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A COMPUTERIZED SIMULATION MODEL FOR EVALUATING ALTERNATIVE COW-CALF FARM PLANS

by

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ABSTRACT

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Sylvio R. Sabourin

Cow-calf enterprises are basic to the beef industry which in turn forms an important segment of the livestock industry in Manitoba. An increase in the availability of management development information would be quite useful to improve the profitability and viability of cow-calf producers. This suggests the need for an analytical tool which would assist cow-calf managers in decision making and extension workers and farm advisors in providing technical assistance.

The present study attempts to develop a methodology for evaluating alternative cow-calf farm plans. To satisfy this objective a simulation model is built, computerized, tested, and shown to be a useful analytical tool which predicts the physical and financial results of cow-calf farm plans.

The following steps are undertaken in this study. First, the simulation technique is described and previous studies using simulation are reviewed. A comparison of the simulation technique with other techniques, such as linear

programming and econometrics, leads to the conclusion that simulation is the most appropriate for this study.

The methodology for evaluating alternative cow-calf farm plans consists of: (1) specifying and describing alternative farm plans, (2) feeding data about each planned operation one year at a time to a simulation which forecasts physical and financial results, (3) examining and comparing the simulated results of the alternative plans, and (4) choosing the "best" plan based on criteria specified by the user of the model.

The development of a suitable simulation model forms the major part of this study. Efforts are made to ensure that the model (a) can be adjusted to reasonably represent and simulate any Manitoba cow-calf enterprises, (b) can be quickly and easily used with very little computer programming knowledge, (c) requires a minimum amount of inputs, and (d) speeds up and facilitates the work involved in partial budgeting.

The key feature of the model is the flexibility in input requirements. That is, a group of parameters are assigned initial average values and the user of the model can change as many or as few of these initial values as he wishes in order to represent his situation. The validity of the model is confirmed in three stages. First, the simulated results obtained from a range of given data input situations are checked against results generated independent of the model. This first stage verifies that all segments of the model are operational and that the model's logic is sound.

The second stage involves the simulation of three illustrative farm plans. By comparing the results with those obtained using the Cash Flow Forecaster (developed by the Economics Branch of Manitoba Department of Agriculture and the Canfarm Service Agency of Agriculture Canada) and checking them manually, the model is found to be reasonably accurate and capable of representing and simulating individual cow-calf farm plans.

In the third stage, a sensitivity analysis procedure performed on one farm plan indicates that the model results change in the proper direction and magnitude when key variables and parameters are assigned different values. From these three stages, the model is judged to be valid within a certain degree of confidence and valuable to assist in farm planning. One key potential use is in the evaluation of government farm development programs.

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TABLE OF CONTENTS

APPENDICES Page

APPENDICES Page

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

A. The Setting of the Problem

In Manitoba, the cattle industry is an important segment of agriculture. In 1971, 64 percent of the farms or 22,388 farms had cattle.[1] Excluding dairy products, the receipts in 1975 from the cattle industry totalled $148,164,000 or 16 percent of the total farm cash receipts from farming operations in Manitoba.[2] Historically, the receipts from the cattle industry have totalled approximately 20 percent of the total farm cash receipts.[3] In 1975 and historically, receipts from the cattle industry (including calves but excluding dairy products) made up approximately 41 percent of the total farm cash receipts from all livestock and livestock products.[4] The cattle

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[1]Manitoba Department of Agriculture, Manitoba Agriculture, 1975 Yearbook, Printed by R. S. Evans--Queen's Printer for Province of Manitoba, 1975, p. 40.

[2]Statistics Canada, Farm Cash Receipts, Catalogue No. 21-201, Annual (Ottawa: Queen's Printer for Canada, 1975), p. 13.

[3]Ibid., Annuals, 1970-1975, pp. 6-13.

[4]Ibid., Annuals, 1970-1975, pp. 6-13.

industry is therefore one of the most important of all livestock industries.

The cattle industry as described above can be divided into four parts:

a) the production of feeder calves from a beef herd (cow-calf enterprise),

b) the production of feeder calves from a dairy herd,

c) the fattening of feeder cattle for slaughter, and

d) the replacement and expansion of breeding herd.

Most of the feeder calves come from cow-calf enterprises. The number of beef cows and beef heifers over 2 years is more than four times the number of dairy cows and dairy heifers over 2 years.[5] The cow-calf enterprise is therefore the basic sector of the cattle industry.

The objectives of agriculture implied by the Guidelines for the Seventies encouraged farmers to increase their productive capacity in the livestock area and recommended programs to provide financial and management assistance. More specifically, the three basic objectives of agriculture include:

"(a) Expanding agricultural output to raise total income from agriculture...

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[5]Manitoba Department of Agriculture, Manitoba Agriculture, 1975 Yearbook, Printed by R. S. Evans--Queen's Printer for Province of Manitoba, 1975, p. 26.

(b) Stabilizing net farm income through diversifying agricultural production and through effective action in the marketing of farm products and purchases of farm supplies.

(c) Enhancing the economic viability of low and middle income producers, through programs geared specifically towards providing the smaller and medium sized farmers with financial and management assistance."[6] Furthermore, "...agricultural production must be expanded through programs enabling farmers, particularly those with smaller farm units, to increase their productive capacity in the livestock area."[7]

In an attempt to satisfy the specific objectives of agriculture stated above, several programs have been launched by the federal and provincial governments to encourage cow-calf enterprises. In 1972, the Farm Diversification Program began. It provides:

a) farm management advisory services and farm workshop training,

b) conversion grants up to a maximum of $2,000 per farm for non-operating capital expenditures for improvements for cattle production, and

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[6]The Province of Manitoba, Guidelines for the Seventies: Introduction and Economic Analysis, Volume 1, March 1973, p. 85.

[7]Ibid., p. 85.

c) Provincial Government guaranteed farm diversification loans up to a maximum of $10,000 for conversion to or expansion of livestock enterprises. Interest rates are the same as for other loans made through the Manitoba Agricultural Credit Corporation.[8]

The program is mainly for farmers less than 45 years of age with a gross income between $5,000 and $15,000[9] from the sale of their farm products and who show potential for establishing a viable farm operation. The three primary objectives of the program are:

a) to increase incomes of farmers in designated areas,

b) to encourage farm diversification particularly into livestock by encouraging expansion of existing livestock enterprises and by encouraging farmers to enter livestock production,

c) to increase productivity of farmers through the improvement of management ability, transfer of technical information, and development of skills by

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[8]The three features provided by the Farm Diversification Program were basically obtained from: Manitoba Department of Agriculture, Farm Diversification Program (published and distributed by the Manitoba Department of Agriculture under the Manitoba-Canada ARDA III Agreement, 1974).

[9]It should be noted that the gross value of production or the sales criterion was initially from $5,000 to $15,000 but these figures are adjusted periodically to reflect the agricultural price changes based on price indices of farm products.

providing intensive, on-farm management assistance and developing "farm plans" with farmers.[10]

The provincial government through the Manitoba Agricultural Credit Corporation provides direct loans to farmers and guarantees lines of credit made to farmers by approved lending institutions. Under the Livestock Grant Program, the corporation provides incentives to diversify into livestock. On expenditures for yearling heifers and cows, a borrower is eligible for a 20 percent rebate grant at the end of five years.[11] In addition to financial assistance, the Manitoba Agricultural Credit Corporation provides management and technical assistance to cow-calf producers.

From 1973 to 1975, livestock prices have declined and feed costs have remained relatively high. This has depressed the income of beef producers and prompted the Manitoba government to enact the Manitoba Beef Producers' Income Assurance Plan, designed to:

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[10] Description and Progress Report, ARDA III, Manitoba/Canada Agricultural and Rural Development Agreement, 1972 and 1973 (published under the authority of Honourable Samuel Uskiw, Minister of Agriculture, Province of Manitoba and the Honourable Don Jamieson, Minister of Regional Economic Expansion, Government of Canada), pp. 11-13.

[11] On expenditures for sheep and dairy enterprises, a borrower is also eligible for a 20 percent rebate grant at the end of five years.

"(a) Offer a five-year price guarantee to cow-calf producers.

(b) Provide early winter financial assistance to producers.

(c) Encourage an on-farm shift from straight cow-calf production to more stable and profitable slaughter beef production. In addition to providing support for calves, the plan assures a guaranteed price for a specified number of slaughter animals in the third, fourth and fifth years of the agreement.

(d) Enable producers to plan ahead in their management."[12]

The program also offers beef management advisory services.

The Federal Government has also established a Beef Stabilization Program to help beef producers. This program also guarantees prices for calves and slaughter cattle. In addition, extension workers situated all over the province provide technical assistance to beef producers.

B. Statement of the Problem

The problem can now be stated more specifically. The beef industry forms an important segment of Manitoba's agriculture but is facing serious financial difficulties.

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[12]Government of Manitoba, Beef Producers' Income Assurance Plan, Printed by R. S. Evans--Queen's Printer for the Province of Manitoba, 1975, p. 1.

Programs established by the federal and provincial governments are offering financial assistance and management advice to beef producers.[13] These factors indicate a need for better management and better farm planning by producers to increase size, profit, and viability of their beef enterprises.

Beef producers suffering economic hardships will have to adopt better techniques and improve both their technical and their allocative efficiency. One of the factors which will assist farmers to adopt new techniques and to become more efficient is the availability of information or extension services. This is confirmed by the following two studies.

In a recent study, Huffman has empirically found that the allocative ability, measured by the rate of adjustment of a sample of farmers, is positively related to the educational level of the farmers, the availability of information or the amount of agricultural extension services, and the farm size or the number of acres on the farm.[14]

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[13]The programs are designed especially for cow-calf producers or feedlot operators who (i) are experiencing financial losses or (ii) show potential for establishing a viable farm operation and wish to expand their livestock enterprise or enter livestock production.

[14]W. E. Huffman, "Decision Making: The Role of Education," American Journal of Agricultural Economics, Vol. 56, No. 1 (February 1974), pp. 85-97.

His study has also found that agricultural extension services and education are substitute sources of allocative efficiency. Although the scope of his study is narrow in the sense that it focuses on a single dimension of allocative ability,[15] it has important implications for this study. Education and extension services are potential sources of allocative efficiency which significantly hasten adjustment to changes in market conditions. It would therefore be highly desirable to increase and improve the extension services in Manitoba for beef producers who are facing unfavorable market conditions. Furthermore, if extension services can substitute for education, an increase in extension services should greatly improve the allocative efficiency and production of beef producers.

In a recent study which focused on technical efficiency, Müller has empirically verified the claim that information affects technical efficiency.[16] This information could be provided by extension services.

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[15]Huffman's study focuses on the adjustment of Midwestern U.S. farmers to the changing optimum quantity of nitrogen fertilizer in corn production.

[16]In the study: J. Müller, "On Sources of Measured Technical Efficiency: The Impact of Information," American Journal of Agricultural Economics, Vol. 56, No. 4 (November 1974), pp. 730-738, the data set consisted of a sample of California dairy farms from the San Joaquin Valley.

In view of the evidence presented above, it seems that any analytical tool which would assist extension workers and farm advisors in providing information to farmers and in planning individual farms should increase the rate of adoption of new techniques and thereby have a positive effect on beef production. At the present, no technique is available to quickly forecast the results of alternative farm plans or alternative decisions. Techniques such as partial budgeting are time consuming and require extensive data collection and calculations. A framework which indicates all the required inputs to determine the expected results of a farm plan with a comprehensive data collection from which one finds average or benchmark values for coefficients is not available. A sophisticated budgeting technique could be used to determine and compare the results of alternative management practices or proposed farm plans. In view of the financial difficulties facing the beef industry and the numerous government programs which are assisting beef producers, a methodology for evaluating farm plans would be especially useful to farm managers, farm advisors, and other people implementing government programs which provide management advisory services.

C. Scope of this Study

As discussed previously the cow-calf enterprise[17] is basic to the beef industry. At the present time, cow-calf producers need financial and technical assistance due to declining profits.[18] The scope of this study will be limited to the development of an analytical tool to assist cow-calf managers in decision making and to assist extension workers, farm advisors, and researchers in analyzing cow-calf enterprises and cow-calf farm plans.

D. Objectives of this Study

In view of the above scope, the main objective of this study is to develop a methodology for evaluating alternative cow-calf farm plans. More specifically, the

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[17]A cow-calf enterprise consists of a breeding herd whose function is to rear calves to weaning age.

[18]The fact that cow-calf producers are experiencing a decline in net returns is further supported by the following recent study: D. O. Ford, M. Senkiw, C. F. Framingham, and J. A. MacMillan, "An Evaluation of the Farm Diversification Program in the Interlake Region of Manitoba." Draft Research Bulletin, Department of Agricultural Economics, University of Manitoba, 1976. From a sample of clients participating in the Farm Diversification Program, it was found that the clients who expanded their cow-calf and/or stocker-feeder enterprises did much poorer than their counterparts with other livestock enterprises. Further analysis of the data supporting that study indicated that the cow-calf enterprises of 19 out of 23 clients experienced a decline in net returns to management during the period examined, 1973 to 1975.

primary objectives are to:[19]

(1) Develop and computerize a cow-calf farm simulation model which:

a) can reasonably represent and simulate a Manitoba cow-calf enterprise,

b) requires a minimum input requirement or a minimum amount of information from the cow-calf enterprise,

c) can be adjusted by the user to forecast and then evaluate individual cow-calf situations,

d) requires a minimum amount of computer programming knowledge to be used,

e) can be quickly and easily used by a farm manager or a farm advisor to predict and evaluate the outcome of almost any cow-calf farm plan or practice,

f) speeds up and facilitates the work involved in partial budgeting,

g) will offer flexibility in use by assigning initial average values to a set of parameters and allowing the user of the model to change these initial values if the user of the model

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[19]The objectives of this study are specified in a manner similar to the following study: E. L. Ladue, "A Computerized Farm Business Simulator for Research and Farm Planning" (unpublished Ph.D Thesis, Michigan State University, Department of Agricultural Economics, 1971), pp. 3-4.

considers them inaccurate or if the user has better information on the value of any parameter. The initial values would serve as benchmark values for the user of the model.

(2) Show the usefulness of the model by:

a) confirming the model's validity and demonstrating an application of the model as an analytical tool to assist farm planning. That is, the model is used to forecast the results of three illustrative farm plans. The model simulates the impact of three different management decisions or practices on a typical farm.

b) discussing further uses and applications of the model for farm managers, farm advisors and researchers.

(3) Critically evaluate simulation as a technique (analytical tool) in forecasting and evaluating cow-calf farm plans.

Although the development of a simulation model was specified in the first objective, it was first necessary to critically examine and compare simulation with other potential techniques for the purposes of this study. This is therefore specified as a third objective.

E. Methodology or Procedure

First, a review and a critical evaluation of techniques available to forecast the results of farm plans is made. Simulation is found to be the "best" method to realistically represent a cow-calf enterprise and predict the consequences of a proposed farm plan. Then a methodology for evaluating alternative cow-calf farm plans utilizing a deterministic simulation model is described. The methodology consists of: (1) specifying and describing alternative farm plans, (2) forecasting the results of each farm plan one year at a time, (3) then examining and comparing the simulated results of the alternative plans, and (4) deciding which plan is the "best" one based on the criteria specified by the user of the model.

A major task of this study was the development of a suitable simulation model. Model building essentially consisted of determining the important variables, specifying the parameters, and developing a set of mathematical relationships which would adequately represent the physical and financial components of a cow-calf enterprise. Working with faculty members and research staff in the Department of Agricultural Economics and Farm Management, the author was involved in designing a model to estimate the costs and returns to farmers participating in the Farm Development Program from the information given in their Farm Management Records. The model developed as part of the study done to evaluate the Farm Development Program[20] provided ideas and

[20]The Farm Development Program evaluation study is described in: D. O. Ford, M. Senkiw, C. F. Framingham, and

guidelines to specify some of the mathematical equations used in this study.

The computerized dairy farm business analysis simulation model developed by Ladue[21] which represents and simulates Michigan dairy farms also helped in designing the conceptual model of this study. Although no mathemathical equations or parameter values from Ladue's study were used, the methodology of model development closely follows Ladue's study. The major differences between the models are associated with their application. Ladue's model is designed to analyze dairy enterprises in Michigan State whereas the model in this study is designed to analyze cow-calf enterprises in Manitoba.

The simulation model operates as follows. Information on the planned cow-calf enterprise is collected by the user of the model. The data requirements of the model are basically: initial livestock numbers; feeding, building, and pasture systems; ration and expected rates of gain; and other management inputs. The input requirements are quite flexible since many of the input relationships such as

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J. A. MacMillan, op. cit. The livestock segment of the model used for evaluating the Farm Development Program is described in: Maurice Senkiw and Alvin Pokrant, "A Cost/Return Simulator for Dairy, Cow/Calf and Stocker/Feeder Enterprises" (unpublished paper, University of Manitoba Department of Agricultural Economics, 1976).

[21]E. L. Ladue, op. cit.

labor requirements, bedding requirements, prices and costs of factors and products have been assigned initial values which need only be changed if the user of the model disagrees with these values. The data collected on the planned cow-calf enterprise are input for the computer simulation model which produces a detailed forecast of the physical and financial results of the plan. The output or forecasts consist of tables showing (a) monthly cattle numbers, (b) annual cattle numbers, (c) a summary of physical components and dollar records of the cow-calf operation, (d) management indicators, (e) labor requirements by month, and (f) an annual cash flow forecast. The operation of one calendar year is predicted from each run of the computer simulation model.

The model is then tested for validity in three steps. First, the model is tested for face validity. A range of data situations (including extreme and unusual cases such as very high rates of gain or death rates) are input to the model and the results are compared with expected results calculated independent of the model. If the simulated results are unreasonable or inaccurate the model (and computer program) is modified accordingly.

The second step involves the simulation of three illustrative farm plans. The results are checked manually and compared with results obtained using the Cash Flow Forecaster (developed by the Economics Branch of Manitoba Department of Agriculture and the Canfarm Service Agency of

Agriculture Canada). The simulated results of the three typical plans are further discussed and compared to demonstrate the usefulness of the model for farm planning.

In the third step, a sensitivity analysis is performed on one farm plan to investigate the relative responsiveness of model results to changes in the value of selected parameters or variables. The corresponding changes in the simulated results obtained by assigning different values to parameters and variables are checked against expected direction and magnitude of change. These three steps are followed in order to establish the degree of validity of the model.

F. Sources of Data

Two sets of data were required in this study. Data were collected to assign initial parameter values and to establish the relationships in the model. Data were also collected to formulate the illustrative farm and its three alternative plans.

Data were obtained from various agricultural publications and research reports. Appendix C lists the specific sources of the values initially assigned to the model parameters. In Appendix B, the equations used in the simulation model are developed. The illustrative farm plans were built from the author's experience in the cow-calf industry and from several manuals which gave recommended practices for a cow-calf enterprise in Manitoba.

G. Outline of this Study

Following this introductory chapter, a critical evaluation of simulation as a technique (analytical procedure) in evaluating alternative cow-calf farm plans is presented. It includes a comparison of simulation with other techniques and reasons for choosing simulation in this study. A review of previous studies using simulation is also included. Chapter III develops the general structure of the methodology which is essentially the use of a simulation model. Model design considerations are discussed, followed by a description of the major and specific concepts of the simulation model. Chapter IV tests the model validity in three stages. The model is first tested for face validity. Second, the results of three typical farm plans are simulated, checked manually, and compared with results obtained by using a related model. Third, a sensitivity analysis is performed on one farm plan to test the model behaviour. The simulated results of the three farm plans are further examined to demonstrate an example of the model's use in farm planning. Further uses and applications of the model are also given. Chapter V discusses limitations and possible modifications of the model. Chapter VI presents the summary and conclusions of the study.

Five appendices are included. Appendix A consists of a user manual for the cow-calf budgetary simulation model. It should be referred to whenever the inputs to the model are discussed. Appendix B gives a detailed description of each segment of the model and should be referred to whenever information on the operation of the model is required. Appendix C lists the data sources for the values initially assigned to some of the model parameters. Appendix D consists of three sample inputs to the simulation model, while Appendix E contains the three corresponding sample outputs from the simulation model. The sample inputs and the sample outputs are those of the three illustrative farm plans examined in Chapter IV.

CHAPTER II

A CRITICAL EVALUATION OF SIMULATION AS A TECHNIQUE (ANALYTICAL TOOL) IN FORECASTING AND EVALUATING COW-CALF FARM PLANS

In this chapter, the simulation technique is defined and the steps involved in developing and using simulation models are described. A comparison of simulation with other techniques will be included, as well as a review of previous studies using simulation. Finally, an evaluation of simulation as a technique or an analytical tool will be made.

A. The Definition of Simulation

"Simulation is a methodology for studying systems."[1] Mize and Cox "...use simulation to mean the process of conducting experiments on a model of a system in lieu of either (1) direct experimentation with the system itself, or (2) direct analytical solution of some problem associated with the system."[2] Through the use of a model, simulation provides the experimenter with a structured means of varying the components of the model in order to

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[1] J. H. Mize and J. G. Cox, Essentials of Simulation (Englewood Cliffs: Prentice-Hall, 1968), p. 186.

[2] Ibid., p. 1.

get better insight into the system and then to derive a solution from the model or to attain an objective or purpose.[3]

Naylor defines simulation as "...a numerical technique for conducting experiments with certain types of mathematical models which describe the behavior of a complex system on a digital computer over extended periods of time.... The principal difference between a simulation experiment and a 'real world' experiment is that, with simulation, the experiment is conducted with a model of the real system instead of with the actual itself."[4] According to Naylor, simulation essentially involves the use of models of real systems to conduct experiments.

Professor Halter views simulation as "...the operation of an abstract model or prototype of a real system designed to trace out the dynamic interactions in order to answer specific questions about the system."[5] Similarly, Driver finds that simulation entails "...conceptual

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[3]Ibid., p. 3.

[4]T. H. Naylor, Computer Simulation Experiments with Models of Economic Systems (New York: John Wiley and Sons, Inc., 1971), p. 2.

[5]A. N. Halter, "Simulation Models in the Study of National and Regional Economies," National and Regional Economic Models of Agriculture, Economics Branch Publication No. 72/9, edited by R. K. Eyvindson (Ottawa: Canada Department of Agriculture, 1972), p. 36.

processes, operating models, a tool for constructing experiments, describing or explaining the dynamic behaviour of a system, and specifying data requirements in a multi-disciplinary setting."[6]

In summary, although simulation cannot reproduce the exact real system, it can however examine the consequences of a model in which all the basic components of the system in question are present.[7]

B. The Simulation Technique

"The philosophy behind the simulation approach is that we can learn to solve complex problems by building a model of the real world situation."[8] In the process of building a detailed model of a system one gets a better understanding of the system.

