechanical skill would be required. One could assume that a person who has an automobile drivers license could learn to successfully operate a terminal with one hour of instruction. [5] System A probably required the user to do the most manipulating of the teletype due to the necessity of sequentially executing three separate programs. Some typing skill or access to a typist would facilitate operating System A. In Systems B, C and D the amount of teletype manipulation was less and typing skill would be less of a consideration. Training for either teletype or telephone should provide for the new user to try several program executions under guidance to

instill confidence in both the mechanics and the software. A minimum of six hours of training is suggested after the equipment has proven to be operational.

Implications For Cooperative Extension

Remote interactive computing facilities were found to have at least four potential applications when used to compute least cost dairy rations. First, specific ration suggestions could be made for individual dairy farmers. Second, extension personnel could create benchmark situations and use the calculated rations as a basis for educational messages in a variety of mass media. Third, the terminals may serve as a training aid in group meetings. For groups of more than five people, the telephone terminal would be better suited. Fourth, extension personnel became more aware of nutritional problems faced by dairymen in their area and through running several solutions were more aware of current economic implications of ration alternatives. Thus, in-service training was obtained. [7] This should enable extension to better serve the educational needs of the dairy industry.

Program Costs

Table 1 indicated the variable cost of obtaining a set of solutions for an individual farm plus the annual fixed costs for terminals. This section indicates a method of studying the total cost of providing the computer capability for calculating nutritionally balanced least cost dairy rations in a cooperative extension agent's field office. A key step would be the estimation of how many solutions a single agent would run per year. Assume that 40 sets of solutions (3 ration calculations) would be made annually; 25 for individual dairymen, 10 during group meetings as training aids and 5 would be used as bases for mass media educational messages. In the first year additional costs would be incurred to install equipment and educate the field agents. It was assumed state specialists would coordinate and present the training, but $100 worth of variable costs would be needed to familiarize each field agent with the equipment and software prior to his operating the system independently. Table 5 presents the two year costs which would be associated with supplying one field agent with System B using a teletype and System C using a telephone terminal. The second year costs would be less as initial training and setup were assumed to be unnecessary.

There was interest in making the ration education programs financially self-supporting through charging fees. This resulted from limited extension budgets and from the opinion that extension should charge at least as much as was being charged for a similar service by a farmer cooperative in the area. If the 25 farmers were to provide the total cost for the first year, each would be charged about $54 and $31 for System B and C, respectively. For the second year the cost per farm would be about $50 and $26 per system. The author would argue that the 25 farmers should pay only the variable costs for their solutions plus a portion of terminal costs. Participants in the group meeting where the solutions would be used as training aids should pay the variable costs for those solutions. Cooperative extension budget allocations should pay for initial training and those solutions used as bases for mass media education efforts. It was suggested that the 25 dairymen be charged about $27 and $15 for Systems B and C, respectively. This would cover the variable costs for their 25 analyses and about half the annual terminal costs.

Table 5
Annual Costs of Activating Ration Calculation Capability
40 Analyses, 2 Years, Using Systems B and C

Costs	System B	System C
	dollars	
First Year:		
Equipment Installation	0	40.00
Initial Training	100.00	100.00
Terminal Rental	900.00	180.00
Variable Costs of 40 Solution Sets	342.40	452.40
Total First Year Cost	1,342.40	772.40
Second Year:		
Terminal Rental	900.00	180.00
Variable Costs of 40 Solution Sets	342.40	452.40
Total Second Year Cost	1,242.40	632.40

Supplementary System Software

Each of the systems had available other problem solving programs with potential application by agricultural extension workers. System A could access the complete statistical program library which was included in the Call/360 system. However, only about 10 programs would have direct use in solving farm problems. Systems B and D would both have access to the complete CMN library of programs which had about 27 other problem solving algorithms with potential farm applications. System C had about 35 other programs for farms. There would be a wide variation in training required for a field agent to use the other available programs. Documentation varies among programs. Some programs assume a higher level of training by the user than do others. The fixed costs per set of dairy solutions could be reduced in relation to the amount of other system programs which would be utilized. The dearth of supplementary software on System A compared to the other systems would preclude the author from recommending the adoption of System A.

Summary

It would be desirable for county agricultural agents and regional dairy agents in Northern New England to have interactive remote computer terminals in their offices with access to systems which would provide nutritionally balanced least cost dairy ration computations. In August, 1972, four such systems were available to the region. This paper described the four systems, suggested ways to integrate these systems into ongoing extension programs and discussed the associated costs. It was concluded that the best alternative would be the Michigan Telplan System using Program #31, titled Least Cost Dairy Rations. The system had an intermediate variable cost and the cheapest fixed cost due to using a telephone instead of a teletype. The Michigan system had the simplest method of obtaining modified analyses, could consider a premixed purchased concentrate, would require a minimal amount of training to be utilized by extension field agents and be the most flexible aid in the agents' total plan of work. The Computerized Management Network utilizing program LP002 to solve the University of Maine's feeding matrix would also have potential for field use in Northern New England. The variable cost was the least and two premixed concentrates could be simultaneously analyzed. More agent training would be needed as an understanding of how to manipulate a linear programming matrix was needed. Annual costs, excluding special start-up costs, would be about $630 and $1,240 for the Michigan and CMN systems, respectively. Because of constantly changing computer hardware, changes in software content and the chance of rate increases on telephone equipment, the factors in the above paper should be reviewed at least annually to see if the conclusions remain valid.

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