Simulation is a way of testing alternative plans, alternative decisions, or alternative policies without

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[6]H. C. Driver, "Discussion: Simulation Models in the Study of National and Regional Economies," National and Regional Economic Models of Agriculture, Economics Branch Publication No. 72/9, edited by R. K. Eyvindson (Ottawa: Canada Department of Agriculture, 1972), p. 61.

[7]D. B. Trebeck, Simulation of Extensive Beef Production in the Clarence Region of New South Wales, Miscellaneous Bulletin No. 16, edited by G. Mason (New South Wales Department of Agriculture, Division of Marketing and Economics, 1972), p. 3.

[8]Halter, op. cit., p. 36.

tampering with the real system.[9] Controlled experiments on the real system are sometimes expensive or even impossible to conduct, and so mathematical models can be used to simulate reality.

In this study, only mathematical models suitable for testing on the computer will be examined. Constructing such a mathematical model follows a process called abstraction, whereby symbols are arranged into mathematical and logical statements to express the relationships among the components of a system.[10] This model is then used to simulate alternative plans, alternative decisions, or alternative policies.

C. Developing and Using Simulation Models

Simulation can be viewed as an iterative problem-solving process. The steps involved in the process are: (1) problem definition, (2) mathematical modeling, (3) model refinement and testing, and (4) model application in solving problems. The process of developing and using simulation models can be conceptualized as the process shown in Figure II-1. Although the process is basically one which flows from the problem definition stage to the model application stage (as indicated by the forward arrows), it

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[9] Mize and Cox, op. cit., p. 6.

[10] Mize and Cox, op. cit., p. 6.

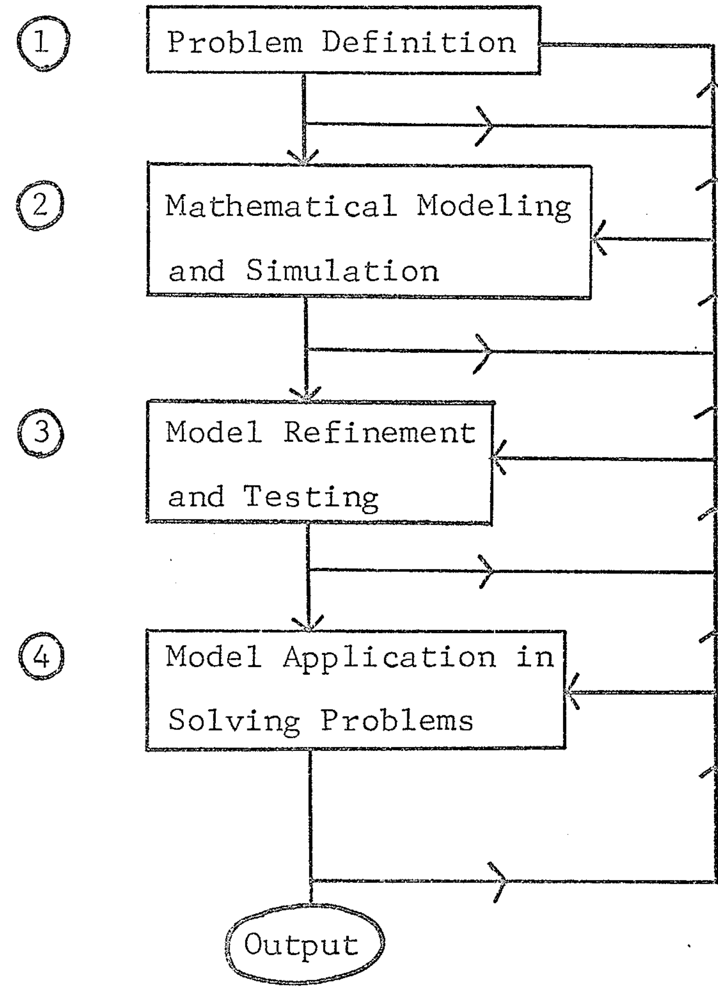

Figure II-1: Simulation as an iterative problem investigating process.

SOURCE: A. N. Halter, "Simulation Models in the Study of National and Regional Economies," National and Regional Economic Models of Agriculture, Economics Branch Publication No. 72/9, edited by R. K. Eyvindson (Ottawa: Canada Department of Agriculture, 1972), p. 38, Figure 1.

is also a learning process in that some of the previous stages might be repeated if the information obtained in a latter stage render this previous stage inaccurate or contradictory (as indicated by the reverse arrows). This learning process introduces a certain amount of model refinement. The resulting output of a simulation model consists of a set of indicators associated with a specific plan or strategy. In examining the results of alternative plans, the decision maker can weigh heavily only the indicators that he considers important and choose the best plan using his own decision criteria.[11]

Following this rather general description of the simulation process, each stage of Figure II-1 will now be examined:[12]

1. Problem Definition: In the problem definition stage, one attempts to identify the major questions to be answered, the hypotheses to be tested, or the effects to be estimated. One needs to "...clearly specify the functions

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[11]Halter, op. cit., p. 37.

[12]Except where otherwise indicated, the basic ideas for the explanation of each stage of Figure II-1 have been taken directly from Halter, op. cit., pp. 37-43. Supplementary information on the methodology or process of developing and using simulation models was obtained from J. R. Anderson, "Simulation: Methodology and Application in Agricultural Economics," Review of Marketing and Agricultural Economics, Vol. 42, No. 1 (March 1974), pp. 4-29; and Naylor, op. cit., pp. 11-36.

and mechanisms of the system, what measures of system performance are appropriate, and what alternative means are available for achieving [the] objectives..."[13]

2. Mathematical Modeling and Simulation: This stage requires a symbolic specification of the important variables and the structural interrelationships. The direction of causation must be determined, as must the functional forms of the technological or behavioral relationships that seem to fit the situation being examined. Furthermore, the parameters must be specified and estimated to provide the tentative shape of the functional relations. It is also necessary at this stage to decide whether the model should be probabilistic or deterministic in nature. A computer program is then formulated to conduct simulation experiments with the model.

3. Model Refinement and Testing: The purpose of this stage is to check for gross errors in the model and for inconsistent parameter values or structural relationships. If such errors are detected, they are corrected. A "sensitivity analysis" procedure can be used to test the impact on model behavior of changes in model parameters. These tests indicate what variables are most important in affecting simulated outcomes. This serves as a guide to further data gathering and helps to identify plans which

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[13] Halter, op. cit., p. 37.

might improve the results or the performance of the system. The parameters which appear to be more sensitive are investigated and tested further. The model is also verified to make sure it serves its purpose.

After preliminary tests, the validity of the model must be investigated. A model describing an existing system can be tested for validity by comparing the behavior of the model with the past behavior of the real world system or by examining how well the model predicts the real system. Prediction requires a waiting period which may not be possible. In a model describing a non-existent system, validation by deduction must be relied upon whereby one closely examines the basic assumptions and reasoning behind the construction of the model.

4. Model Applications in Solving Problems: Once the user is convinced that the model represents the most accurate and complete picture of his system, he can now use the model to examine and compare the various plans and management decisions that are of interest to him. In effect, "...[t]he simulation procedure permits us to trace the changes in system state through simulated time and under varying rules of operation. This gives us...a means of 'trying out' alternative policies without actually tampering with the physical system.... The success of a simulation model in providing correct and useful results depends upon how

adequately the model represents the real system being studied."[14]

D. Simulation Model Classifications

There exist many types and forms of simulation models. The important thing is that the model adequately represents or abstracts the real world system being examined. That is, the simulation technique is more of a process which utilizes a model to analyze the results of a number of alternatives for the real world system.[15]

In this study, the real world system is a cow-calf farm. In order to study the effects of various management alternatives without actually putting the decisions into practice, a model will be built to represent or abstract the real farm system. The model used for simulation could be based on a linear programming model, an econometric model, a budgeting model, or other types of models. Once the model abstracts the farm properly, it could be adjusted to represent alternative management decisions and then rerun to determine the results of these changes.

The question which arises then, is what type of model to use to simulate alternative farm practices. There

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[14]Mize and Cox, op. cit., p. 6.

[15]L. V. Mandercheid and G. L. Nelson, "A Framework for Viewing Simulation," Canadian Journal of Agricultural Economics, Volume 17, No. 1 (February 1969), p. 35.

exist three main types of simulation models which could be used for this study. The model could be based on a linear programming approach, on an econometric approach, or on a systems approach. Each of these approaches is discussed briefly below.

Linear programming has the following weaknesses for forecasting farm plans:

1. Linear programming has a single objective function and assumes constant input-output coefficients over the entire range of output possible for an individual farm unit. The fact that different operators will have different objectives and different farms will have different input-output coefficients means that the model will have to be reformulated for each farm plan or for each objective.

2. It would be useful to know some of the sub-optimal or near-optimal solutions for a farm.[16] This is difficult to obtain with linear programming.

3. A linear program does not indicate when the particular results of a farm plan will occur or even if the results can occur during the time period examined.

4. Non-linear production relationships and scale effects cannot easily be handled with linear programming.[17]

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[16] G. F. Donaldson and J. P. G. Webster, "A Simulation Approach to the Selection and Combination of Farm Enterprises," Farm Economist, Vol. 11, No. 6 (1968), p. 221.

[17] Ibid., pp. 220-221.

5. Stochastic variability cannot easily be incorporated in a linear program.[18]

Because of these weaknesses, a linear programming approach would be unsuitable for this study.

A simulation model based on the econometric approach could also be built. This type of model would not be suitable in this study because the real farm system of each individual cannot be represented adequately by a set of statistically significant mathematical equations based on econometric analysis. This is because each farm has a different structure and a different set of decision rules and it is difficult to incorporate many decision rules into a set of mathematical equations. Also, the econometric approach requires a large quantity of data to formulate statistically significant mathematical equations.

Finally, there are simulation models based on a systems approach. "This type of model does not necessarily start off with any given structure, but rather is based on what experts know about the system. The structure of the model becomes evident through branches and loops as included in the computer program. It may not be possible to describe the structure in terms of a complete set of

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[18]J. B. Hardaker, "The Use of Simulation Techniques in Farm Management Research," Farm Economist, Vol. II, No. 4 (1967), p. 163.

mathematical equations."[19] The systems approach seems to be the best way to examine the result of alternative management decisions for a number of reasons. For example, a budgeting analysis can easily be fitted into a systems approach. Also, the results of alternative farm plans can be forecasted by incorporating various decisions and decison rules. These results can be compared and evaluated. Finally, the systems approach is flexible and allows any type of farm system to be examined and any decision rule to be included.

While it is true that simulation is usually defined in a systems context and normally refers to a much freer form of computer modeling without ápriori restrictions, this section has shown that techniques such as linear programming models and econometric models can be viewed as simulation models. However, the term "simulation model" will, from this point on, refer to simulation based on a systems approach.

E. Applicability of a Computerized Simulation Model Based on a Systems Approach for this Study

This section will deal with the advantages, disadvantages, and applicability of a computer simulation model

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[19] W. J. Craddock, "Interpretation and Use of the Results Obtained with National and Regional Economic Models," National and Regional Economic Models of Agriculture, Economic Branch Publication No. 72/9, edited by R. K. Eyvindson (Ottawa: Canada Department of Agriculture, 1972), p. 143.

based on a systems approach for this study. The advantages of a computer simulation model are:

1. "The [simulation modeling] methodology is iterative and hence consistent with scientific procedures and the accumulation of knowledge."[20]

2. A computerized simulation model is not intended to make decisions for planners or to provide only one solution to a problem, but rather to provide a structured means of investigating the various plans of interest. The approach provides the user with the versatility to select his own decision criteria, the possibility of examining multiple objectives simultaneously, a method of examining the consequences of a decision through time, and the possibility of having more than one solution to choose from.[21]

3. Almost any kind of relationship, such as any combinations of step functions, conditional relationships, qualitative variables, indivisibilities, continuous and/or linear equations can be incorporated into the model.[22] A more realistic farm planning model can be constructed using simulation since other techniques impose important

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[20]Halter, op. cit., p. 55.

[21]Halter, op. cit., pp. 55-56.

[22]E. L. Ladue, "A Computerized Farm Business Simulator for Research and Farm Planning" (unpublished Ph.D Thesis, Michigan State University, Department of Agricultural Economics, 1971), p. 41.

restrictions on the kind of relationships which may be included. Farm planning under conditions of variability and uncertainty can easily be accomodated since stochastic variables can easily be included in a simulation model.[23]

4. Unlike linear programming, simulation can (i) handle lumpiness of resources, (ii) allow for preference of some activities in the selection process, (iii) use multiple activities as well as prescribed activity ranges to allow for scale effects and non-linear relationships, (iv) output those generated plans having the highest gross margin from which the decision maker can choose.[24]

5. Systems which are not mathematically tractable can be represented with a simulation model.[25]

6. Simulation shows "how to get there from here". A linear programming solution, on the other hand, gives an optimal organization and allocation of resources without showing how to attain this optimum state or even whether this state is possible. With a simulation model, which moves through time step by step, the decision maker knows how the final state is reached by simply printing out the values of the variables at each step or at each time period.[26]

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[23]Hardaker, op. cit., p. 164.

[24]Donaldson and Webster, op. cit., p. 222.

[25]Ladue, op. cit., pp. 34-35.

[26]Ibid., p. 43.

7. A budgeting analysis of a system can be easily performed using a computer simulation model because a simulation model can easily trace through the expenses and returns of an operation.

8. A simulation model is flexible enough to allow the various farm plans and the objectives of different operators to be realistically incorporated into the model and simulated without having to reformulate the model for each situation.[27]

The main disadvantages or weaknesses of computer simulation models are:

1. A general form does not exist for a simulation model. One must develop a new model to realistically represent the system under investigation. To do this, greater familiarity with the economic system is probably required than would be the case for programming models.

2. One has a tendency to try building a model to answer all questions, whereas the model should be oriented towards specific questions.[28] One has to decide how much of the real system to leave out of the simulation model since the cost of simulation, not only with respect to computer time but also human time to set up the model, increases rapidly as the complexity of the model increases.[29]

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[27] Ibid., pp. 39-40.

[28] Halter, op. cit., p. 56.

[29] Hardaker, op. cit., pp. 168-169.

3. Although simulation provides greater realism, it does not have an optimizing algorithm. "The attainment of a better plan by simulation methods depends on a process of trial and error, and with complex models it is most unlikely that an optimum solution can ever be obtained. The planner must generally be satisfied with an improved plan."[30]

In view of the advantages of simulation, it was decided to develop a simulation model to represent a cow-calf enterprise. Simulation is quite suitable as a tool to simulate cow-calf plans because a cow-calf enterprise is a complex system which is different from one farm to another. A realistic representation of an individual farm can best be done using simulation.

The next section will review previous studies which used the simulation approach.

F. Previous Related Studies Using Simulation

The methods of simulation do not only apply to agriculture but are equally applicable to social systems, engineering systems, scientific systems, business systems, military systems, and governmental systems.[31] This section

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[30] Ibid., p. 164.

[31] Mize and Cox, op. cit., Chapter 9, pp. 186-200 offer a brief exposure to a large variety of simulation studies and indicate appropriate references for details. The studies are grouped into three general categories:

will be limited to a review of studies giving applications of simulation to agriculture as a farm planning tool.

Halter and Dean[32] constructed a simulation model of a large California feedlot integrated with extensive grazing in an effort to improve the managerial decisions of the ranch. The two major sources of uncertainty were the weather and the prices of factors and products. The authors were able to study the decisions involved in the purchasing of feeder cattle for the range and feedlot by simulating the above under various price and weather conditions.

Ladue[33] developed and tested a computerized dairy farm business analysis model which could be used in both research and farm planning.

> "The model was conceived within a systems framework with the farm business viewed as a set of acting and interacting systems. Simulation was selected as the most appropriate modeling technique to be used. The major focus of model construction was development of a model which could realistically simulate the important physical and financial characteristics of an individual farm business."[34]

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industrial and business applications, engineering and scientific applications, and military and governmental applications.

[32]A. N. Halter and G. W. Dean, Simulation of a California Range--Feedlot Operation, (Davis: University of California Agricultural Experiment Station, Giannini Foundation Research Report No. 282, 1965).

[33]Ladue, op. cit.

[34]Ibid., Abstract, pp. 1-2.

The dairy enterprise as well as crop enterprises usually found on dairy farms can be handled by the model. A key feature of the model is that it was developed for use by management in a "what if" context. The simulation model is designed to forecast the consequences of choosing an alternative plan. The model does not indicate which alternative plan is the best plan but leaves it up to the user of the model to decide which plan is best. The results indicated that specific farm situations can be adequately represented and the data generated can be considered a useful information to assist in making farm planning or management decisions. The ideas developed in the above study were used to a great extent to design the cow-calf simulation model of this study.

Ryan[35] in Australia demonstrated the use of a simulation model for feedlot operators in evaluating alternative selling criteria, culling practices, and the benefits derived from increased management ability as indicated by growth rates and death rates. The model was also used to examine the effects of unstable cattle prices and ration costs. The results of the study indicated that animals should be sold on an all in, all out basis. Also, the gross margins were not affected by changes in the culling and sorting practices.

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[35] T. J. Ryan, "A Beef Feedlot Simulation Model," Journal of Agricultural Economics, Vol. 25, No. 3 (September 1974), pp. 265-276.

Blackie and Dent[36] have developed a simulation model for hog production "...as part of an information system which may assist hog farm managers both in choosing between competing management strategies and also in implementing any chosen plan."[37] The authors have attempted to make the hog simulation model and the accompanying information system easy to use. Meaningful results are produced and can be used to investigate impacts of alternative management policies.

Many other studies using simulation models to forecast and evaluate management practices could be mentioned.[38] These studies which have used simulation indicate that it has a good potential as a practical farm planning tool for farm managers and farm advisors.

The present study develops a simulation model capable of forecasting results for alternative cow-calf

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[36]M. J. Blackie and J. B. Dent, "Analyzing Hog Production Strategies with a Simulation Model," American Journal of Agricultural Economics, Vol. 58, No. 1 (February 1976), pp. 39-46.

[37]Ibid., p. 39.

[38]Trebeck, op. cit.; Hardaker, op. cit., pp. 162-171; and J. B. Dent, "Livestock Performance and Capital Investment in Farm Enterprises," Systems Analysis in Agricultural Management, edited by J. B. Dent and J. R. Anderson (Sydney: John Wiley, 1971), pp. 267-294.

farm plans. Such a model would aid decision makers in choosing among alternative cow-calf plans using their own decision criteria. In the next chapter, the methodology and the simulation model will be developed.

CHAPTER III

METHODOLOGY AND MODEL

This chapter will attempt to fulfill the main objective of this study, which is to develop a methodology for evaluating alternative cow-calf farm plans.

A. General Structure of Methodology

The logical steps followed in the methodology developed to forecast and evaluate alternative cow-calf farm plans are summarized in Figure III-1. The first step is to define the alternative cow-calf farm plans to be examined for a number of years. Secondly, each plan is examined year by year as follows. A computerized cow-calf simulation model, which is described below, then forecasts the results of a plan for a certain year. The results for each plan for each year include: a printout of inputs; monthly cattle numbers summary; annual cattle numbers summary; summary of physical and dollar record; management indicators; labor requirements by month; and an annual cash flow. Once all plans have been simulated for each year, the third step is to compare the results of each plan year by year and decide which one is most suitable.

Essentially, the methodology uses a budgeting approach where alternative detailed plans of future cow-calf

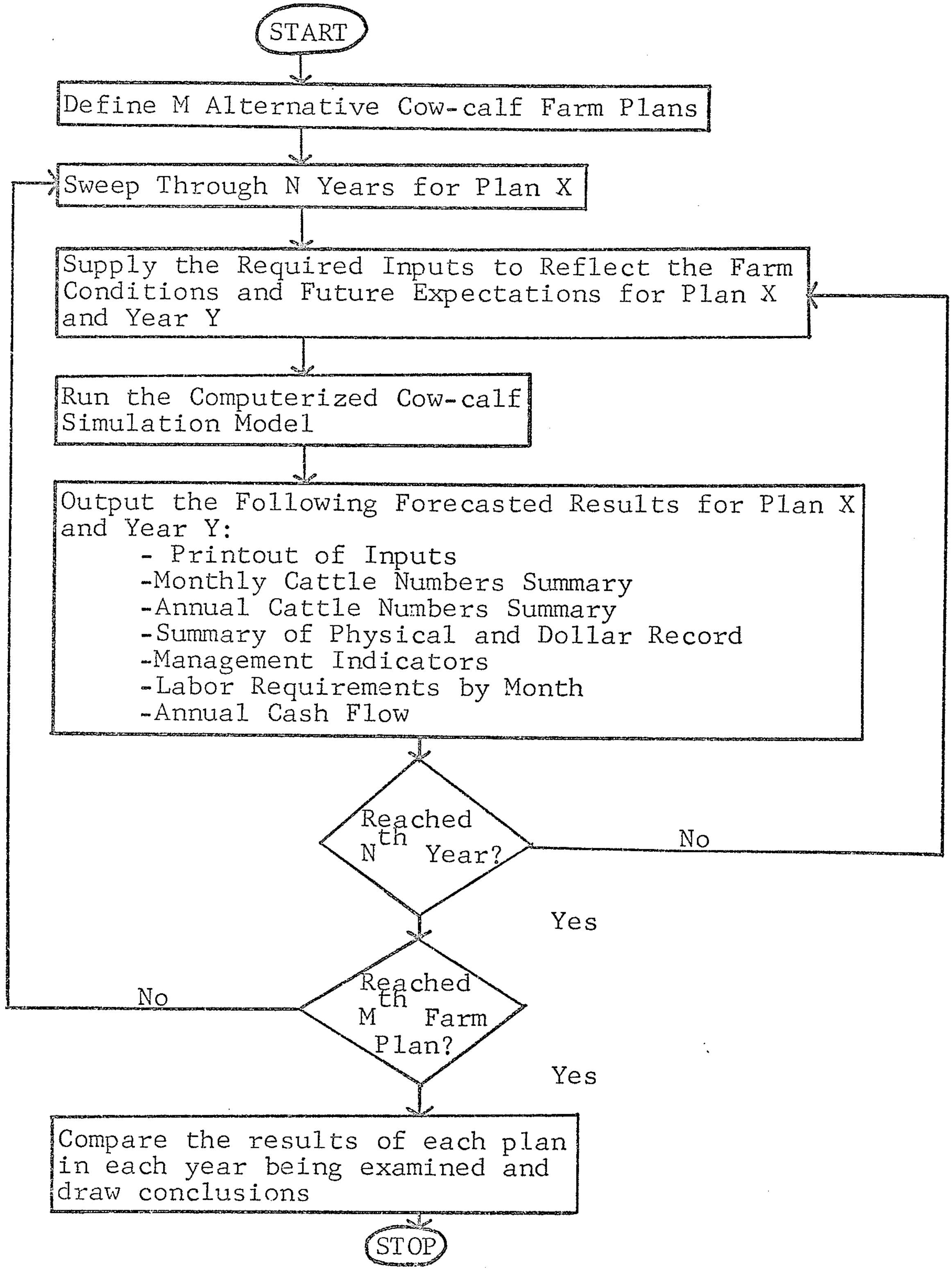

Figure III-1: Framework or methodology to forecast and evaluate alternative cow-calf farm plans.

operations are being examined. The resources required and expectations on prices and calving percentages for each plan for each year are provided to a simulation model which calculates and prints the results of the farm plan. The computerized simulation model speeds up the budgeting procedure. The remainder of this chapter will discuss the simulation model developed for use in this framework.[1]

B. Model Design Considerations[2]

Before presenting the details of the simulation model, several considerations in the design of the simulation model will be discussed.

1. Time Interval

Prior to developing the simulation model, one must decide on the time interval to be used to simulate the cow-calf enterprise. That is, should the cow-calf enterprise be simulated on a yearly, monthly, weekly or daily basis? The advantage of having a shorter time interval is that the

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[1]It should be noted that the simulation model is computerized but the methodology which uses the simulation model is not. That is, the farm plans must be developed manually in a form acceptable to the computerized simulation model. The forecasts generated by the simulation model must also be evaluated individually.

[2]The model design considerations discussed in this section were also discussed in the thesis: E. L. Ladue, "A Computerized Farm Business Simulator for Research and Farm Planning" (unpublished Ph.D. Thesis, Michigan State University, Department of Agricultural Economics, 1971).

simulated results are more accurate and more realistic. The disadvantage of a shorter time interval is that the model is more complicated and more difficult to computerize.[3]

In the cow-calf simulation model used in this study, the time interval is a combination of years and months. That is, the financial results of the operation are reported on a yearly basis but many of the calculations are based on monthly values. The repairs, depreciation, investment, gross returns, and total costs calculations are made on a yearly basis, while livestock numbers on the farm, labor, feed, and bedding are calculated on a monthly basis. In general, all values which vary greatly over a year were calculated on a monthly basis and all others were calculated on a yearly basis. Appendix B describes the details of the calculations made in the simulation model.

It should be noted that the overall results of the simulation model are based on a calendar year operation. However, as was shown in the methodology, the farm plans can be simulated for as many years as one desires by simulating each consecutive year.

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[3]The advantages and disadvantages of short time intervals are discussed further in Ladue, op. cit., pp. 81-84.

2. Computer Language to be Used[4]

The programming language to be used in developing the model depends on the features of the programming language and on the knowledge of the researcher. Many general purpose and special purpose languages for simulation are available. Examples of the former include FORTRAN and ALGOL, while CSMP and DYNAMO are examples of the latter. With regard to special purpose languages, it was felt that they tend to force a certain degree of form on the model construction and design which appears inappropriate in a cow-calf simulation model. Of the general purpose languages, FORTRAN is the one which is most widely used and most well-known.

It was decided that the FORTRAN language would be used in this study for a number of reasons: (i) it has the required flexibility, (ii) the author is familiar with it, and (iii) it is available at most computer centers.

3. Farm Planning Versus Research Emphasis

Although the emphasis in constructing the model was on farm planning, the simulation model is designed to be used by both farmers and researchers. The minimum input

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[4]The ideas in this section are taken from P. J. Charlton, "Computer Languages for System Simulation," Systems Analysis in Agricultural Management, edited by J. B. Dent and J. R. Anderson (Sydney: John Wiley, 1971), pp. 53-70 and Ladue, op. cit., pp. 78-81 where this topic is discussed in greater detail.

requirements of the computer program are simple enough to be provided by most farm managers, and the program also allows enough flexibility to suit almost any cow-calf operation. At the same time, the model would also be quite useful for researchers since the cow-calf simulation model is quite detailed and almost all the model relationships can be changed by the user.

4. Deterministic Versus Probabilistic in Nature

The cow-calf simulation model in this study is deterministic in nature except for the allocation of deaths to the various months and ages (for growing animals), as explained in Appendix B.

The main advantage[5] of a deterministic model, as it applies to this study, can be stated as follows:

> "For extension application a deterministic model has the further advantage of being somewhat more easily understood by farmers and agents. The repeatability (for each run of the model through time) of elements not being manipulated makes comparisons appear more direct. In order to evaluate an alternative, a stochastic[or probabilistic]model must be run several times and the results summarized. The summarized results of several runs are usually more difficult to understand than a single deterministic run."[6]

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[5]The advantages and disadvantages of deterministic and stochastic (probabilistic) models are discussed in detail in Ladue, op. cit., pp. 85-90.

[6]Ladue, op. cit., p. 88.

A deterministic model was used in this study for the reasons stated above, and also because deterministic models are easier to build and usually require less data since fewer parameters have to be estimated.[7] Only the allocation of deaths is handled in a probabilistic way because it is impossible to know when deaths will occur. Since the number of deaths can be estimated from past experience, the distribution of deaths throughout the year is determined by assuming that each animal is as likely to die at any month of the year as another animal of the same category.

5. Desirable Characteristics of the Model

The characteristics which are necessary to encourage farmers or farm advisors to use computer models to evaluate farm plans include clarity, speed, and reliability.[8] Blackie and Dent state this need succinctly:

> "For a model to be used effectively by farm managers, it needs not only mimic accurately the real system but also to be accessible to managers.... The data required must be readily obtainable by the manager

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[7]Parameters of probability distributions for variables do not have to be estimated in a deterministic model.

[8]These three characteristics in relation to computer models for farm planning are discussed in W. Candler, M. Boehlje, and R. Saathoff, "Computer Software for Farm Management Extension," American Journal of Agricultural Economics, Vol. 52, No. 1 (February 1970), pp. 72-73.

and the information returned from the information system must be in a form that is easily understood by the farm manager."[9]

C. Major Concepts of the Simulation Model

A general outline of the model will be given by describing the following major concepts: (1) Input Requirements, (2) General Structure of the Model, (3) Isolation of the Cow-Calf Enterprise, and (4) Assumptions Regarding the Availability and Mobility of the Inputs to the Cow-Calf Enterprise.

1. Input Requirements

The main feature of this model is the flexibility of the inputs required. The input requirements of the model can best be described by indicating how the values of the parameters of the model are to be specified. The values of the parameters of the model can either be built into the model or specified by the user. It follows that the parameters will be divided into two groups, with the first group being user specified and the second group including those parameters which are built into the model. The input requirements are thus divided into necessary inputs and optional inputs.

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[9] M. J. Blackie and J. B. Dent, "Analyzing Hog Production Strategies with a Simulation Model," American Journal of Agricultural Economics, Vol. 58, No. 1 (February 1976), p. 39.

In an effort to reduce the necessary inputs, this model will use what Candler, Boehlje, and Saathoff have called "input by exception", which are the optional inputs. "Rather than calculate all the needed coefficients, the user has only to indicate with which of our coefficients he disagrees and substitute his own coefficient for it. This is a much less demanding exercise, and the stimulus of looking at our figure may suggest a more realistic coefficient to the farmer."[10] This idea has also been adopted by Ladue in his computerized farm business simulation model.[11]

Parameters of the first group (necessary inputs) are those specific to each farm such as: number of livestock which initially exist on the farm; feeding, building, and pasture systems; rations and expected rates of gain; and other management practices. The user of the model must assign values to each of these group one parameters and input them to the simulation model for each run. They represent the minimum inputs required to simulate a particular farm plan.

Parameters of the second group (optional inputs) are those for which values will be already included in the

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[10]Candler, Boehlje, and Saathoff, op. cit., p. 75.

[11]The idea of having two groups of inputs or parameters has been taken from Ladue, op. cit., pp. 99, 108-110.

model, that is, those for which values will initially be assigned. These parameters include the following: dates of livestock transaction; labor requirements for fence repair, for health care, for checking the herd while on pasture, for feeding, and for bedding and manure removal under various systems; bedding requirements; average days on various types of ration; average weights of new born calves and mature animals; average interest rates by year; and average prices and costs of outputs and inputs by year. The initial values given to these parameters are average or representative values based on various sources such as: research and extension publications, farm management manuals, and other related studies. Agricultural representatives, livestock specialists, companies manufacturing various livestock inputs, and other research workers provided initial values for parameters having no average value documented in any specific source.[12]

The user of the model can change any of the values of the group two parameters if he so wishes, while leaving the values of all other parameters unchanged. Thus the program is ready to run by changing the value of any number of group two parameters. In this way the user can

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[12]The sources from which the initial values of each parameter of the second group are obtained are listed in Appendix C.

change only those group two parameter values which he considers inappropriate in the model or which do not apply to a particular situation or which he prefers to estimate from data specific to his own farm.[13]

2. General Structure of the Model

The cow-calf simulation model follows the general structure presented in Figure III-2 and is broken down into five sequential steps:[14]

Step 1: Input the group one data, that is, the data specific to each farm plan. This includes: (a) livestock numbers information, (b) building inventory, (c) machinery and equipment (including handling facilities), (d) feeding and manure and bedding removal system used, (e) health care

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[13]A list of the necessary or group one inputs is given in Part I of Appendix A and a list of the optional or group two inputs and their initial values is given in Part II of Appendix A. Part III of Appendix A describes how the user can change the initial values given to the group two inputs.

[14]The three last steps are performed by a computer program developed for the simulation model. In steps one and two, the user of the model provides the inputs required for the computerized simulation model to forecast the results of a specific farm plan. It should be noted that the computer program handles step three and step four simultaneously. For example, as soon as the computer program has calculated the total pounds of feed required, the associated cost of the feed is calculated. Since the physical characteristics are always calculated before the associated costs and returns for each input and each output, the physical characteristics calculations are grouped in step three and the cost and return calculations are grouped in step four.

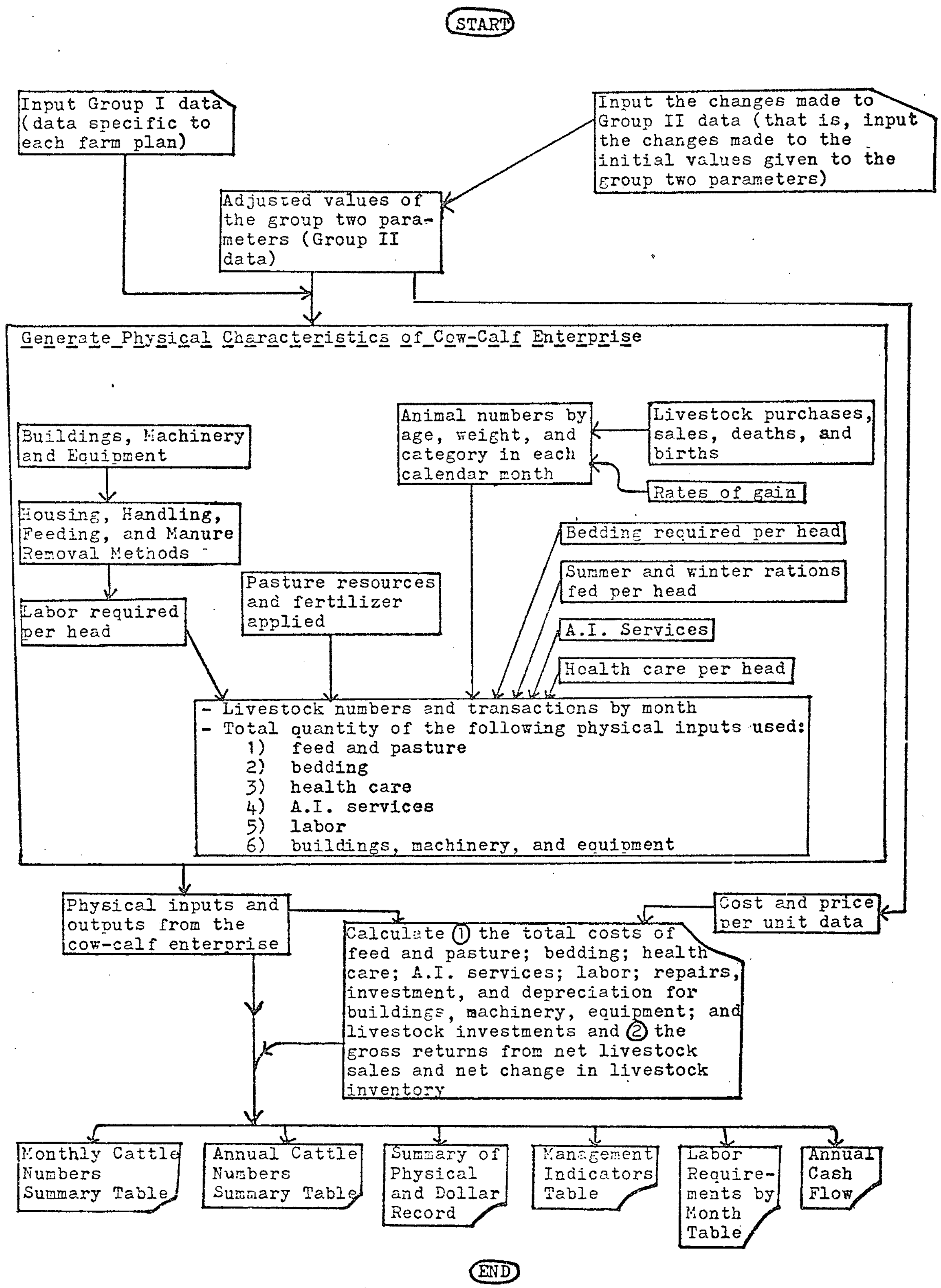

Figure III-2: Cow-Calf Simulation Model

and breeding practices, (f) pasture resources, (g) rations fed, (h) expected rates of gain, and (i) type of bedding used. (See Appendix A Part I).

Step 2: Input the changes made to the initial values given to the group two parameters. (See Appendix A Parts II and III).

Step 3: Combine the group one inputs and the adjusted group two inputs and generate the following physical characteristics of the farm:

a) animal numbers by category, age, weight, and value in each calendar month,

b) total number of livestock transactions--purchases, sales, deaths, and births--in each calendar month,

c) total pounds of each type of feed required during the year,

d) total pounds of bedding required during the year,

e) total number of vaccinations, vitamin injections, and A.I. services by month,

f) total number of hours of labor required by month for each task of the cow-calf enterprise, and

g) quantity and quality of the following resources used by the cow-calf enterprise: buildings, machinery, equipment, and pasture.

Step 4: From the physical characteristics of the farm and the cost and price list contained in the adjusted values of the group two parameters, calculate the following (1) costs and (2) returns for the entire year of operation.

(1) Costs of:

a) feed and pasture

b) bedding

c) health care

d) A.I. services

e) miscellaneous articles

f) labor

g) repairs, investment, and depreciation

for: buildings

machinery

equipment

handling facilities

breeding herd.

(2) Returns from:

a) net livestock sales

b) net change in livestock inventory.

Step 5: Output the following six forecasts of the cow-calf enterprise from the simulation model:

1) monthly cattle numbers summary,

2) annual cattle numbers summary,

3) summary of physical and dollar record,

4) list of management indicators,

5) labor requirements by task by month, and

6) annual cash flow.

Appendix B gives a detailed discussion of each of the above steps.

3. Isolation of the Cow-Calf Enterprise

This model simulates a cow-calf enterprise in isolation from the other enteprises on the farm. As defined in the model, the cow-calf enterprise entails rearing calves to weaning age. The model examines the inputs required for that enterprise and the outputs produced. If a farm contains more than one enterprise such as crops, forages, dairy, stocker-feeders, or hogs, any inputs transferred to the cow-calf enterprise from one of these enterprises is costed (at market value) and treated as an input to the cow-calf enterprise as if the input was purchased from another individual. Similarily any output transferred from the cow-calf enterprise to another enterprise is costed (at market value) and treated as an output from the cow-calf enterprise. For example, if tame hay is fed to the livestock, tame hay is treated as an input to the cow-calf enterprise whether it was produced on the same farm or bought from another farm. It follows that the farmers' cost of grain and forage production is not considered to be a feed cost for the cow-calf enterprise. Instead, the cow-calf enterprise will purchase all of the feed required at market price whether the crop or forage enterprise is on the same farm or on another farm. By isolating the cow-calf enterprise in this way, all the returns and the costs of this enterprise are taken into account. In this way, the complete budget of the isolated cow-calf enterprise is being analyzed by the simulation model.

4. Assumptions Regarding the Availability and Mobility of the Inputs to the Cow-Calf Enterprise

In the simulation model no restrictions are placed on the availability of labor and other resources. If extra labor, pasture, building space, feed, or other inputs are required, it is assumed that there are some available at market price.

It is also assumed that the operator is financially able to purchase all the inputs required for the planned operations. This differs from other computer budgeting models where the financial situation of the operator is taken into account.[15]

D. Specific Concepts of the Simulation Model[16]

Only the specific concepts which are most important to this simulation model are discussed below. A detailed

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[15]An example of this is found in the model developed in K. T. Sanderson and A. T. G. McArthur, Computer Methods for Development Budgets, Agricultural Economics Research Unit Publication No. 45 (Lincoln College, Agricultural Economics Research Unit, 1967).

[16]Some of the concepts used in this study have been developed in the model used to evaluate the Farm Development

description of the calculations involved in each segment of the cow-calf simulation model is given in Appendix B.

1. Animal Months[17]

A distinguishing feature of this model is that the livestock numbers are treated on a monthly basis instead of a yearly basis. That is, from the information given in the group one and the group two data, the simulation model forecasts or generates the exact number of animals by category, age, weight, and value that will be kept on the farm in each month.[18] This allows exact calculations of feed, bedding, labor, health care requirements, and livestock value by month. The livestock transactions, that is, purchases, sales, births, and deaths, are also specified by month. Each of these transactions are assumed to occur on the last day of each month.

Program. That model is described in: Maurice Senkiw and Alvin Pokrant, "A Cost/Return Simulator for Dairy, Cow/Calf and Stocker/Feeder Enterprises" (unpublished paper, University of Manitoba, Department of Agricultural Economics, 1976).

[17]An animal month is defined as one animal of a certain category, age, and weight kept for one month on the farm.

[18]The model used in this study is the only model where the computer program generates the exact number of animals by category, age, weight, and value that will be kept on the farm in each month from information on the livestock beginning inventory and the various livestock transactions given in Appendix A (Part I #5) and Part II #1).

2. Labor Requirements

Estimates of labor required per animal by category for feeding and for manure and bedding removal under various systems are provided in the group two data. Three feeding systems, namely, hand feeding, self feeding, and mechanized feeding, and two bedding and manure removal systems, namely, manual and mechanical are allowed. Estimates of labor required for health care, fence repair, and checking the herd while on pasture are also provided in the group two data. It should be noted that labor requirements are calculated and reported on a monthly basis. This allows the user of the model to estimate how many labor hours must be hired or allocated in each month for the planned cow-calf enterprise.

3. User Defined Inputs

The model is made more flexible by allowing inputs to be specified by the user of the model. For example, the user could specify his own feed and its corresponding cost per pound or his own vaccination type and its corresponding cost per treatment.

4. Choice of Prices and Costs

Group two data contains a list of average prices and costs for 1973, 1974, and 1975. The user of the model can choose the year for the prices and costs he wishes to use in calculating the costs and returns for his operation. The user can also examine the results for his farm operation if the price of any product or factor had been different by specifying the price or cost he wants to use. The procedure for changing the initial values of any of the group two parameters is given in Appendix A Part III.

E. Model Structure, Model Use, and Economic Theory

Economic theory (mainly production economics) was used to design and develop the model. Economic theory has indicated the kinds of relationships, the types of parameters, the magnitudes of the parameter estimates, and the variables to include in the simulation model, so that it can represent and simulate practically any Manitoba cow-calf plan. For example, a producer planning to increase his herd can consider different types of feeding systems to take advantage of the scale effect. If he is using a hand feeding system, he can plan to switch to a self-feeding system when he increases the size of his herd. The labor required per animal would be lower in a more mechanized feeding system. The model was designed to handle this kind of scale effect. The labor required for feeding can be described graphically as shown in Figure III-3. Three systems of feeding are allowed, namely, (1) hand-feeding, (2) self-feeding, and (3) mechanized feeding. Hours of labor required are specified as a function of the feeding system and the number of animals fed in each month. Mathematically,

$$X = a_i Y \quad \text{for } i = 1, 2, 3$$

where:

$i = 1$ represents the hand-feeding system

$i = 2$ represents the self-feeding system

$i = 3$ represents the mechanized feeding system

and X represents the number of hours required for feeding in a certain month, Y represents the number of animals on the farm during that month, and the coefficients a_1, a_2, and a_3 are assigned initial values such that $a_1 > a_2 > a_3$. In Figure III-3, OA represents the hand-feeding system, OB represents the self-feeding system, and OC represents the mechanized feeding system. The values of a_1, a_2, and a_3

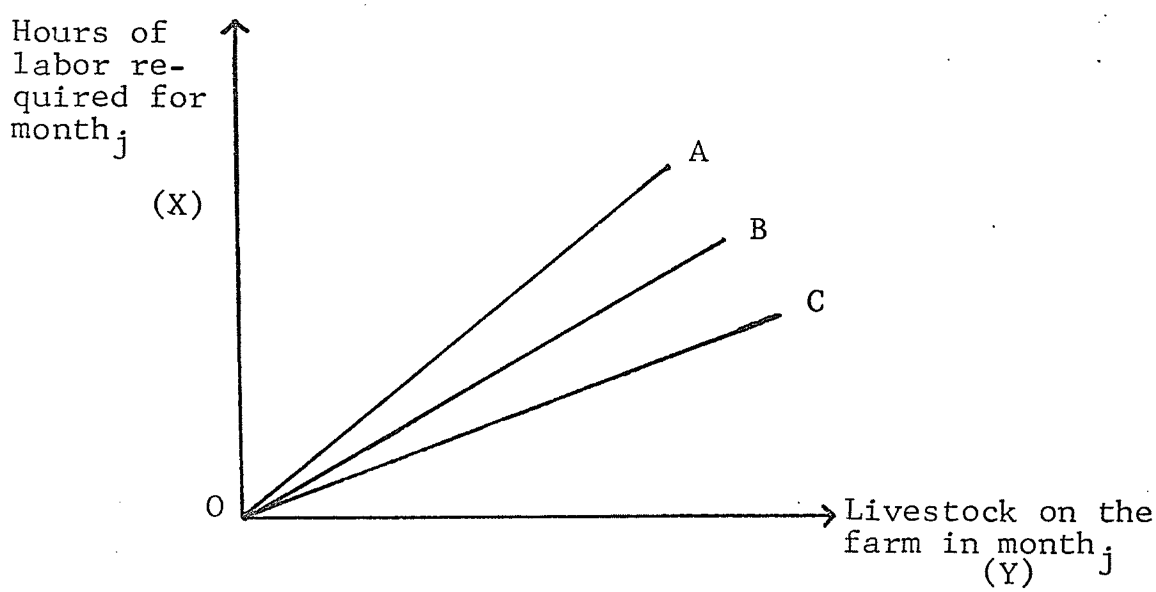

Figure III-3: Effects of feeding systems on labor requirements.

can be changed by the user of the model, in which case the diagram shown in Figure III-3 would also change. Labor required for manure and bedding removal is treated in a similar manner except that only two systems are allowed. Details of the other equations involved, the handling of parameters and the initial values assigned to the parameters in the simulation model are given in Appendix B.

CHAPTER IV

VALIDATION AND APPLICATION OF MODEL

This chapter is divided into three sections. The first section will discuss the procedure used to validate the model. The second section will demonstrate the usefulness of the model as a farm planning tool with an application of the model. The application will consist of simulating the results of three alternative cow-calf farm plans. The application will also serve the purpose of testing the model's logic and checking for any computer programming errors. A sensitivity analysis procedure performed on one farm plan will further validate the model. The third section will discuss further uses of the model as an analytical tool for farm managers, farm advisors, or researchers.

A. Validating the Model

A computer simulation model must be verified and validated before it can be used to analyze the real system which it is designed to represent. Naylor and Finger indicate that "...simulation models based on purely hypothetical functional relationships and contrived data which have not been subjected to empirical verification are void of meaning."[1] In reviewing simulation, Anderson also indicates that the major weakness of simulation lies in the fact that there does not exist a fixed and agreed validation procedure which can be applied to all simulation models.[2] The reason for the difficulty in validating simulation models is that there exists no single specific set of criteria for differentiating between those models which adequately represent the real system and those models which do not. In addition, many of the criteria available are not appropriate for validating certain models.[3]

In spite of the difficulties involved, two general approaches to the problem of validation have been developed. One approach developed by Naylor and Finger consists of a three-stage procedure incorporating the

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[1]T. H. Naylor and J. M. Finger, "Verification of Computer Simulation Models," Management Science, Vol. 14, No. 2 (October 1967), p. B-92.

[2]J. R. Anderson, "Simulation: Methodology and Application in Agricultural Economics," Review of Marketing and Agricultural Economics, Vol. 42, No. 1 (March 1974), p. 17.

[3]For a further discussion on the problems involved in validating simulation models, see C. F. Herman, "Validation Problems in Games and Simulation with Special Reference to Models of International Politics," Behavioural Science, Vol. 12, No. 3 (May 1967), pp. 216-231 or E. L. Ladue, "A Computerized Farm Business Simulator for Research and Farm Planning" (unpublished Ph.D. Thesis, Michigan State University, Department of Agricultural Economics, 1971), pp. 142-145.

methodology of rationalism, empiricism, and positive economics. The first stage involves the use of theories, general knowledge, and experience which are available about the system to specify the components, select the variables, and formulate the functional relationships to be included in the model. The second stage involves an empirical verification of the assumptions on which the model is based using the best available statistical and non-statistical tests. The third stage consists of testing the model's predictive ability. Instead of testing the model's validity at the end of model construction, this approach suggests a validation process which starts at the problem formulation stage and ends at the model application stage. Although the above does not guarantee a problem-free validation procedure, it does ease the task of model building.[4]

The second approach developed by Hermann suggests a combination of five types of validity criteria to form a unified approach to validation. The first type, face validity which can be applied in the construction stage, is used to verify that the model output is at least superficially reasonable. During preliminary trial runs, internal validity may be checked to make sure that the

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[4]For a more detailed discussion on this approach see Naylor and Finger, op. cit., pp. B-95 - B-97 or Ladue, op. cit., pp. 146-148.

model is relatively stable. Event validity, which involves comparing observed events or patterns with those occurring in the simulation, and research hypothesis validity, which entails attempting to distinguish similar performance from that of systems independent of the model's programmed structure can both be employed while the research is being performed to check the outputs produced by the model. If the previous validity checks indicate unacceptable divergence between model results and real world results, variable-parameter validity, which tests individual model relationships against known counterparts, and programmed hypothesis validity, which involves predicting researchable or empirically verifiable hypotheses can then both be engaged.[5]

From the above discussion, one can see that the reality of certain aspects of the model can be tested. One should keep in mind, however, that the validation of a model is always a matter of degree.[6] It should also be remembered that validating one aspect of the model tells us nothing about the validity of other aspects of the model. Given the difficulty in establishing a definite

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[5]For a critique and a more detailed discussion of each of these five validity criteria and the method involved in combining these five validity criteria see Hermann, op. cit., pp. 220-226, 230 or Ladue, op. cit., pp. 148-151.

[6]Hermann, op. cit., p. 225.

set of rules or validation criteria it does not seem unreasonable to follow Karl R. Popper's suggestion, as interpreted by Naylor and Finger that:

> "...we concentrate on the degree of confirmation of a model rather than whether or not the model has been verified. If in a series of empirical tests of a model no negative results are found but the number of positive instances increases then our confidence in the model will grow step by step."[7]

That is, the model should be subject to as many tests as possible and as many validation criteria as possible. The more tests it passes and the more difficult the tests are the more valid the model will be. Only if the model fails a test should it be changed.[8]

In this study, Popper's philosophy was followed, in that the model was tested in various ways or steps. In the first step the model was tested for face validity. A series of given input data situtations were simulated and the results of the model were checked against expected results calculated (manually) independent of the model. If the resulting values were not as expected, the model was examined and corrected. This process was actually done in two parts. First, the segment of the model which generates the number of animals on the farm in each month

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[7]Naylor and Finger, op. cit., p. B-93.

[8]Ladue has also adopted the Popper philosophy in his study as shown in Ladue, op. cit., pp. 151-152.

was constructed and tested. This first segment was tested by assigning extreme or unusual values to the input variables and input parameters. For example, the number of deaths was increased drastically to test if deaths were properly distributed. Then, the size of herd was increased to check for any unreasonable results. Following this, the size of herd was reduced to only a few animals to test how the model would handle small integer values. In a similar manner, many decision and size variables were changed to test if the model could be used to analyze any reasonable cow-calf farm plan in Manitoba. All results were checked by doing hand calculations and if the results were wrong adjustments or modifications were made to the model (and computer program). That is, omitted variables were added and misspecified relationships were corrected. This first part was the most complicated because an infinite number of patterns of animal numbers is possible.

The second part was the construction and testing of the cost and return segment of the model. This segment was connected to the first segment of the model and tested for face validity. Several runs were required before the model gave expected results. Again, extreme values were used in the model. The results were then checked manually for accuracy, and any necessary corrections were made. All features and facilities of the model such as the various user defined inputs, the different feeding systems, the different manure and bedding removal systems, and the use of prices and costs for different years were tested to see if they were operational. (See Appendices A and B.) Also, the ability to enter management decisions such as sales and purchases and the ability to change the value of the group two parameters were tested.

Although the input data to the computerized model should be error free, several checks for the errors expected to be most common were included in the computer program. These error checks were tested by purposely feeding in data with errors.

The results were always the same whenever the model was run more than once with the same input values. This occurs because the model is deterministic in nature except for deaths. Even for deaths, the results are always the same from run to run because the number of deaths is specified by the user, and although the distribution of deaths is determined by the model, the same set of decision rules is used in each run to distribute the deaths. Random numbers are not used in the process of distributing the deaths throughout the year.

The second step in model validation involved the simulation of three complete illustrative farm plans described in the next section. The results of the three farm plans were also calculated manually and compared with the computer outputs. Errors in the computer outputs were found and the computer program was modified to correct these errors. This provided a way of testing and correcting the complete model.

Furthermore, the three illustrative farm plans were simulated using the cash flow forecaster (developed by the Economics Branch of Manitoba Department of Agriculture and the Canfarm Service Agency of Agriculture Canada). The Cash Flow Forecaster generated a summary of animal numbers and transactions (deaths, births, purchases, and sales) by month, a feed and bedding utilization summary, and various cost and return calculations from inputs similar to those of this study.[9] The results were comparable to those obtained from the simulation model of this study.[10] This verified the following segments: the generation of animal numbers and transactions by category in each month of the year, the feed calculations, and the bedding calculations. Other segments of the model were not adequately verified because the Cash Flow Forecaster required inputs such as prices and costs of various products and factors, labor required in each month, and expected repair costs which are included in or calculated by the model of this study.

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[9]The inputs had to be manipulated to a form acceptable to the Cash Flow Forecaster.

[10]The main discrepancies in the results obtained from the Cash Flow Forecaster and the model of this study are due to the fact that all calves are assumed to be born alive in the Cash Flow Forecaster whereas the model of this study allows the user to specify the percentage of calves born alive.

The third step in model validation consists of a sensitivity analysis on one farm plan to investigate the relative response of the model to changes in parameter values and variables. The sensitivity analysis results are presented and discussed in a further section.

Each of the above tests served to check for computer programming errors and to check the model's logic. Since the values of many of the model parameters can be changed by the user of the model, the validity of the model results depends partly on how well the user of the model specifies the values of these parameters. The initial values assigned to the parameters in the model are chosen to represent an "average" cow-calf enterprise in Manitoba. (See Appendix C for the sources of the values assigned.) They were examined by farm advisors and people acquainted with Manitoba cow-calf operations and judged to be appropriate. These initial values could be changed as more information on these values is obtained from various sources. As such, the initial values assigned only serve as guidelines or benchmarks for users of the model since they can be changed to fit any specific farm plan.

Other tests and checks of validity could be imposed on the model, but as more and more farm plans are simulated, errors in the model or in the computer program will inevitably be found and corrected. By this process the model will attain a higher degree of validity. The validation procedure discussed in this section and the example given in the next section, attempt to show that the model can adequately represent any reasonable Manitoba cow-calf enterprise and can also simulate the consequences of alternative cow-calf farm plans.

B. An Application of the Model as a Farm Planning Tool

In this section, the simulation model will be further tested and the usefulness of the simulation model as a farm planning tool will be demonstrated by applying it to an illustrative 1973 cow-calf operation. The application of the model will consist of simulating or predicting the results of three alternative operations planned at the end of 1973 for the next calendar year (1974) for the illustrative cow-calf enterprise.[11] Following the methodology described in Figure III-1 in Chapter III, the plans will be simulated one at a time by filling out the input forms shown in Appendix D and running the computerized cow-calf simulation model for each year.[12] Then, the "best" farm plan will be chosen by comparing the results of the plans. The three farm plans will also represent

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[11]The years are arbitrarily chosen.

[12]It should be noted that although only one year is simulated in this example, the farm plans could be simulated for more than one future year. This could be done simply by filling out the input forms shown in Appendix A and running the computerized cow-calf simulation model for each year for each plan.

three reasonable options or strategies that the manager of the cow-calf enterprise would be considering for the 1974 operation.

The remainder of this section is divided into five parts. The first part will describe the illustrative cow-calf farm and the three alternative plans. The second part will give the results of the three alternative illustrative farm plans. The third part will indicate the choice of the "best" plan. The results of a sensitivity analysis performed on one farm plan to further investigate the model's validity will be summarized and discussed in the fourth part. The fifth part will present implications of this application of the model.

1. Description of Illustrative Farm Plans

The first alternative plan for the 1974 operation consists of a continuation of exactly the same operation as the 1973 operation. Therefore, the description of the first plan for the 1974 operation applies equally to the 1973 illustrative cow-calf enterprise. The cow-calf enterprise will be structured as follows. The herd consists of 100 cows, 4 bulls, and 21 replacement heifers. The cows which are culled or die are replaced in October by heifers raised on the farm and bred at 15 months of age to calve at two years of age.[13] Calves are born in April

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[13]In October, when entering the cow herd, the replacement heifers are eighteen months of age (three months

and weaned in October. Fifty percent of the heifer calves are retained on the farm as replacement stock and all other calves are sold at weaning. Details on the inputs required for this plan and all subsequent plans are given in Appendix D in sample input numbers 1, 2, and 3 respectively. The 1973 calendar year "average" prices and costs are used in the cost and return calculations when the results of the 1974 operation are simulated.[14] The 1973 prices and costs are chosen to forecast the results for 1974 on the assumption that the best indicators of future prices and costs are the average prices and costs which exist during the year when the cow-calf farm plan is being made.

In the second farm plan being considered for 1974, the farm manager wants to know if it is more profitable to buy replacements instead of raising replacement heifers. The farm manager therefore plans to sell all the replacement stock which exists on the farm in January of 1974 and

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after breeding age). It should be noted that 21 replacement heifers are retained, but only 16 actually enter the cow herd. One dies and four are culled before entering the cow herd because they are non-breeders, not heavy enough, or because of other reasons.

[14]The average 1973 calendar year prices and costs form part of the group two data which are used to simulate the results of the farm plans. As discussed earlier in Chapter III, the initial values assigned to the group two data are listed in Appendix A Part II.

buy bred replacement heifers when they are required.[15] The farm manager also intends to increase his cow herd by 10 percent in January of 1974. The same resources (buildings, pasture, equipment, labor, etc.) which were used to raise the replacement heifers can be allocated to the cow herd. Therefore, the cow herd can be increased by approximately 10 percent to make use of the resources which would be otherwise unused. The main advantages that the farm manager sees in this farm plan are the following:

a) Feed costs would be reduced.

b) Resources such as buildings, pasture, equipment, and labor would become available and could be used to maintain more cows. Therefore, the cow herd could be increased and more calves would be weaned per year.

c) All calves would be sold at weaning. That is, none would have to be kept as replacement stock.

d) Investment in replacement stock would be zero.

Although the farm manager sees the above advantages, he wants to know if this farm plan will be more profitable than the previous plan.

The transactions required to initiate the second plan occur on January 31, 1974. That is, at the end of January cows are purchased to increase the cow herd by 10

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[15] Replacement heifers are required to replace cows which are culled in October or which die during the year.

percent and all replacement heifers are sold. The herd will then consist of 110 cows, 4 bulls, and no replacement heifers. As in plan one, calves are born in April and weaned in October. The calves are all sold at weaning. In October, the cows are culled and replaced by bred eighteen month old heifers which are purchased. The 1973 calendar year "average" prices and costs are again used to calculate the costs and returns in forecasting or simulating the 1974 results of this second plan.

In plan three, the farm manager intends to expand the cow-calf enterprise by 50 percent in January of 1974. The herd then consists of 150 cows, 6 bulls, and 32 replacement heifers. The replacement stock is raised on the farm as was the case in plan one. All calves not needed for replacements are sold at weaning. The timing of events is the same as in plan one. Fifty percent of the heifer calves are retained on the farm as replacement stock and all other calves are sold at weaning. The cows are culled and replaced by bred eighteen month old heifers (raised on the farm) in October. The additional pasture required is rented, additional feeding equipment is bought, additional labor and feed is provided, and the additional shelter space and grain storage bins are built. The transition date is again January 31, 1974. At the end of January, cows and bulls are purchased to increase the breeding herd by 50 percent and replacement heifers are purchased to increase the replacement stock by 50 percent.

Average 1973 prices and costs are used to calculate the costs and returns for 1974 in this plan also.

It should be again noted that the details of the three planned cow-calf farm operations discussed above are given in the three completed input forms given in Appendix D combined with the adjusted initial values assigned to the group II parameters. Each input form contains the inputs required by the simulation model to forecast the results of a cow-calf operation for one year. The forecasts or the simulated results are given below.

2. Simulated Results of Illustrative Farm Plans

Appendix E contains the computer output for each of the three illustrative cow-calf farm plans. This output gives detailed simulated results for each of the three illustrative farm plans, which are summarized in Tables IV-1 to IV-5.

From Table IV-1, the farm manager gets an overall picture of the size of the farm operation and the transactions, such as births, purchases, sales, and deaths, which are predicted for each plan.[16] One observes that no

[16]The computer output which corresponds to Table IV-1 given in Appendix E, gives the same information but on a monthly basis from which the farm manager gets a more detailed picture of the size of the farm operation in each month and from which he can find out on what month of the year each transaction takes place. The computer output also gives an annual summary of livestock numbers.

Table IV-1

1974 Summary of Annual Livestock Numbers for Each Plan

Animal Category	Beginning	Born	Bought	Sold	Died	End
--- Plan #1 ---						
Bulls	4	0	0	0	0	4
Cows	100	0	0	12	4	100
Calves	0	90	0	63	6	0
Heifers (7-18 mos)	21	0	0	4	1	21
Heifers (over 18 mos)	0	0	0	0	0	0
--- Plan #2 ---						
Bulls	4	0	0	0	0	4
Cows	100	0	10	12	4	110
Calves	0	99	0	92	7	0
Heifers (7-18 mos)	21	0	16	21	0	0
Heifers (over 18 mos)	0	0	0	0	0	0
--- Plan #3 ---						
Bulls	4	0	2	0	0	6
Cows	100	0	50	18	6	150
Calves	0	135	0	94	9	0
Heifers (7-18 mos)	21	0	11	6	2	32
Heifers (over 18 mos)	0	0	0	0	0	0

heifers (over 18 months) were kept in either of the plans. In plan 1, the cows, bulls, and heifers (7-18 months) remained the same in number; 90 calves were born; 12 cows and 4 replacement heifers were culled; 63 calves were sold; 4 cows, 6 calves, and 1 replacement heifer died during the year. In plan 2, the bulls remained the same in number; the number of cows increased by 10 percent and the replacement heifers were all sold on January 31; 99 calves were born; 16 bred replacement heifers were bought on October 31st to replace the cows which were culled or which died; 12 cows were culled; 92 calves were sold; 4 cows and 7 calves died during the year. In plan 3, the number of bulls, cows, and replacement heifers increased by 50 percent; 2 bulls, 50 cows, and 11 replacement heifers were purchased on January 31; 135 calves were born; 18 cows and 6 replacement heifers were culled; 94 calves were sold; 6 cows, 9 calves, and 2 replacement heifers died during the year. It should be noted that the beginning inventory was the same in each illustrative farm plan.

From Table IV-2, the farm manager can compare the physical and dollar components of the alternative farm plans.[17] The results of each of the alternative plans

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[17]The computer output that corresponds to Table IV-2, given in Appendix E, contains much more detailed information on each of the physical components and dollar records for each farm plan.

Table IV-2

1974 Summary of Dollar Record for Each Plan[a] (1973 $)

	Plan #1		Plan #2		Plan #3	
I. Costs of Production						
1) Repairs		520.30		520.30		739.34
-Buildings	349.99		349.99		523.25	
-Fences and Corrals	56.58		56.58		84.86	
-Machinery and Equipment	113.73		113.73		131.23	
2) Feed		9405.77		8602.45		15534.86
-Taxes	332.64		332.64		332.64	
-Rent	0.00		0.00		2146.22	
-Fertilizer	0.00		0.00		0.00	
-Tame Hay	6896.70		6727.95		9876.15	
-Native Hay	0.00		0.00		0.00	
-Grain	1581.48		953.58		2305.98	
-Supplement	0.00		0.00		0.00	
-Silage	0.00		0.00		0.00	
-User Defined Feed #1	0.00		0.00		0.00	
-User Defined Feed #2	0.00		0.00		0.00	
-Salt	94.25		93.26		138.46	
-Minerals	500.70		495.03		735.42	
3) Bedding		1690.56		1634.40		2423.52
4) Health Care		52.21		50.27		78.47
-Vitamins	35.47		37.40		53.24	
-Vaccinations	16.74		12.87		25.23	
5) Artificial Insemination		0.00		0.00		0.00
6) Miscellaneous Expenses		555.39		605.88		807.84
Total Out of Pocket Costs		12224.21		11413.29		19584.04
7) Labor		3220.98		3228.43		4603.87
8) Depreciation		1454.08		1454.08		2074.91
9) Investment		9524.39		9406.09		12517.05
Total Costs of Production		26423.66		25501.89		38779.86

(continued)

Table IV-2 (continued)

	Plan #1	Plan #2	Plan #3
II. Gross Returns			
1) Beginning Inventory[b]	-46604.00	-46604.00	-46604.00
2) Sales	19265.52	29249.68	28771.15
3) Purchases	0.00	-10293.52	-23640.00
4) Closing Inventory	46604.00	45952.38	70016.56
Total Gross Returns	19265.52	18304.54	28543.71

[a]The format followed in this table is similar to the format used in the computer outputs in Maurice Senkiw and Alvin Pokrant, "A Cost/Return Simulator for Dairy, Cow/Calf and Stocker/Feeder Enterprises" (unpublished paper, University of Manitoba, Department of Agricultural Economics, 1976).

[b]Beginning inventory is given a negative value because in calculating total gross returns net inventory is required. Net inventory equals closing inventory minus beginning inventory.

given in Table IV-2 may be compared because each one represents forecasts for 1974 based on the average prices and costs for 1973. In Table IV-2, a breakdown of the various costs and returns is given. The total costs of production are approximately 3 percent lower in plan 2 than in plan 1 and 47 percent higher in plan 3 than in plan 1. The total gross returns are approximately 5 percent lower in plan 2 than in plan 1 and 48 percent higher in plan 3 than in plan 1.[18]

When comparing plan 1 and plan 2, one finds that just as the farm manager expected, the feed cost is lower in plan 2 than plan 1. This occurs because it is cheaper to feed 10 extra cows than to feed the replacement stock required for replacing the cows which die or which are culled. The investment cost is lower in plan 2 than in plan 1 because the investment in 10 extra cows is lower than the investment in the replacement stock required by plan 1. The feed cost and the investment cost are the main factors which cause the costs of production to be lower in plan 2 than in plan 1. When comparing the returns, however, one finds that although more calves are sold in plan 2, the gross returns for that plan are lower than for plan 1. This occurs because the additional value of the calves sold is lower than the cost of purchasing the

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[18]Appendix B describes how each of the cost and return components are calculated.

replacement heifers in plan 2 plus the loss in the sales of culled replacement heifers which occur in plan 1.

In comparing plan 1 and plan 3, one finds that all cost components except feed and investment costs are approximately 50 percent higher in plan 3 than in plan 1. Feed costs are approximately 65 percent higher in plan 3 while investment costs are approximately 31 percent higher in plan 1. The main reason for this is that additional pasture required in plan 3, is rented. The cost of renting one acre of pasture is equal to the taxes per acre and the investment cost per acre as explained in Appendix B. The cost of renting and owning one acre of pasture is therefore the same. However, the cost of renting pasture shows up in the feed cost under the cost of rent, whereas the cost of owning pasture is split up between taxes, which show up under feed cost, and investment cost for pasture. This shows up in the investment cost component. In plan 1 all pasture is owned, whereas in plan 3 the additional pasture required for expansion is rented. This is the main reason why feed cost is more than 50 percent higher in plan 3 while investment cost is less than 50 percent higher in plan 3. In comparing plan 1 and plan 3 it should be sufficient to say that both total costs of production and total gross returns are approximately 50 percent higher in plan 3 than in plan 1.

Table IV-3 is the most important table since it contains many of the criteria for choosing among several

Table IV-3

1974 Summary of Management Indicators for Each Plan

	Plan #1	Plan #2	Plan #3
A. PHYSICAL MANAGEMENT INDICATORS			
1) Weaning weight (lbs.)	404.0	404.0	404.0
2) Percentage calves born alive (%)	90.9	90.8	90.6
3) Percentage calf crop weaned (%)	93.3	92.9	93.3
4) Daily rate of gain of			
calves (lbs.)	1.80	1.80	1.80
heifers (7-18 mos) (lbs.)	1.50	1.50	1.50
heifers (over 18 mos) (lbs.)	N/A	N/A	N/A
5) Percentage death loss of			
cows and bulls (%)	3.9	3.6	4.0
calves (%)	13.7	14.5	13.7
heifers (%)	5.3	0.0	7.2
B. OVERALL FINANCIAL MANAGEMENT INDICATORS (1973 $)			
1) Returns to labor, investment and management	5587.23	5437.17	6884.76
2) (a) Returns to labor and management	-3937.16	-3968.92	-5632.29
(b) Returns to labor and management (per hour of labor)	-2.57	-2.58	-2.57
3) (a) Returns to investment and management	2366.25	2208.74	2280.89
(b) Returns to investment and management (as a percentage of investment)	2.24	2.11	1.64
4) Net returns to management	-7158.14	-7197.35	-10236.16

plans.[19] From this table, the farm manager can compare the physical management indicators and the overall financial management indicators of the alternative plans. The former are physical parameters giving an indication of the level of physical efficiency of the operation, while the latter are financial measures which forecast or give an indication of how profitable the operation will be.

The physical management indicators of Table IV-3 indicate that the weaning weight, percent calves born alive, percent calf crop weaned, daily rates of gain, and percent death losses are approximately the same for each of the three farm plans. The only apparent different indicator is percent death loss for heifers. A zero death loss occurs in plan 2 because there are heifers on the farm for only one month of the year. The zero death loss is therefore not too significant. In plan 3 a slightly higher percent death loss for heifers compared to plan 1 is observed. Therefore, since the physical management indicators of Table IV-3 are approximately the same for each of the three farm plans, one can conclude that each plan has the same level of physical efficiency. The calculations involved to obtain each of the management indicators found in Table IV-3 are described in Appendix B.

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[19]The computer outputs which corresponds to Table IV-3, given in Appendix E, contains the same information for each of the plans.

The overall financial management indicators of Table IV-3 indicate four independent criteria for choosing among the several plans. The returns to labor, investment, and management indicate the profits from the cow-calf operation if the labor, investment, and management costs are not considered. The returns to labor, investment, and management actually represent the amount available to pay for investment, labor, and management. On that basis, plan 3 is better than plan 1 and plan 1 is better than plan 2.

The returns to labor and management alone indicate the profits from the cow-calf operation if labor and management costs are not considered. The returns to labor and management actually represent the amount received by the operator for paying either himself or hired help for the time spent working on the enterprise and for bearing the responsibilities of management and risk after having paid an interest allowance on enterprise investment in buildings, fences and corrals, equipment, pasture, and livestock.[20] On the basis of the overall returns to labor and management, plan 1 is better than plan 2 and plan 2 is better than plan 3. Calculated on a per hour of labor basis, the three plans give approximately the same returns to labor and management.

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[20]The rate of interest on investments used by the simulation model is 9 percent.

The returns to investment and management indicate the profits from the cow-calf operation if investment and management costs are not considered. The returns to investment and management actually represent the amount received by the operator for paying the opportunity cost of the capital invested in the enterprise and for bearing the responsibilities of management and risk after having paid for the labor[21] used on the farm.[22] On the basis of the overall returns to investment and management, plan 1 is better than plan 3 and plan 3 is better than plan 2. Calculated as a percentage of investment, the return to investment and management is higher in plan 1 than in plan 2 and higher in plan 2 than in plan 3.[23]

The net returns to management indicate the profits from the cow-calf operation if all costs are considered. The net returns to management actually represent the amount

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[21]Labor could be either hired labor or time the operator spent himself working on the farm.

[22]The average farm wage rate used by the simulation model is 2.10 dollars per hour.

[23]For example, referring to Table IV-3 one could say that in plan 1 the operator would receive 2,366.25 dollars to pay for the opportunity cost of the capital invested in the enterprise and for bearing the responsibilities of management and risk and 2.10 dollars for each hour spent working on the farm. Calculated as a percent of investment, the operator would get 2.24 percent return on his capital invested in the enterprise, nothing for bearing the responsibilities of management and risk, and 2.10 dollars for each hour spent working on the farm.

received by the operator for bearing the responsibilities of management and risk after having paid labor used on the farm the average farm wages and after having paid an interest allowance on investment. On that basis plan 1 is better than plan 2 and plan 2 is better than plan 3.

From the four overall financial management indicators discussed above, one can say that plan 1 is superior to plan 2 in all cases. Plan 1 is also superior to plan 3 except in the case of the returns to labor, investment, and management. That is, only if investment, labor, and management costs are not considered is plan 3 better than plan 1.

From Table IV-4, one can observe the expected labor requirements for each plan for each month.[24] From this information, the farm manager knows how much labor must be hired or allocated to the cow-calf enterprise in each month for any of the plans. Plan 1 requires slightly less labor than plan 2. Plan 3 requires approximately 43 percent more labor than plan 1 or plan 2.

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[24]The computer output which corresponds to Table IV-4, given in Appendix E, indicates where the labor is used in each month, that is, the number of hours required in each month for feeding, manure and bedding removal, health care, fence repair, and checking the herd while on pasture for each of the alternative plans.

Table IV-4

1974 Summary of Labor Requirements for Each Plan

	Total Hours of Labor Required		
Month	Plan #1	Plan #2	Plan #3
January	222.3	222.3	222.3
February	201.8	203.8	302.4
March	242.8	247.2	364.9
April	200.7	201.4	301.6
May	275.8	283.3	413.8
June	2.0	2.0	3.0
July	2.0	2.0	3.0
August	2.0	2.0	3.0
September	2.0	2.0	3.0
October	6.2	2.0	9.4
November	183.6	179.7	275.2
December	192.5	189.6	290.9
Total	1533.8	1537.3	2192.3

From Table IV-5, the farm manager can compare the annual cash flow of the cow-calf enterprise in each plan.[25] As was discussed in Chapter III, the cow-calf enterprise is isolated from all the other enterprises on the farm. All the inputs to and outputs of the cow-calf enterprise are bought from or sold to other enterprises on the same farm or other individuals. Therefore all inputs to the cow-calf enterprise appear as expenses and all outputs from the cow-calf enterprise appear as sales in the cash flow table. Furthermore, neither the current debt situation nor the financial resources of the operator are used in the cash flow table. It is assumed that all capital purchases are cash purchases. Therefore all purchases appear as an expense in the cash flow table. Thus, the annual cash flow given in Table IV-5 actually represents the amount of cash required during the year for each of the farm plans. It is left up to the farm manager or the user of the model to determine whether or not the cash will be borrowed and to calculate the amount of interest and principal that will have to be paid during the year. From Table IV-5, it can be seen that plan 1 requires slightly more cash than plan 2 and plan 3 requires much more cash than either plan 1 or plan 2. The main reasons for higher

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[25]The computer output which corresponds to Table IV-5, given in Appendix E, contains the same information for each of the plans.

Table IV-5

1974 Annual Cash Flow of Each Cow-Calf Plan (1973 $)

	Plan #1	Plan #2	Plan #3
Expenses			
Repairs	520.30	520.30	739.34
Feed			
-Taxes	332.64	332.64	332.64
-Rent	0.00	0.00	2146.22
-Fertilizer	0.00	0.00	0.00
-Tame Hay	6896.70	6727.95	9876.15
-Native Hay	0.00	0.00	0.00
-Grain	1581.48	953.58	2305.98
-Supplement	0.00	0.00	0.00
-Silage	0.00	0.00	0.00
-User Defined Feed #1	0.00	0.00	0.00
-User Defined Feed #2	0.00	0.00	0.00
-Salts	94.25	93.26	138.46
-Minerals	500.70	495.03	735.42
Bedding	1690.56	1634.40	2423.52
Health Care	52.21	50.27	78.47
Artificial Insemination	0.00	0.00	0.00
Miscellaneous Expenses	555.39	605.88	807.84
Cash Purchases			
-Livestock	0.00	10293.52	23640.00
-Buildings	0.00	0.00	9900.30
-Fences and Corrals	0.00	0.00	220.00
-Machinery and Equipment[a]	50.00	50.00	1050.00
-Pasture	0.00	0.00	0.00
Total Expenses	12274.21	21756.81	54394.34
Sales			
Livestock	19265.52	29249.68	28771.15
Buildings	0.00	0.00	0.00
Fences and Corrals	0.00	0.00	0.00
Machinery and Equipment[b]	0.00	0.00	0.00
Pasture	0.00	0.00	0.00
Total Sales	19265.52	29249.68	28771.15
Net Cash Statement	6991.30	7492.87	-25623.18

[a]Only the portion allocated to the cow-calf enterprise is included in this figure.

[b]Only the portion allocated to the cow-calf enterprise is included in this figure.

cash requirements in plan 3 are an increase in investments and an increase in breeding stock inventory. It should be noted that the net cash statement does not represent the profit. The overall financial indicators of Table IV-3 discussed previously give an indication of the profits.

From the results presented in these five tables, the farm manager can decide on one of the three plans or develop other plans to be simulated. This will be discussed in the next part of this section.

3. Choice of the Best Plan

The best plan can be chosen by comparing the resulsts which were presented in the previous section and giving the advantages and disadvantages of each plan. Plan 1 and plan 2 require approximately the same amount of labor, have similar physical management indicators, and require approximately the same amount of cash to operate. But, the profits as shown by the overall financial management indicators, were slightly smaller in plan 2 than in plan 1. This means that the advantages of decreasing the feed costs, having no investment in replacement stock, being able to have 10 percent more cows and wean more calves per year with the same capital resources and the same labor are outweighed by the cost of buying replacement heifers. In short, the costs associated with raising one replacement heifer till it is ready to enter the cow herd, are lower than the average market price of 18 month old replacement heifers. It is more profitable to allocate enough capital resources to raise replacement heifers than to allocate all capital resources to the cow herd in the illustrative cow-calf farm.

By comparing plan 1 and plan 3, one finds that although the physical management indicators are approximately the same, plan 3 requires 43 percent more labor and approximately five times more cash. In addition, plan 3 is less profitable than plan 1 as shown by three of the four overall financial management indicators. Plan 1 is therefore better than plan 3 as well. That is, it is not profitable to expand the cow-calf enterprise by 50 percent.

Although plan 1 is the "best" of the three plans, it is only profitable if investment in the capital resources are not based on their full market value.[26] That is, plan 1 is profitable only if the investment costs are not all considered as shown by the financial indicators of Table IV-3.[27] The farm manager could test out other farm

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[26]Full market value of the resources actually represents the current value of the resources which in this study is calculated as present replacement value minus depreciated value. The detailed calculations are given in Appendix B.

[27]Another way of stating this is: plan 1 is profitable if the farm manager considers the opportunity cost of his capital resources to be lower than the investment cost of his capital resources where investment cost is equal to current rate of interest on investments times current value of investments in the cow-calf enterprise. This could be due to factors such as difficulty in moving the resources or difficulty in finding alternative uses for the resources. As shown by the returns to investment and management (calculated as a percent of investment) given in

plans using the simulation model until a more profitable one is obtained. To develop his plans he could use the five tables and the corresponding computer outputs as a guide to find out where improvements could be made.

4. Sensitivity Analysis

The model and the farm plan results were further tested by performing a sensitivity analysis to examine the model response to changes in parameter values and variables. Further simulations using the first farm plan as a base were conducted to find out the relative effects of changing the value of one parameter or one variable keeping all others constant. The parameters or variables which appeared to be more sensitive from the initial runs were investigated further by parametrically changing their values and verifying the corresponding direction and magnitude of change in the simulated results. The sensitivity analysis results are summarized in Table IV-6 and discussed briefly below.

Table IV-3, it can be seen that for plan 1 the operator gets 2.24 percent return on his capital invested in the enterprise, and 2.10 dollars for each hour spent working on the farm (where no amount is allocated for bearing the responsibilities of management and risk). If the operator is satisfied with a lower return on his investments or if his capital resources would have no alternative use, plan 1 would be profitable for him because he would get some return on his capital although it is lower than the average market return estimated to be approximately 9 percent.

Table IV-6

Summary of Sensitivity Analysis Results on Selected Parameters and Variables[a]

Parameter (or Variable) Examined	Value Assigned to Parameter (or Variable)	Net Returns to Management ($)	Elasticity Coefficent (Percent change in net returns to management for a one percent change in value of parameter or variable)
1) Number of calves born alive	85	-8171.27	
			-2.13
	88	-7589.46	
			-2.61
	90[b]	-7158.14	
			-2.58
	93	-6576.32	
			-3.19
	95	-6145.00	
2) Rate of gain of calves (lbs./day)	1.20	-9886.34	
			-0.69
	1.40	-8889.99	
			-1.22
	1.60	-7553.65	
			-0.46
	1.80[b]	-7158.14	
			-1.02
	2.00	-6428.38	
3) Number of cow deaths	3	-6823.41	
			+0.17
	4[b]	-7158.14	
4) Average live weight of cows (lbs.)	1200[b]	-7158.14	
			-0.12
	1400	-7026.82	
5) Percent of heifer calves retained for replacement	40	-7103.95	
			+0.08
	50[b]	-7158.14	
6) Rate of interest on investment (%)	1.00	+1307.99	
			-135.87
	2.00	+249.72	
			+378.74
	3.00	-808.55	
			+56.69
	5.00	-2925.08	
			+26.57
	7.00	-5041.61	
			+17.35
	9.00[b]	-7158.14	
			+12.88
	11.00	-9274.66	
7) Labor cost ($/hr.)	1.50	-6237.86	
			+0.41
	2.10[b]	-7158.14	
8) Replacement value of steel grain storage bin ($/bu.)	.25	-7134.35	
			+0.01
	.34[b]	-7158.14	
9) Value of improved land in crop district 4 ($/acre)	120.00	-6081.81	
			+0.51
	165.30[b]	-7158.14	

(continued)

Table IV-6 (continued)

Parameter (or Variable) Examined	Value Assigned to Parameter (or Variable)	Net Returns to Management ($)	Elasticity Coefficient (Percent change in net returns to management for a one percent change in value of parameter or variable)
10) Livestock prices ($/cwt.)	20% lower than Plan #1	-10166.98	
			-1.60
	10% lower than Plan #1	-8661.20	
			-1.90
	Values used in Plan #1	-7158.14	
			-2.35
	10% higher than Plan #1	-5653.32	
			-3.07
	20% higher than Plan #1	-4149.30	
11) Feed costs[c] ($/lb.)	20% lower than Plan #1	-5343.51	
			+1.57
	10% lower than Plan #1	-6250.82	
			+1.35
	Values used in Plan #1	-7158.14	
			+1.19
	10% higher than Plan #1	-8065.45	
			+1.07
	20% higher than Plan #1	-8972.77	
12) Winter Rations[d] (lbs. fed per day)	10% lower than Plan #1	-6310.31	
			+1.26
	Values used in Plan #1	-7158.14	
			+1.12
	10% higher than Plan #1	-8005.95	
13) Feeding System	Hand feeding	-7972.14	
			N/A
	Self feeding[b]	-7158.14	
			N/A
	Mechanized feeding	-6342.84	
14) Manure and bedding removal system	Manual	-7802.50	
			N/A
	Mechanical[b]	-7158.14	

[a]The sensitivity analysis was done with respect to farm plan number one.

[b]This value was assigned in plan number one.

[c]Excluding salt and minerals.

[d]Excluding pasture.

The relative effect each variable or parameter has on the model results are demonstrated by showing their effect on the net returns to management. Elasticity coefficients giving the percent change in net returns to management for a one percent change in the value of the parameter or variable are calculated in Table IV-6.[28]

The parameters or variables which affected net returns to management the most were number of calves born alive, rate of gain of calves, rate of interest on investment, livestock prices, feed costs, and winter rations.[29] The elasticity coefficients indicating the direction and magnitude of change in net returns to management show that the model behaves correctly when each of the parameters or variables examined is assigned different values. As the number of calves born alive increases by one percent, the net returns to management increase by

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[28]The absolute change in net returns to management can be easily calculated from the second column of Table IV-6. The calculated elasticity coefficient actually measures the relative responsiveness of net returns to changes in the value of the parameter or variable examined.

[29]An empirical study, by B. A. Hackett [<u>1965 Alberta Cow-Calf Enterprise Analysis</u>, Publication No. 816-420-2 (Alberta: Economics Division and Animal Industry Division, Alberta Department of Agriculture, 1966)] also found that the variation in profit depended on calving percentage, value received per calf weaned, amount of feed fed and feed cost per cow, and investment in buildings and equipment.

approximately 2.6 percent[30] over the range examined.

A one percent increase in rate of gain of calves increases net returns to management by approximately 0.8 percent. As indicated by the elasticity coefficients, a transition occurs when rate of gain is increased from 1.60 to 1.80 pounds per day. A rate of gain of 1.60 gives a weaning weight below 400 pounds. A rate of gain of 1.80 gives a weaning weight over 400 pounds. Since the price per pound for calves is lower if the calf weighs above 400 pounds, the net returns to management are affected less by a change in rate of gain above 1.60 pounds per day.

The elasticity coefficient associated with the rate of interest on investment ranges from -135.87 to 12.88 as this rate was increased from 1.0 percent to 11.0 percent. A transition occurs when the interest rate increases from 2.0 percent to 3.0 percent because net returns to management changes from a positive to a negative value.

A one percent increase in livestock prices increases net returns to management from 1.60 percent to 3.07 percent over the range examined. The magnitude of the elasticity coefficient increases as livestock prices increase.

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[30]When net returns to management is negative, a negative elasticity coefficient indicates that losses are reduced, while a positive elasticity coefficient indicates that losses are increased.

A decrease in net returns to management from 1.57 percent to 1.07 percent results when feed costs increase by one percent over the range examined. The magnitude of the elasticity coefficient decreases as feed costs increase.

As the quantity of feed fed per day during the winter increases by one percent, net returns to management decrease by 1.26 percent to 1.12 percent. As in most of the cases, the magnitude of the elasticity coefficients decreases as the magnitude of net returns to management increases. An increase in winter rations increases the magnitude of the net returns to management and decreases the magnitude of the elasticity coefficient.

The two last parameters examined verify the fact that a different feeding system or a different manure and bedding removal system affects labor requirements, and thus net returns to management. By examining the absolute values of the net returns to management, one finds that the model behaves correctly when a different system is specified.

The other parameters or variables examined affect net returns to management in the right direction but, as was expected, appear to be relatively insensitive as indicated by the magnitude of the elasticity coefficients.

The sensitivity analysis described in this section has served the purpose of testing the relative response of the model to changes in parameter values and variables.[31] The fact that the model behaves properly helps to confirm the model's validity.

5. Implications of this Application of the Model

No specific plan or management practices can be recommended based on the results of this application because, although the farm plans developed are realistic, they are illustrative farm plans and the results are useful only if the assumptions used in the farm plans are valid.[32] The cow-calf farm plans described in this chapter are three possible alternatives that the farm manager was considering. It would be difficult to calculate the results of the three plans without the simulation model since many factors and calculations are involved. Many alternative cow-calf farm plans for as many years as desired can be quickly evaluated using this computerized simulation model.

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[31] It should be noted that an infinite number of tests could be performed to check the model responsiveness when different combinations of parameters or variables are assigned various values. This is left for future exercises.

[32] For example, further runs by the simulation model have shown that if the herd performance and calving percentage were expected to improve in plan 2 by 5 percent because replacement heifers would be purchased, then plan 2 would become more profitable than plan 1. The returns to labor, investment, and management would have been 7 percent higher in plan 2 than in plan 1. An increase in calving percentage and output per cow would imply an increase in technical efficiency.

Different decision criteria for choosing the best plan can be followed by the user of the model by examining any of the five computer outputs. For example, an operator might not necessarily want to maximize profits. His decision criteria might be to choose the farm plan which gives a greater cash flow or the farm plan which requires the minimum amount of feed or the minimum amount of labor or capital investments. Or, if the operator values the opportunity cost of his labor to be zero, he might want the plan which maximizes returns to labor and management rather than net returns to management. Many different decision criteria could be made. It is left up to the user of the model to make his own decision criteria. No one plan can be the best for all operators.

The application of the model has also served the purpose of testing and correcting the complete model as indicated in a previous section. The sensitivity analysis done on one farm plan has further validated the model.

The example given in this chapter has shown that deterministic simulation models can serve as a sophisticated budgeting technique for evaluating several different farm plans.[33] The calculations done by the simulation model can be done by hand, but the use of the model makes

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[33]E. L. Ladue, "A Computerized Farm Business Simulator for Research and Farm Planning" (unpublished Ph.D. Thesis, Michigan State University, 1971), p. 87.

what would otherwise be a long and difficult task, a fast and relatively error free operation. For these reasons, one can conclude that the cost of developing and using a simulation model such as the one described in this study can be justified.

C. Further Uses and Applications of the Model

The simulation model has many uses and applications other than the one given in the previous section. For example, the farm manager could use the simulation model to achieve technical efficiency or allocative efficiency. This could be done by using the model to show the effects on technical efficiency of increasing the calving percentage by using more fertile bulls. A further run of the simulation model has shown that an increase in the calving percentage of 5 percent in plan 1 would increase the returns to labor, investment, and management by 18 percent.

The simulation model could also be used to show the effect of increasing the number of artificial insemination services and decreasing the number of bulls in an attempt to become more allocatively efficient. A further run of the simulation model was done to show the effect on plan 1 of selling 2 bulls and replacing them with 50 artificial insemination services. The calving percentage and the physical output was assumed to remain the same. The simulated results have shown an increase in the costs of production of 0.8 percent, with output constant. It would therefore be allocatively inefficient to reduce the number of bulls and replace them with artificial insemination services.

The model could be used by farm managers, farm advisors, or researchers to find out what happens to the operation when any of the parameters take on different values. For example, one could simulate the results of a plan if the prices increase by 10 percent or decrease by 10 percent. The effects of a change in death rates could also be simulated.

Many other farm management or economic questions could be answered using this model. Some of these are: (a) Is it profitable to fertilize pasture or to feed grain during the pasture season or to creep feed calves? (b) Should different rations or bedding type be used? (c) What kind of manure removal system or feeding system should be used? (d) How much feed and bedding will be required during the year? (e) Will labor have to be hired?, or (f) Is zero grazing profitable?

In the process of using this model the user would get a better understanding of the cow-calf enterprise because he would be forced to find and examine the values of the parameters of the model representing the cow-calf enterprise. It would therefore be useful as a learning tool.

Furthermore, the cow-calf simulation model can be used to predict, and thus aid in evaluating the effects of a program such as the Farm Development Program (FDP) on the cow-calf enterprise of a specific farmer by assuming that a set of outcomes determined by the objectives of the program will occur. For example, if one assumes that the FDP program will achieve the following objectives:

(i) increase the cow herd of the farmer by 10 percent,

(ii) increase the calving percentage of the farmer by 5 percent,

(iii) increase the carrying capacity of the pasture by 25 percent by adding fertilizer,

then the cow-calf simulation model can be used to evaluate the program by:

a) simulating the cow-calf enterprise without the changes due to the program,

b) simulating the cow-calf enterprise with the changes due to the program,

c) comparing the results of the cow-calf enterprise in (a) and (b), drawing conclusions about the results of the program, and deciding if its objectives for the specific farmer are valuable or desirable.

The model could also be used to do an analysis of the cow-calf enterprises in Manitoba. Data on the planned cow-calf enterprises which would serve as inputs to the model of this study could be collected from representative cow-calf producers in Manitoba. The model could be used to generate the physical and financial results of each cow-calf enterprise being sampled. From these results, the variation in profits among cow-calf enterprises and the major management factors affecting this variation could be studied. Recommendations could then be given to cow-calf producers. The next chapter will discuss limitations and possible modifications of the model.

CHAPTER V

LIMITATIONS AND POSSIBLE MODIFICATIONS OF THE MODEL

In this chapter, two related topics will be discussed. First, the main limitations of the model will be given, and then, several possible modifications to improve the model or to widen the uses of the model will be discussed.

A. Limitations of the Model

In order to keep the model reasonable in size and complexity, the following limitations were imposed. First, the model does not check whether or not the resources used in the cow-calf enterprise are sufficient for the size of the enterprise to obtain the expected physical returns from the enterprise. For example, the model does not check if the buildings are satisfactory for the number of head wintered or whether the pasture is sufficient for the number of head grazing in the summer months. Also, the user of the model must specify the rations fed and the expected rates of gain[1] for each category of animals. The computer program does not check whether the rations given

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[1] The user of the model must specify the expected rates of gain for growing animals only.

or the expected rates of gain are reasonable or not. In short, the model (or the computer program for the model) assumes no errors in the input data. Thus, the user of the model must make sure that the detailed farm plan which is input to the simulation model takes into account all the requirements of the cow-calf enterprise.

A second limitation is that the model does not consider the other enterprises on the farm. The user of the model must see how the results of the cow-calf enterprise affect the other enterprises on his farm. For example, the user of the model must calculate from the forecasted labor requirements whether hired labor will be required or whether family labor will be sufficient. Similarly, from the estimated total feed and total bedding requirements, the user of the model must calculate if feed or bedding will have to be bought or if feed and bedding produced on the farm will be sufficient.

A third limitation, which was mentioned in Chapter IV, is that the financial capabilities of the operator are not taken into account. The model only indicates how much cash will be required for the year of operation. The farm manager must calculate how much money will have to be borrowed in each month and what the repayment terms will be. These limitations were imposed in order to keep the input requirements small and to reduce the model size and complexity.

B. Possible Modifications of the Model

Many modification of the model could be made. The model could be refined to include many other aspects of the farm operation. However, the first three modifications mentioned are actually changes to remove the limitations of the model discussed in the previous section.

The first modification would be to include certain checks on the inputs supplied by the user of the model. For example, the model could check if the buildings supplied, the rations supplied, and the pasture available is sufficient to meet the needs of the livestock numbers on the farm during each month of the year. This procedure would be complex because there exist many types of buildings, many possible rations, and pastures with different carrying capacities.

A second modification would be to include and analyze information from other enterprises on the farm being simulated. The information could include such things as amount of feed produced on the farm and amount of labor available. This would make the analysis more complete but would require more calculations from the model.

Thirdly, the model could be modified to handle all borrowing, debt repayment, principal and interest calculations. The model could supply this information on a monthly basis if the initial financial status of the farm operator was known and if the month, in which payment for each expense is made, was known. This information would be useful for the farm manager and for the lending institutions to assess the farm manager's financial standing and ability to repay loans. In implementing these changes to the model, one should also include the income and expenses from all other enterprises on the farm since income from any of the enterprises can be used to pay expenses incurred or loans made for any purposes. Financial calculations of this kind would be easier to make if all the enterprises on the farm were simulated.

The fourth modification deals with changing the prices and costs. The prices and costs of products and input factors were given initial values as shown in Appendix A Part II for 1973, 1974, and 1975. The user of the model can choose one of the three years for the level of prices and costs. If one wants to use different price levels or cost levels, the price or cost level of each item must be changed individually as shown in Appendix A Part III. This is acceptable if the user of the model wants to change only a few of the price or cost levels of a certain year. If the user of the model wants to change all the cost and price levels by a certain percentage, then the task becomes quite time consuming. In that case, a useful modification to the model would be to include a routine which would allow the levels of different groups of prices such as those of all types of livestock, or costs such as those of all types of buildings, to change by a certain percentage. In this way, one entry in the input data form could facilitate a change in the levels of a group of prices or costs by any desired percentage.[2]

A fifth possible modification would be the inclusion in the model of various recommended rations for mature and growing animals, along with expected rates of gain. This would reduce the amount of information needed in the required input data form (Appendix A Part I). The user of the model would only have to specify the ration number for each category of animal which comes closest to the expected ration instead of indicating how much of each feed is provided in each of the planned rations.

A sixth modification would be the addition of another table in the output of the model. It would be useful to know the amount of different feeds and bedding required in each month instead of only the total physical amount of different feeds and bedding required during the whole year which is given in the physical and dollar record summary output.[3] This would be useful for the farm

[2]A modification similar to this fourth one was suggested as an extension to Ladue's simulation model in: E. L. Ladue, "A Computerized Farm Business Simulator for Research and Farm Planning" (unpublished Ph.D. Thesis, Michigan State University, 1971), pp. 176-178.

[3]It should be noted that feed and bedding requirements are already calculated on a monthly basis but only the annual requirements are printed in the physical and dollar record summary output as shown in Appendix E.

operator who wants to know the month(s) for which he will have to buy extra feed.

A seventh modification or addition to the model would be to add production functions to the model to reduce the number of exogenous variables. An example of one production function which could be incorporated in the model is the rate of gain of replacement heifers as a function of rations fed, pasture available, health care, bedding, and shelter.

An eighth modification or extension to the model would be to build a simulation model similar to the one developed in this study for each of the enterprises which are usually found on a farm, namely, forage enterprise, crop enterprise, stocker or feeder enterprise, dairy enterprise, and hog enterprise. Then the simulation model of each of these enterprises could be linked together to form a complete farm planning simulation model. In examining cow-calf enterprises it would be especially valuable to include the forage and the cropping enterprises because most cow-calf operators have a forage and a cropping enterprise from which they obtain their feed.

In making the above modifications or other modifications to the model the analyst should consider the model size versus model realism relationship. The costs of developing the model usually increase more than proportionally to the size of the model, so that the analyst must weigh carefully the value of the added realism against the added cost. The analyst or researcher should consider whether or not a smaller and less costly model can be used to answer the type of questions asked.

CHAPTER VI

SUMMARY AND CONCLUSIONS

After discussing the importance, the financial situation, and the need for better management of the cow-calf enterprises in Manitoba, as well as the value of management development information and the complexity involved in making management decisions, the need to develop a methodology for evaluating alternative cow-calf farm plans was stated. The specific objectives of this study were to:

(1) develop and computerize a cow-calf farm simulation model which (a) can reasonably represent and simulate a Manitoba cow-calf enterprise, (b) requires a minimum amount of inputs, (c) can be adjusted to simulate individual cow-calf situations, (d) requires very little computer programming knowledge, (e) can be quickly and easily used, (f) speeds up and facilitates the work involved in partial budgeting, and (g) is flexible in input requirements, that is, the user of the model can change the initial values of as many or as few parameters as he wishes.

(2) show the usefulness of the model by (a) confirming the model's validity and demonstrating an application of the model as an analytical tool to assist farm planning, and (b) discussing further uses and applications of the

model for farm managers, farm advisors, and researchers.

(3) critically evaluate simulation as a potential technique for use in this study.

In attaining these objectives, the following steps were undertaken. First, a description of the simulation technique and a review of previous studies using simulation were made. A comparison of the simulation technique with other techniques, such as linear programming and econometrics, led to the conclusion that simulation was most appropriate for this study.

A procedure for evaluating alternative cow-calf farm plans was developed and described in Chapter III. Essentially, the results of each plan are determined using the simulation model. These results are then compared and used to evaluate the alternative cow-calf plans.

The development of a suitable simulation model forms the major part of this study. Although designed for researchers, farm advisors, and farm managers, the model was built mainly as a farm planning tool. For this reason, the input and output formats are straightforward. The flexibility in input requirements is the key feature of this model, which is essentially a sophisticated budgeting technique where data about the planned operation are fed to the model and physical and financial parameters are determined by the model.

The validity of the model was confirmed in three stages. The model was first tested for face validity and accuracy. Extreme and unusual cases were tested to see how the model and the computer program would accomodate such situations. Second, three illustrative farm plans were simulated to test the complete model. The third stage consisted of a sensitivity analysis on one farm plan to demonstrate the relative response of the model to changes in parameter values and variables.

From these three tests the model was judged to be valid within a certain degree of confidence. In the first stage, any necessary modifications were incorporated into the model (and computer program) to ensure that the simulated results from a range of given data input situations corresponded with results generated independent of the model. By simulating three typical farm plans, checking the complete results manually, and comparing part of the results with those obtained from the Cash Flow Forecaster (developed by the Economics Branch of Manitoba Department of Agriculture and the Canfarm Service Agency of Agriculture Canada), the model was found to be realistic and reasonably accurate. The third stage of validity testing, sensitivity analysis, indicated that the model behaved properly. That is, when selected variables and parameters were assigned different values in the model, the corresponding changes in the simulated results paralleled the expected direction and magnitude of change.

In spite of the above validation procedure, the following inaccuracies or omissions in the model were pointed out by examiners of this study: (i) labor requirements for feeding are too high, (ii) income tax calculations are not included, (iii) no interest on operating capital is calculated, (iv) carrying capacities and forage species of the various fields of pasture are not identified, (v) births of all calves usually do not occur during the same month as assumed in the model, (vi) labor required for assisting cows in calving, for checking cows for pregnancy, for branding, and for clipping eartags are not computed, (vii) health care costs are too high, and (viii) age distribution of mature animals is not taken into account. By adjusting the model to include the above suggestions, the model would be more valid and complete.

The usefulness of the model as an analytical tool to aid farm planning is demonstrated by simulating the three alternative illustrative cow-calf farm plans mentioned above. Briefly, in the first plan the replacement stock is raised on the farm; in the second plan all replacement stock is bought when required, all calves are sold at weaning, and the cow herd is increased by ten percent; and in the third plan the cow-calf herd is increased by fifty percent. The results indicate that plan number one is more profitable than plan number two or plan number three. It was also found that even plan number one is profitable only if the resources are not valued at full market value. Many other farm plans could be tested. Several limitations of the model and possible modifications of the model were suggested.

Users of the model should remember that the model is deterministic or mechanical in nature. Many management aspects not handled by the model must be considered in obtaining the results that the simulation model indicates. For example, the timeliness of actions, such as, months during the year that bulls are available for breeding, time interval between each check of the herd while on pasture, frequency of manure and bedding removal, assisting cows and heifers at time of calving, and routine health care treatments are important in determining the productivity of the operation. Selecting the proper cows to cull and the proper heifers to keep as replacements are important decisions exogenous to the model. Many other factors such as adequate nutrition, breeding practices, and pregnancy testing should be considered when using the model. The simulated results of a farm plan become more useful if one remembers the management practices that must be followed to obtain the calving percentages, the rates of gain, and the death rates specified in the model.

In conclusion, the purpose of this study was mainly to develop and demonstrate the usefulness of a new model to be used by farm managers, farm advisors, and researchers to forecast and evaluate alternative cow-calf farm plans. Since the objective of this study was not to give advice on various management practices but to develop a new analytical tool to aid in farm management, the model demonstrations indicated the usefulness of the simulation model, even though no farm management practices can be recommended because the farms examined were illustrative constructions. In effect, this study describes a framework which indicates all the required inputs to forecast the results of a cow-calf farm plan and the comprehensive data collection which is required for a computerized simulation model. The simulation model serves as a laboratory to quickly conduct experiments on various farm plans without using actual physical farm enterprises. The simulation model can be used to forecast the results of alternative farm plans and the user of the model can choose the "best" farm plan using his own decision criteria.

SUGGESTION FOR FURTHER RESEARCH

The model developed in this study could be used by farm advisors to help transfer information to individual farmers and to help develop and evaluate their cow-calf farm plans. It could be used to show the effect of adopting better or new techniques on their cow-calf enterprise. A study could then be conducted to find out if the farmers who used the model to gain information for planning their farm have increased their efficiency and have adopted better or new techniques faster than other farmers who did not use the model.

APPENDICES

APPENDIX A

APPENDIX A[1]

USER MANUAL FOR THE COW-CALF BUDGETARY SIMULATION MODEL

I. Introduction

This appendix consists of a user manual for the computerized cow-calf simulation model. Part I gives the required inputs which are specific and unique to each cow-calf enterprise. It consists of the first group of inputs which contains the parameters representing the characteristics of the specific cow-calf farm plan to be simulated. The inputs of Part I represent the minimum data required for simulating a cow-calf farm plan for one calendar year.

Part II provides the group two parameters which have initial values specified by the model. The values assigned to these parameters, also given in Part II, are the initial values which are assumed by the model unless they are changed (that is, input by exception) using the methods shown in Part III. The user of the model should examine all of the values assigned to the parameters in Part II and change those which are incorrect or unsuitable. The initial values given in Part II are intended to be

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[1]The procedure followed in this appendix is similar to the procedure followed by Ladue, op. cit., Appendix A, pp. 211-297.

"average" values or "normal" practices which serve as benchmarks or guidelines for users of the model. Appendix B details the calculations performed by the model while Appendix C indicates the sources of the initial values assigned to the parameters given in Part II of this appendix.

Refer to Appendix D for the three sample inputs required to simulate the three illustrative farm plans. The group one parameter values as well as the changes made to the group two parameter values are indicated for each farm plan. Appendix D also indicates the card number and the column number to use to input each of the parameter values.

To use this model, one should fill out the input form as shown in Appendix D. From this, the cards can be punched and the computer program for the simulation model can be run. Three sample outputs (those of the three illustrative farm plans) from the computerized simulation model are given in Appendix E.

PART I-- Required Input Data (Group one data)

1. General Information

a) Name ______________________________

b) Crop District ______________________

2. Output Header Information

a) No. of alternative plans to be simulated is ________ of which this is the ______ (1st, 2nd, 3rd, or other).

b) Other identifying information to be printed: ______ ____

3. Year of Operation

The operation of calendar year 19___ is being simulated.

4. Year of Prices and Costs

Prices and costs from year 19___ are to be used.

5. Livestock Numbers Information

a) Beginning Inventory (Number on Jan. 1st by category)

No. of bulls ____________

No. of cows _____________

No. of calves by age (months)

Age	0	1	2	3	4	5	6
Number							

No. of replacement heifers by age (months)

Age	7	8	9	10	11	12	13	14
Number								

Age	15	16	17	18	19	20	21	22
Number								

Age	23	24	25	26	27	28	29	30
Number								

b) Natural Occurrence Expected

Category of Livestock	Number Born Alive	Number of Deaths	No. of Culls (sold)
Bulls	X		
Cows	X		
Calves (0-6 mos.)			X
Replacement Heifers	X		

6. Buildings Used for the Cow-Calf Enterprise

a) Sheds or Barns

Size (sq. ft.)	Age[2]	Wired and Insulated[3]

[2]Age refers to the age at the beginning of the year.

[3]Put a "1" if building is wired and insulated and a "2" if building is not wired or not insulated.

b) Hay Storage Facilities

Size (tons)	Age

c) Grain Storage Facilities

Size (bu.)	Age	Type code[4]

d) Silos

Size (tons)	Age	Type code[5]

[4]Codes are 1--wood, 2--steel.

[5]Codes are 1--bunker, 2--concrete, 3--sealed.

7. Fences, Pens, Corrals, and Working Chutes Used for Cow-Calf Enterprise

a) Fences

Perimeter length (mi.)	Age

b) Pens, Corrals, and Working Chutes

Perimeter length (ft.)	Age

8. Machinery and Equipment

Description[6]	Age (years)	Life (years)	Present Replacement Value[7] ($)	Portion Used in the Cow-Calf Enterprise (fraction)

9. Systems (choose the most suitable number)

a) Feeding System: (1. Hand feeding / 2. Self feeding / 3. Mechanized Feeding) ________

---

[6]Description of machinery or equipment should be given using less than 20 letters.

[7]Present Replacement Value refers to the current cost of replacing the machine or piece of equipment with a new machine or piece of equipment of the same size and type.

b) Manure and Bedding Removal System:

(1. Manual
2. Mechanical) ________

10. Summer Activities (indicate with 1 for yes and 0 for no).

Category	a) Sent to pasture during summer	b) Fed a ration during summer	c) Kept inside during summer
Bulls			
Cows			
Calves (0-6 mos.)			
Heifers (7-18 mos.)			
Heifers (over 18 mos.)			

11. Vitamins (injected or fed apart from those provided in the regular rations given below in Questions #15 and #16.)

No. of treatments	Month given	Vitamin code[8]

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[8]Vitamin codes: 1--vitamin A,D,E (for growing animals),
2--vitamin A,D,E (for mature animals),
3--user defined vitamin.

12. Vaccinations

No. of vaccinations	Month given	Vaccination code[9]

13. Artificial Insemination

No. of cows bred with A.I. ____________

14. Pasturing Practices

a) Pasture Resources Available for the Cow-Calf Enterprise

No. of acres	Improved--1 Unimproved--2	Owned--1 Rented--2

---

[9]Vaccinations Codes: 1--IBR; 2--Blackleg; 3--Malignant Edema; 4-- 3-way; 5--User defined vaccination.

b) Fertilizer Applied on Pasture Grazed by the Cow-Calf Herd

Code[10]	Total No. of tons

[10] Fertilizer Codes:
1. 11-55-0
2. 11-48-0
3. 34-0-0
4. 46-0-0
5. 24-0-0
6. User defined fertilizer.

15. Winter Rations (in pound per day)

Feed Code	Feed	Bulls	Lactating Cows	Gestating Cows	Dry Cows	Calves (0-6 mos.)	Replacement Heifers (7-18 mos.)	Replacement Heifers (over 18 mos.)
1	Tame Hay							
2	Native Hay							
3	Grain							
4	Supplement							
5	Silage							
6	User Defined feed #1							
7	User Defined feed #2							
8	Salt and Minerals Code[11]							

[11]Salt and Minerals Code:
1--No salt, no minerals
2--Salt, no minerals
3--Minerals, no salt
4--Salt and minerals.

16. Summer Rations (in pound per day) Excluding Pasture

Feed Code	Feed	Bulls	Lac-tating Cows	Ges-tating Cows	Dry Cows	Calves (0-6 mos.)	Re-place-ment Heifers (7-18 mos.)	Re-place-ment Heifers (over 18 mos.)
1	Tame Hay							
2	Native Hay							
3	Grain							
4	Supple-ment							
5	Silage							
6	User Defined feed #1							
7	User Defined feed #2							
8	Salt and Minerals Code[12]							

[12] Salt and Minerals Code: 1--No salt, no minerals
2--Salt, no minerals
3--Minerals, no salt
4--Salt and minerals.

17. Expected Rates of Gain (in lbs. per day)

a) Average rate of gain expected for heifers (7-18 mos.) ______________.

b) Average rate of gain expected for heifers (over 18 mos.) ___________.

18. Bedding Used

Straw -- (Yes = 1; No = 0) ____________.

User Defined -- (Yes = 1; No = 0) _____________.

PART II-- Parameters with Initial Values Assumed by the Model (Group two data)

This section lists the group two parameters and their initial values assumed by the model. The values which are underlined are the initial assumed values for the respective parameters. The numbers in parentheses are the identification numbers for the respective parameters which enable the user to change any of the initial values assigned by the model as explained in Part III of this appendix. Appendix C gives the sources of the values assigned to these group two parameters.

1. Livestock Numbers Information

   a) Deaths are distributed evenly by age for growing animals and by month for mature animals.

   b) Bulls are culled in month (100) 8.

   c) Cows are culled in month (101) 10.

   d) Heifers are culled in month (102) 5.

   e) Births occur in month (103) 4.

   f) At (104) 18 months of age all the heifers are transferred to the cow category.

   g) At 6 months of age, that is, at weaning (105) 25% of the calves enter the replacement heifer category, (106) 25% of the calves are sold as heifer calves, and (107) 50% of the calves are sold as steer calves.

2. Labor Requirements

   a) Labor requirements for fence repair is (108) 5.0 hours per mile. All fence repair is done in month (109) 5.

b) Labor required for one dehorning is (110) .25 hour. In month (111) 5, (112) 100% of calves born alive are dehorned.

c) Labor required for one castration is (113) .25 hour. In month (114) 5, (115) 50% of calves born alive are castrated.

d) Labor required for one vaccination or for one vitamin treatment is (116) .10 hour.

e) Labor required to check herd while on pasture is (117) 2.0 hour(s) per month.

f) Labor requirements for feeding by month per animal for selected systems are presented in Table A-1.

g) Labor requirements for manure and bedding removal are described below. For a manual system (298) 2.0 hour(s) is (are) required to remove 100 cu. ft. of manure and bedding. For a mechanical system, (299) 1.0 hour(s) is (are) required to remove 100 cu. ft. The volume of manure and bedding produced daily by the different animal categories are summarized in Table A-2.

3. Rates of Gain

a) Non-creep fed calves gain (305) 1.67 pounds per day.

b) Creep fed calves gain (306) 1.87 pounds per day.

Table A-1

Labor Required for Feeding by Month per Animal for Selected Systems

Animal Category \ Month	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Hand Feeding System[a]												
Bulls	(118) 2.116	(119) 1.764	(120) 2.424	(121) 1.334	(122) 1.712	(123) 1.277	(124) 1.396	(125) 1.547	(126) 1.630	(127) 1.329	(128) 1.464	(129) 1.727
Cows	(130) 2.116	(131) 1.764	(132) 2.424	(133) 1.884	(134) 1.712	(135) 1.277	(136) 1.396	(137) 1.547	(138) 1.630	(139) 1.329	(140) 1.464	(141) 1.727
Calves (0-6 mos.)	(142) .400	(143) .400	(144) .400	(145) .400	(146) .400	(147) .400	(148) .400	(149) .400	(150) .400	(151) .400	(152) .400	(153) .400
Heifers (7-18 mos.)	(154) .977	(155) .780	(156) .886	(157) .862	(158) .903	(159) .845	(160) .845	(161) .845	(162) .845	(163) .885	(164) .885	(165) 1.028
Heifers (over 18 mos.)	(166) 1.026	(167) .922	(168) 1.093	(169) 1.014	(170) 1.075	(171) .999	(172) .997	(173) 1.075	(174) 1.116	(175) .952	(176) .975	(177) 1.026
Self Feeding System[a]												
Bulls	(178) 1.588	(179) 1.323	(180) 1.819	(181) 1.414	(182) 1.285	(183) .958	(184) 1.047	(185) 1.161	(186) 1.223	(187) .997	(188) 1.099	(189) 1.295
Cows	(190) 1.588	(191) 1.323	(192) 1.819	(193) 1.414	(194) 1.285	(195) .958	(196) 1.047	(197) 1.161	(198) 1.223	(199) .997	(200) 1.099	(201) 1.295
Calves (0-6 mos.)	(202) .300	(203) .300	(204) .300	(205) .300	(206) .300	(207) .300	(208) .300	(209) .300	(210) .300	(211) .300	(212) .300	(213) .300
Heifers (7-18 mos.)	(214) .681	(215) .544	(216) .618	(217) .601	(218) .630	(219) .589	(220) .589	(221) .589	(222) .589	(223) .617	(224) .617	(225) .717
Heifers (over 18 mos.)	(226) .715	(227) .643	(228) .762	(229) .707	(230) .750	(231) .697	(232) .681	(233) .750	(234) .778	(235) .664	(236) .680	(237) .715

(continued)

Table A-1 (continued)

Animal Category \ Month	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Mechanized Feeding System[a]												
Bulls	(238) 1.059	(239) .882	(240) 1.213	(241) .943	(242) .857	(243) .638	(244) .698	(245) .774	(246) .815	(247) .665	(248) .733	(249) .863
Cows	(250) 1.059	(251) .882	(252) 1.213	(253) .943	(254) .857	(255) .638	(256) .698	(257) .774	(258) .815	(259) .665	(260) .733	(261) .863
Calves (0-6 mos.)	(262) .200	(263) .200	(264) .200	(265) .200	(266) .200	(267) .200	(268) .200	(269) .200	(270) .200	(271) .200	(272) .200	(273) .200
Heifers (7-18 mos.)	(274) .385	(275) .307	(276) .349	(277) .340	(278) .356	(279) .333	(280) .333	(281) .333	(282) .333	(283) .349	(284) .349	(285) .405
Heifers (over 18 mos.)	(286) .404	(287) .363	(288) .431	(289) .399	(290) .424	(291) .394	(292) .385	(293) .424	(294) .440	(295) .375	(296) .384	(297) .404

[a]The figures given are hours of labor required per animal by month by animal category for feeding.

c) At weaning, steer calves weigh (307) 25.0 pounds more than heifer calves.

4. Ration Lengths

a) If a winter lactation ration is specified, it is fed to all cows who nurse a calf for (308) 1 month(s) in the winter from the beginning of month (309) 5 to the end of month (310) 5.

b) If a winter gestation ration is specified, it is fed to all cows on the farm for (311) 2 month(s) in the winter from the beginning of month (312) 3 to the end of month (313) 4.

c) If a summer lactation ration is specified, it is fed to all cows who nurse a calf for (314) 5 month(s) in the summer from the beginning of month (315) 6 to the end of month (316) 10.

Table A-2

Volume of Manure and Bedding Produced
Daily per Animal

Animal Category	Volume of Manure and Bedding per Animal (cu. ft./day)	
Bulls	(300)	2.0
Cows	(301)	1.2
Calves (0-6 mos.)	(302)	0.3
Heifers (7-18 mos.)	(303)	0.7
Heifers (over 18 mos.)	(304)	1.2

d) If a summer gestation ration is specified, it is fed to all cows on the farm for (317) 0 month(s) in the summer from the beginning of month (318) 0 to the end of month (319) 0.

5. Bedding Requirements

See Table A-3 for the amount of bedding required per head per day by the different animal categories.

6. Animal Live Weights

a) Calves weigh (325) 80 pounds when they are born.

b) Cows have an average weight of (326) 1200 pounds.

c) Bulls have an average weight of (327) 1300 pounds.

Table A-3

Daily Bedding Requirements per Animal

Animal Category	Pounds of Bedding per Head per Day	
Bulls	(320)	8
Cows	(321)	8
Calves (0-6 mos.)	(322)	4
Heifers (7-18 mos.)	(323)	6
Heifers (over 18 mos.)	(324)	8

7. Average Interest Rates by Year

Table A-4 indicates the average interest rates by year.

8. Average Prices of Products and Factors by Year

The average prices of various products and factors are listed by year and divided into 14 groups from (a) to (n) in Table A-5.

9. Salt and Mineral Requirements

The salt and minerals required per month per head by the different animal categories are given in Table A-6.

Table A-4

Average Rate of Interest on Investments by Year

Year		Rate of Interest on Investments (%)
1973	(328)	9.00
1974	(329)	10.00
1975	(330)	10.00

Table A-5

Average Prices and Costs by Year

Item	Units	Prices and Costs ($) 1973	1974	1975
a) Livestock prices				
Steers < 300 lbs.	$/cwt	(331) 63.68	(332) 37.94	(333) 21.28
Steers ≥ 300 lbs. ≤ 400 lbs.	$/cwt	(334) 60.21	(335) 36.84	(336) 27.55
Steers > 400 lbs. ≤ 575 lbs.	$/cwt	(337) 54.85	(338) 41.90	(339) 32.41
Heifers > 300 lbs.	$/cwt	(340) 57.41	(341) 28.85	(342) 18.15
Heifers ≥ 300 lbs. ≤ 400 lbs.	$/cwt	(343) 51.76	(344) 36.46	(345) 21.28
Heifers > 400 lbs. ≤ 550 lbs.	$/cwt	(346) 45.94	(347) 36.09	(348) 25.43
Heifers > 550 lbs.	$/cwt	(349) 42.27	(350) 33.24	(351) 27.07
Heifers (culls)	$/cwt	(352) 38.04	(353) 29.92	(354) 24.36
D3 cows	$/cwt	(355) 33.28	(356) 25.99	(357) 19.32
D4 cows (culls)	$/cwt	(358) 30.14	(359) 20.60	(360) 15.90
Bulls	$/cwt	(361) 38.90	(362) 33.66	(363) 22.12
Bulls (culls)	$/cwt	(364) 35.01	(365) 30.29	(366) 19.91
Vealers (Medium and common)	$/cwt	(367) 50.05	(368) 41.01	(369) 21.83
b) Fertilizer cost				
11-55-0	$/ton	(370) 114.00	(371) 144.00	(372) 184.00
11-48-0	$/ton	(373) 103.00	(374) 132.00	(375) 169.00
34-0-0	$/ton	(376) 70.00	(377) 98.00	(378) 125.00
46-0-0	$/ton	(379) 83.00	(380) 121.00	(381) 155.00
24-0-0	$/ton	(382) 52.00	(383) 76.00	(384) 97.00

(continued)

Table A-5 (continued)

Item	Units	Prices and Costs ($) 1973	1974	1975
User Defined	$/ton	(385)	(386)	(387)
c) Labor costs				
Labor (farm wages without board)	$/hr	(388) 2.10	(389) 2.52	(390) 3.05
d) Feed costs				
Tame hay[a]	$/lb	(391) .015	(392) .018	(393) .018
Native hay[b]	$/lb	(394) .011	(395) .013	(396) .013
Grain[c]	$/lb	(397) .055	(398) .051	(399) .044
Supplement	$/lb	(400)	(401)	(402)
Silage[d]	$/lb	(403) .006	(404) .007	(405) .007
User defined feed #1	$/lb	(406)	(407)	(408)
User defined feed #2	$/lb	(409)	(410)	(411)
Salt	$/lb	(412) .027	(413) .030	(414) .030
Minerals	$/lb	(415) .072	(416) .127	(417) .127
e) Artificial insemination	$/cow	(418) 10.75	(419) 11.83	(420) 13.71
f) Bedding costs				
Bedding--straw	$/lb	(421) .008	(422) .009	(423) .009
Bedding--user defined	$/lb	(424)	(425)	(426)
g) Building and fences costs				
Insulated and wired barn	$/sq. ft.	(427) 3.98	(428) 4.43	(429) 4.77
Non-insulated and non-wired barn	$/sq. ft.	(430) 3.13	(431) 3.48	(432) 3.74
Fence	$/mi	(433) 775.80	(434) 1158.00	(435) 1286.00
Pens, corrals, and working chutes	$/ft	(436) 1.10	(437) 1.64	(438) 1.82
Grain storage (wood)	$/bu	(439)	(440)	(441)
Grain storage (steel)	$/bu	(442) .34	(443) .38	(444) .41

(continued)

Table A-5 (continued)

Item	Units	Prices and Costs ($) 1973	1974	1975
Hay storage	$/ton	(445) 11.37	(446) 12.65	(447) 13.62
Bunker silos	$/ton	(448) 14.22	(449) 15.81	(450) 17.02
Concrete silos	$/ton	(451) 51.17	(452) 56.92	(453) 61.28
Sealed silos	$/ton	(454) 108.00	(455) 120.20	(456) 129.40
h) Vitamin costs				
Vitamin A, D, E, (for growing animals)	$/treatment	(457) .07	(458) .07	(459) .08
Vitamin A, D, E, (for mature animals)	$/treatment	(460) .17	(461) .18	(462) .20
User defined	$/treatment	(463)	(464)	(465)
i) Vaccination costs				
IBR	$/treatment	(466) .17	(467) .18	(468) .20
Blackleg	$/treatment	(469) .13	(470) .14	(471) .15
Malignant edima	$/treatment	(472) .11	(473) .12	(474) .13
3-way	$/treatment	(475) .41	(476) .44	(477) .48
User defined	$/treatment	(478)	(479)	(480)
j) Miscellaneous expenses[e]	$/cow	(481) 5.61	(482) 6.57	(483) 7.26
k) Value of improved land				
Crop district 1	$/acre	(484) 98.12	(485) 126.00	(486) 153.80
Crop district 2	$/acre	(487) 122.70	(488) 150.20	(489) 186.70
Crop district 3	$/acre	(490) 158.60	(491) 209.50	(492) 259.40
Crop district 4	$/acre	(493) 165.30	(494) 245.80	(495) 272.90
Crop district 5	$/acre	(496) 137.10	(497) 212.30	(498) 231.40

(continued)

Table A-5 (continued)

Item	Units	Prices and Costs ($) 1973	1974	1975
Crop district 6	$/acre	(499) 95.33	(500) 116.00	(501) 132.10
Crop district 7	$/acre	(502) 88.65	(503) 100.80	(504) 119.20
Crop district 8	$/acre	(505) 126.40	(506) 149.90	(507) 157.40
Crop district 9	$/acre	(508) 122.00	(509) 147.40	(510) 167.90
Crop district 10	$/acre	(511) 100.10	(512) 124.00	(513) 141.40
Crop district 11	$/acre	(514) 117.90	(515) 135.30	(516) 134.00
Crop district 12	$/acre	(517) 90.14	(518) 98.43	(519) 101.70
Crop district 13	$/acre	(520) 104.80	(521) 124.60	(522) 151.40
Crop district 14	$/acre	(523) 125.90	(524) 142.80	(525) 146.70
1) Value of unimproved land				
Crop district 1	$/acre	(526) 32.70	(527) 41.98	(528) 51.28
Crop district 2	$/acre	(529) 40.91	(530) 50.05	(531) 62.23
Crop district 3	$/acre	(532) 52.85	(533) 69.82	(534) 86.45
Crop district 4	$/acre	(535) 55.09	(536) 81.94	(537) 90.97
Crop district 5	$/acre	(538) 45.69	(539) 70.76	(540) 77.13
Crop district 6	$/acre	(541) 31.77	(542) 38.66	(543) 44.04
Crop district 7	$/acre	(544) 29.55	(545) 33.59	(546) 39.74
Crop district 8	$/acre	(547) 42.14	(548) 49.96	(549) 52.46
Crop district 9	$/acre	(550) 40.65	(551) 49.12	(552) 55.96
Crop district 10	$/acre	(553) 33.37	(554) 41.34	(555) 47.14

(continued)

Table A-5 (continued)

Item	Units	Prices and Costs ($) 1973	1974	1975
Crop district 11	$/acre	(556) 39.29	(557) 45.10	(558) 44.66
Crop district 12	$/acre	(559) 30.04	(560) 32.81	(561) 33.90
Crop district 13	$/acre	(562) 34.93	(563) 41.52	(564) 50.47
Crop district 14	$/acre	(565) 41.97	(566) 47.61	(567) 48.91
m) <u>Taxes on improved land</u>				
Crop district 1	$/acre	(568) 1.19	(569) 1.44	(570) 1.91
Crop district 2	$/acre	(571) 1.39	(572) 1.68	(573) 2.23
Crop district 3	$/acre	(574) 2.00	(575) 2.41	(576) 3.21
Crop district 4	$/acre	(577) 1.26	(578) 1.51	(579) 2.00
Crop district 5	$/acre	(580) 2.48	(581) 2.98	(582) 3.96
Crop district 6	$/acre	(583) .97	(584) 1.13	(585) 1.46
Crop district 7	$/acre	(586) 1.47	(587) 1.77	(588) 2.34
Crop district 8	$/acre	(589) 1.23	(590) 1.48	(591) 1.97
Crop district 9	$/acre	(592) 1.20	(593) 1.45	(594) 1.92
Crop district 10	$/acre	(595) 1.29	(596) 1.56	(597) 2.07
Crop district 11	$/acre	(598) 1.00	(599) 1.20	(600) 1.58
Crop district 12	$/acre	(601) .58	(602) .69	(603) .91
Crop district 13	$/acre	(604) 1.26	(605) 1.52	(606) 2.00
Crop district 14	$/acre	(607) .43	(608) .52	(609) .69
n) <u>Taxes on unimproved land</u>				
Crop district 1	$/acre	(610) .39	(611) .48	(612) .64

(continued)

Table A-5 (continued)

Item	Units	Prices and Costs ($) 1973	1974	1975
Crop district 2	$/acre	(613) .45	(614) .56	(615) .74
Crop district 3	$/acre	(616) .66	(617) .80	(618) 1.07
Crop district 4	$/acre	(619) .42	(620) .50	(621) .67
Crop district 5	$/acre	(622) .82	(623) .99	(624) 1.32
Crop district 6	$/acre	(625) .32	(626) .38	(627) .49
Crop district 7	$/acre	(628) .49	(629) .59	(630) .78
Crop district 8	$/acre	(631) .41	(632) .49	(633) .66
Crop district 9	$/acre	(634) .40	(635) .48	(636) .64
Crop district 10	$/acre	(637) .43	(638) .52	(639) .69
Crop district 11	$/acre	(640) .33	(641) .40	(642) .52
Crop district 12	$/acre	(643) .19	(644) .23	(645) .30
Crop district 13	$/acre	(646) .42	(647) .51	(648) .67
Crop district 14	$/acre	(649) .14	(650) .17	(651) .23

[a]Contains 51 percent TDN and 15.2 percent protein (as fed).

[b]Contains 50 percent TDN and 7.8 percent protein (as fed).

[c]Grain is composed of one half oats, one fourth barley, and one fourth wheat by weight.

[d]Silage is composed of corn silage.

[e]Miscellaneous expenses include veterinarian services, treatment for warbles, lice, and flies, gas, oil, and miscellaneous overhead expenses such as hydro, telephone, fire insurance, accounting fees, bank charges, dues, box rentals, buying and selling fees, etc..

Table A-6

Monthly Salt and Mineral Requirements
Per Animal

Animal Category	Consumption in lbs./animal/month Salt	Minerals
Bulls	(652) 25/12 = 2.08	(653) 50/12 = 4.17
Cows	(654) 25/12 = 2.08	(655) 50/12 = 4.17
Calves (0-6 mos.)	(656) 13/12 = 1.08	(657) 25/12 = 2.08
Heifers (7-18 mos.)	(658) 19/12 = 1.58	(659) 38/12 = 3.17
Heifers (over 18 mos.)	(660) 25/12 = 2.08	(661) 50/12 = 4.17

PART III-- Changing Assumed Parameter Values and Entering Management Decisions[13]

This section describes how the user of the model can change the assumed parameter values given in Part II of this appendix (i.e. the group two data) or how the user of the model can enter management decisions such as purchases or sales of livestock and capital resources. There are five possible types of changes or decisions that can be made. They are:

Code	Type of change
01	Change in value of a parameter
02	Livestock purchase
03	Livestock sale
04	Capital purchase
05	Capital sale

An explanation and an example of each of these changes is given below.

1. Change in Value of a Parameter

Data required:

(a) Type of change code (columns 1 to 2).

(b) Identification number of parameter changed (columns 3 to 5).

(c) New value of parameter (columns 6 to 10).

[13] The procedure and ideas of this section are taken from Ladue, op. cit., Appendix A, pp. 285-296.

Example:

0	1	1	0	3					5	
1	2	3	4	5	6	7	8	9	10	← column number

Explanation: Columns 1 and 2 contain the code number indicating the type of change being made. In this case a "01" indicates that a change in the value of a parameter listed in Part II of this appendix is being made. Columns 3, 4, and 5 give the identification number of the parameter being changed. These identification numbers are found in Part II of this appendix. They are given in parentheses immediately before or above the initial assumed values of the parameters as explained in the beginning of Part II of this appendix. Columns 6 to 10 indicate the new value assigned to the parameter by the user of the model. In the example given, the user tells the model to change the month of birth of calves from April to May. One card is required for each change.

2. Livestock Purchase

Data required:

(a) Type of change code (columns 1 to 2).

(b) Month of purchase (columns 3 to 4).

(c) Category of animal[14] (column 5).

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[14]The following codes are used to identify the category of animals: 1--bulls, 2--cows, 3--calves (0-6 mos.), 4--heifers (7-18 mos.), 5--heifers (over 18 mos.).

(d) Age of animal in months[15] (columns 6 to 7).

(e) Number of animals (columns 8 to 10).

Example:

0	2	0	2	4	0	9	0	0	2	
1	2	3	4	5	6	7	8	9	10	←column number

Explanation: Columns 1 and 2 contain the code number indicating the type of change being made. In this case a "02" indicates that a livestock purchase is occurring (i.e. being planned to occur). Columns 3 to 4 give the month of the purchase. As will be explained in the next appendix, all transactions are assumed to occur at the end of the months. Column 5 indicates the category of animal being purchased. Columns 6 to 7 indicate the age (in months)[16] of the animal being purchased. Columns 8 to 10 indicate the number of animals of that category (and age) purchased in that month. In the example given, the user indicates that two nine month old replacement heifers will be purchased at the end of January. One card is required for each different purchase.

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[15]This applies to growing animals only.

[16]This applies to growing animals only.

3. Livestock Sale

Data required:

(a) Type of change code (columns 1 to 2).

(b) Month of sale (columns 3 to 4).

(c) Category of animal[17] (column 5).

(d) Age of animal in months[18] (columns 6 to 7).

(e) Number of animals (columns 8 to 10).

Example:

0	3	0	6	2			0	0	5	
1	2	3	4	5	6	7	8	9	10	← column number

Explanation: Columns 1 and 2 contain the code number indicating the type of change being made. In this case a "03" indicates that a livestock sale is occurring (i.e. being planned to occur). Columns 3 to 4 give the month of sale. As will be explained in the next appendix, all transactions are assumed to occur at the end of the months. Column 5 indicates the category of animal being sold. Columns 6 to 7 indicate the age (in months)[19] of the animal being sold. Columns 8 to 10 indicate the number of

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[17]The following codes are used to identify the category of animals: 1--bulls, 2--cows, 3--calves (0-6 mos.), 4--heifers (7-18 mos.), 5--heifers (over 18 mos.)

[18]This applies to growing animals only.

[19]This applies to growing animals only.

animals of that category (and age) sold in that month. In the example given, the user indicates that five cows will be sold at the end of June. One card is required for each different sale.

4. Capital Purchase

Data required:

(a) Type of change code (columns 1 to 2).

(b) Type of capital being purchased[20] (column 3).

(c) Cost of purchase[21] (columns 4 to 10).

Example:

0	4	3	4	0	0	0	.	0	0	
1	2	3	4	5	6	7	8	9	10	← column number

Explanation: Columns 1 and 2 contain the code number indicating the type of change being made. In this case a "04" indicates that a capital purchase is occurring (i.e. being planned to occur). Column 3 contains the code number indicating the type of capital being purchased. In this case a "3" indicates that a machine or a piece of equipment is being purchased. Columns 4 to 10 indicate the cost

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[20]The following codes are used to identify the type of capital being purchased: 1--buildings, 2--fences and corrals, 3--machinery and equipment, 4--pasture.

[21]Only the value of the portion used by the cow-calf enterprise is included in this figure. This applied especially to a machinery or equipment purchase because many machines and pieces of equipment used in the cow-calf enterprise are also often used in other enterprises.

of the purchase. In the example given, a machine or a piece of equipment is purchased and the cost allocated to the cow-calf enterprise is $4000.00. One card is required for each different purchase.

5. Capital Sale

Data required:

(a) Type of change code (columns 1 to 2).

(b) Type of capital being sold[22] (column 3).

(c) Value of sale[23] (columns 4 to 10).

Example:

0	5	1	1	2	0	0	.	0	0	
1	2	3	4	5	6	7	8	9	10	← column number

Explanation: Columns 1 and 2 contain the code number indicating the type of change being made. In this case a "05" indicates that a capital sale is occurring (i.e. being planned to occur). Column 3 contains the code number indicating the type of capital being sold. In this case a "1" indicates

[22]The following codes are used to identify the type of capital being sold: 1--buildings, 2--fences and corrals, 3--machinery and equipment, 4--pasture.

[23]Only the value of the portion used by the cow-calf enterprise is included in this figure. This applies especially to a machinery or equipment sale because many machines and pieces of equipment used in the cow-calf enterprise are also often used in other enterprises.

that a building is being sold. Columns 4 to 10 indicate the value of the sale. In the example given, a building is sold and the value of the sale allocated to the cow-calf enterprise is \$1200.00. One card is required for each different sale.

APPENDIX B

APPENDIX B

DETAILED DESCRIPTION OF EACH SEGMENT OF THE COW-CALF BUDGETARY SIMULATION MODEL

I. Introduction

The purpose of this appendix is to describe each segment of the model used in the methodology for simulating cow-calf farm plans. This model is somewhat similar to the model developed for evaluating the Farm Development Program in the Interlake Area.[1] The description given in this appendix includes both the changes made to the model and the ideas taken directly from the model used to evaluate the Farm Development Program.

This appendix illustrates how the simulation model uses the inputs described in Appendix A to analyze a cow-calf operation. Following this introduction, this appendix is further subdivided into five sections which are: (a) general discussion of the model; (b) generation of monthly animal numbers by category, age, weight, and value; (c) generation of physical characteristics and associated

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[1]Some of the ideas used in this model have been developed in the model used for evaluating the Farm Development Program which is described in: Maurice Senkiw and Alvin Pokrant, "A Cost/Return Simulator for Dairy, Cow/Calf and Stocker/Feeder Enterprises" (unpublished paper, Winnipeg: University of Manitoba, Department of Agricultural Economics, 1976).

costs of inputs; (d) calculations of gross returns; and (e) outputs from the simulation model.

II. General Discussion of Model

Since Chapter III gives the major and specific concepts of the simulation model, they will not be repeated here. The intent of this appendix is to give the details of the simulation model. A few general ideas will be briefly discussed before going on to the details of the model.

1. Assumed Model Parameter Values

It should be pointed out that all the model parameters of group two have been initialized to the values given in Part II of Appendix A. These parameter values are considered to be "average" values or "normal" practices on a Manitoba cow-calf operation. These initialized parameters could serve as benchmarks or guidelines for a user in examining his own situation. It also reduces the required inputs. These parameter values can be changed as shown in Part III of Appendix A if they do not match the situation desired by the user.

2. Summer and Winter Months

This simulation model operates on a calendar year basis. To analyze the cow-calf enterprise the simulation model divides the calendar year into two seasons--the summer and the winter. The summer is usually a pasture season and the winter is usually an indoor season. The summer is assumed to last five months which are June, July, August, September, and October. The winter is assumed to be the other seven months which are January, February, March, April, May, November, and December.

3. Animal Categories

This model is designed to handle a cow-calf enterprise which consists of a breeding herd whose function is to rear calves to weaning age. The model includes breeding stock, replacement stock, and calves (birth to weaning). Five categories of animals are thus defined to simulate the operation. They are: (a) bulls, (b) cows, (c) calves (0-6 mos.), (d) replacement heifers (7-18 mos.), and (e) replacement heifers (19-30 mos.). Bulls and cows are referred to as mature animals. Others are referred to as growing animals.

It should be noted that the animals are divided into seven classes only for the feed calculations. The seven classes are: (a) bulls, (b) lactating cows, (c) gestating cows, (d) dry cows, (e) calves (0-6 mos.), (f) replacement heifers (7-18 mos.), and (g) replacement heifers (over 18 mos.). The only difference between classes and categories is that in classes of animals the cows are further subdivided into lactating cows, gestating cows, and dry cows. The reason for this will be explained in the feed section.

4. Year of Prices and Costs

In calculating costs and returns, the user of the model specifies in (Question #4 Part I) the year of prices and costs to be used in the simulation model. The user can choose from three years--1973, 1974, or 1975. The prices and costs for these three years are given in (Question #8 Part II). The prices and costs of the year specified by the user will be used by the simulation model to calculate the cost and return components of the cow-calf enterprise. It should be noted that the user of the model could insert new prices or costs for any item for any year as indicated in Appendix A Part III. These modified prices and costs would then be used by the simulation model to calculate the cost and return components.

III. Generation of Monthly Animal Numbers by Category, Age, Weight, and Value

1. Animal Months[2] by Category and Age

The first major requirements of this simulation model are: (a) the number of livestock by category and age kept on the farm during each calendar month of the year, (b) the number of transactions--i.e. births, purchases, sales, and deaths by category and age[3], and (c) the beginning and ending inventory.

The number of livestock by category and age kept on the farm during each calendar month of the year is generated by the simulation model as shown below. The number of transactions and the beginning and ending inventory are also calculated below. It should be noted that all transactions are assumed to occur at the end of each month.

For calves, the number by age in each month kept on the farm, the number of transactions, and the beginning and ending inventory are obtained using the following steps or decision rules:

(i) The opening inventory by age is obtained directly from (Question #5a Part I). This determines the number of calves by age in January.

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[2] An animal month is one animal kept on the farm for one month.

[3] Age is only specified for growing animals. Age of mature animals is not required for the calculations of this simulation model.

(ii) The number of births is obtained from (Question #5b Part I) and the month the births occur is given in (Question #1e Part II).

(iii) Any purchase of calves by number, age, and month is obtained from the livestock purchase section of Part III. Otherwise no calves are purchased.

(iv) Any sale of calves by number, age, and month is obtained from the livestock sale section of Part III. Otherwise no calves are sold until they reach six months of age.

(v) The number of deaths is obtained from (Question #5b Part I) and the time of occurrence of the deaths is determined by distributing the deaths uniformly according to the number of calves of each age kept during the year.[4]

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[4]Animal months are used to distribute the deaths and to handle the integer problem. The procedure used can be roughly described as follows. The total number of calf-months in the year are first calculated and then divided by the number of deaths. The resulting figure gives an interval, say x calf-months. The first death is allocated during the first x calf-months; the second death is allocated during the next x calf-months; the third death is allocated during the next x calf-months; and so on until each death has been specified according to age of calf and month of year. The calf-months are added using the following formula:

$$\sum_{j=1}^{12} \left[\sum_{i=1}^{6} \text{number of calves of age}_i \text{ in month}_j \right].$$

Using this procedure the deaths are distributed uniformly according to age of calf and independent of the month of the year. This is desirable because the death age of calf is more important than the time or month during the year in which the death occurred.

(vi) All calves that reach six months of age are either transferred to the replacement heifers (7-18 mos.) category, sold as heifer calves, or sold as steer calves according to the distribution given in (Question #1g Part II).[5]

(vii) Using all of the above steps, the simulation model generates the number of calves by age in each month and stores the results in a 7 by 13 matrix whose rows represent age and columns represent month of the year. The elements of the matrix are filled by transferring all calves of age x in month y to calves of age x+1 in month y+1 after all transactions have taken place. The number of calves in the beginning of the month is the number of calves kept on the farm during the month since all transactions occur at the end of the month. The beginning inventory, the ending inventory, and the total transactions of calves by age are also stored in a vector.

For replacement heifers (7-18 mos.) and replacement heifers (over 18 mos.), the number by age in each month

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[5]Again to handle the integer problem, the total number of calves which reach six months of age during the year are first calculated. Then the number of calves to be kept as replacement heifers, the number of calves to be sold as steer calves, and the number to be sold as heifer calves are determined according to the distribution given in (Question #1g Part II). The first calves which reach six months of age are kept for replacement heifers, the next ones are sold as steer calves, and the last ones are sold as heifer calves.

kept on the farm, the number of transactions, and the beginning and ending inventory are obtained using the following steps or decision rules:

(i) The opening inventory by age is obtained directly from (Question #5a Part I). This determines the number of heifers by age in January.

(ii) Any purchase of heifers by number, age, and month is obtained from the livestock purchase section of Part III. Otherwise no heifers are purchased.

(iii) Sales of heifers can occur in two ways in the simulation model. First, the number of heifers given in (Question #5b Part I) are sold (i.e. culled) in the month given in (Question #1d Part II). The youngest heifers are sold first. Secondly, the livestock sale section of Part III can indicate any sale of heifers by number, age, and month.

(iv) The number of deaths is obtained from (Question #5b Part I) and the time of occurrence of the deaths is determined by distributing the deaths uniformly according to the number of heifers of each age kept during the year. The procedure is similar to the procedure described in the allocation of deaths of calves.

(v) Calf transfer to the replacement heifer category is explained previously in the calves section.

(vi) At the age stated in (Question #1f Part II), all the heifers are transferred to the cow categroy. The heifers transferred to the cow category are assumed to be bred heifers.

(vii) Using all of the above steps, the simulation model generates the number of heifers by age in each month by using a 24 by 13 matrix in a manner similar to the one described for calves. The beginning inventory, the ending inventory, and the total transactions of heifers by age are stored in two vectors--one for heifers (7-18 mos.) and one for heifers (over 18 mos.).[6]

For mature animals, that is, bulls or cows, the age of each animal is not considered. This simplifies the calculations since only the number of heads is required. For cows and bulls, the number in each month kept on the farm, the number of transactions, and the beginning and ending inventory are obtained using the following steps or decision rules:

(i) The opening inventory of bulls and cows is obtained directly from (Question #5a Part I). This determines the number of cows and bulls in January.

(ii) Any purchase of cows or bulls by number and month is obtained from the livestock purchase section of Part III. Otherwise no cows or bulls are purchased.

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[6]It should be noted that heifers are divided in two categories--heifers (7-18 mos.) and heifers (over 18 mos.)--but, they are grouped together in doing the animal month calculations to simplify the simulation model. This does not affect the results or the amount of information generated.

(iii) Any sale of cows or bulls by number and month is obtained from the livestock sale section of Part III. Otherwise no cows or bulls are sold, except for culls given in (Question #5b Part I) which are sold in month (Questions #1b and 1c Part II).

(iv) Heifers transferred to the cow category are explained previously in the heifers section. No transfers in the bull category can occur.

(v) The number of deaths of cows or bulls is obtained from (Question #5b Part I) and the time of occurrence of deaths is determined by distributing the deaths uniformly by number of cows and bulls respectively in each month during the year.

(vi) Using all of the above steps, the simulation model first generates the number of cows kept on the farm in each month by using a vector of length 13 and transferring all cows in month y to cows in month y+1 after all transactions have taken place. Similarly, the number of bulls kept on the farm in each month is generated. The beginning inventory, the ending inventory, and the total transactions of cows and bulls are stored in two vectors--one for cows and one for bulls.

From the procedure described in this section, we can therefore obtain the total number of animals of each category kept on the farm during each month. This is required for three purposes. First, it is used to calculate the total amount of feed required during the year.

Secondly, it is used to calculate the total amount of bedding required during the year. Thirdly, it is used to calculate the total monthly labor requirements for feeding and manure and bedding removal.

The beginning inventory, the ending inventory, and the total number of transactions of each category of animal which are also calculated in the procedure described in the above section are required for two purposes. First, it is combined with the weight by age of each category of animal and the value by age of each category of animal (described in the following two sections) to calculate the gross returns from the cow-calf enterprise. Secondly, it is used to calculate the following management indicators: (a) percent calves born alive, (b) percent calf crop weaned, and (c) percent death loss for each category.

2. Animal Weights by Category and Age

The weight of each animal by category and age is required to calculate the value of each animal by category and age as shown in the next section.

The weight for the mature animals (cows and bulls) is assumed to remain constant during the whole year and to be the same for each cow[7] and for each bull. The assumed weight of each cow is found in (Question #6b Part II). The

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[7]A replacement heifer transferred in the cow category might weigh less than the average cows but the other cows of the herd have quite possibly been gaining weight and thus keeping the average weight of the cows constant during each month of the year.

assumed weight of each bull is found in (Question #6c Part II). These standard weights also apply to any animal which is bought or sold.

The weight of growing animals is calculated differently. A weight by age for each category of growing animals for each cow-calf enterprise being simulated is established from the parameter values of the model as explained below. It is then assumed that all animals of the same age and category in the cow-calf enterprise being simulated are of the same weight. Any animals purchased are assumed to be of the same weight as the other animals of the same age and category already in the cow-calf enterprise. Therefore by establishing a standard weight by age for each category of growing animals on the farm, one can determine the weight of any animal on the farm just by specifying its age and category.

The standard weight by age and category of the growing animals is established from the group one and group two data as follows:

(a) Calves (0-6 mos.): At birth all calves are assumed to weigh (Question #6a Part II) pounds. The rate of gain[8] per day is expected to be (Question #3a Part II)

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[8]It should be noted that the average rate of gain obtained throughout the year is used for calves. It is assumed that it remains constant throughout the year. The same thing is assumed for the rates of gain of the other animal categories.

pounds per day if the calves are non-creep fed, that is only nursed by their mother. The rate of gain per day is expected to be (Question #3b Part II) pounds per day if the calves are creep fed. (Questions #15 and #16 Part I) indicate if calves are creep fed or not.[9] From this information, the simulator calculates the weight of calves by age as follows:

Weight of calves at age 0 = birth weight

Weight of calves at age i = weight of calves at age i-1 + 30 x daily rate of gain of calves

for i = 1, ..., 6, where i = age in months, and the constant 30 converts daily rate of gain to monthly rates of gain.[10]

Steer calves and heifer calves are grouped into one category--the calf category--from birth to weaning (6 months of age). The average weight of all the calves is used as the weight by age from zero to six months of age. At weaning time (6 months of age), the simulator is given information on the percentage of steer calves and the percentage of heifer calves in (Question #1g Part II). Only then it becomes useful to allocate different weights to

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[9]Calves are assumed to be non-creep fed if all seven feeds (codes 1-7) in the calf summer and winter rations have a value of zero as indicated in (Questions #15 and #16 Part I).

[10]It is assumed that each month contains 30 days.

steer calves and heifer calves.[11] At six months of age, the weight of heifer calves is calculated to be different than the weight of steer calves by an amount given in (Question #3c Part II). The calculations are done as follows:

$$\text{Weight of steer calves at weaning} = \left[\text{Average weight of calves at 6 mos. of age}\right] + \left[\frac{\text{(Question \#3c Part II)}}{2.0}\right]$$

$$\text{Weight of heifer calves at weaning} = \left[\text{Average weight of calves at 6 mos. of age}\right] - \left[\frac{\text{(Question \#3c Part II)}}{2.0}\right]$$

(b) Replacement Heifers (7-18 mos.): The daily rate of gain for replacement heifers (7-18 mos.) is expected to be (Question #17a Part I) pounds per day. From this information, the simulator calculates the weight of replacement heifers (7-18 mos.) by age as follows:

Weight of heifers at age 7 = weight of heifer calves at weaning + 30 x daily rate of gain of heifers (7-18 mos.)

Weight of heifers at age i = weight of heifers at age i-1 + 30 x daily rate of gain of heifers (7-18 mos.)

for i = 8, ..., 18, where i = age in months.

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[11]This can be justified by the fact that all calves are usually kept on the farm and form part of the cow-calf enterprise until weaning time when they are either sold as steer calves, sold as heifer calves, or kept as replacement heifers [i.e. enter the replacement heifers (7-18 mos.) category]. Then it becomes important to differentiate between steers and heifers because steer calves usually weigh more and are worth more per pound than heifer calves which therefore affects the returns to the enterprise.

(c) Replacement Heifers (over 18 mos.)[12]: The daily rate of gain for replacement heifers (over 18 mos.) is expected to be (Question #17b Part I) pounds per day. From this information, the simulator calculates the weight of heifers (over 18 mos.) by age as follows:

Weight of heifers at age 19 = weight of heifers at age 18 + 30 x daily rate of gain of heifers (over 18 mos.)

Weight of heifers at age i = weight of heifers at age i-1 + 30 x daily rate of gain of heifers (over 18 mos.)

for i = 20, ..., 30, where i = age in months

The standard weight by age for each category of animals on the farm is thus found by following the procedure shown above.

3. Animal Values by Category and Age

From the standard animal weights by category and age (calculated in the previous section) the simulation model calculates the standard animal values by category and age using the procedure described in this section. The value of each animal by category and age is required to calculate the gross returns from the enterprise during the

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[12] It should be noted that heifers over 18 months of age are in the cow category if the user of the model does not change the value of the parameter in (Question #1f Part II). Only if the user of the model increases the age at which heifers are transferred to the cow category will there be animals in the replacement heifers (over 18 mos.) category.

calendar year and to calculate the investment in breeding stock.

The standard weight of each animal by category and age[13] is calculated in the previous section. (Question #8a Part II) gives the prices for a hundred weight of each category of animals (by weight range for growing animals). From this information the simulation model calculates the value of each animal by category and age as follows:

$$\text{Value of a bull} = \left[\frac{\text{Average weight (in lbs.) of a bull}}{100}\right] \times \left[\text{price (\$/cwt) of a bull}\right]$$

$$\text{Value of a bull which is culled} = \left[\frac{\text{Average weight (in lbs.) of a bull}}{100}\right] \times \left[\text{price (\$/cwt) of a bull which is culled}\right]$$

$$\text{Value of a cow} = \left[\frac{\text{Average weight (in lbs.) of a cow}}{100}\right] \times \left[\text{price (\$/cwt) of a cow}\right]$$

$$\text{Value of a cow which is culled} = \left[\frac{\text{Average weight (in lbs.) of a cow}}{100}\right] \times \left[\text{price (\$/cwt) of a cow which is culled}\right]$$

$$\text{Value}^{14}\text{ of a calf of age i mos.} = \left[\frac{\text{Weight (in lbs.) of a calf aged i months}}{100}\right] \times \left(\frac{\left[\text{price (\$/cwt) of a heifer calf corresponding to its weight}\right] + \left[\text{price (\$/cwt) of a steer calf corresponding to its weight}\right]}{2}\right)$$

for $i = 0, \ldots, 6$

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[13] Age is only specified for growing animals.

[14] These values apply to all purchases and sales of calves from zero to six months of age which the user of the model specifies since the simulation model does not know if they are steer calves or heifer calves. The two equations which follow are used to determine the value of steer calves at weaning and the value of heifer calves at weaning.

$$\text{Value of a steer calf at weaning} = \left[\frac{\text{Weight (in lbs.) of a steer calf at weaning}}{100}\right] \times \left[\text{price (\$/cwt) of a steer calf corresponding to its weight}\right]$$

$$\text{Value of a heifer calf at weaning} = \left[\frac{\text{Weight (in lbs.) of a heifer calf at weaning}}{100}\right] \times \left[\text{price (\$/cwt) of a heifer calf corresponding to its weight}\right]$$

$$\text{Value of a replacement heifer aged i months} = \left[\frac{\text{Weight (in lbs.) of a replacement heifer aged i months}}{100}\right] \times \left[\text{price (\$/cwt) of a heifer corresponding to its weight}\right]$$

for $i = 7, \ldots, 30$

$$\text{Value of a replacement heifer aged i months which is culled} = \left[\frac{\text{Weight (in lbs.) of a replacement heifer aged i months}}{100}\right] \times \left[\text{price (\$/cwt) of a heifer which is culled}\right]$$

for $i = 7, \ldots, 30$

By using the above procedure, a standard value by age[15] for each category of animals on the farm is established. The simulation model can then determine the value of any animal on the farm just by specifying its category (and age). Similarly, the simulation model can determine the value of any animal which is bought, sold, or born just by specifying its category (and age). This follows from the assumptions made in the previous section which indicate that (a) all animals on the farm of a certain category (and age) are of the same weight and

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[15]Age is only specified for growing animals.

(b) all animals purchased or sold are assumed to be of the same weight as other animals of the same category (and age) on the farm.

Information on the standard value of each animal by category (and age) will be used in the following sections to calculate investment in breeding stock and to calculate gross returns from the enterprise during the calendar year.

IV. Generation of Physical Characteristics and Associated Costs of Inputs

This section will describe how the simulation model obtains or generates each of the physical inputs of the cow-calf operation and how the model calculates the costs associated with each of these inputs. Each input and its cost to the cow-calf operation will be examined individually.

1. Buildings

Four types of buildings used by the cow-calf enterprise are considered in this model. They are: (a) barns or sheds, (b) hay storage facilities, (c) grain storage facilities, and (d) silage storage facilities. (Question #6a Part I) indicates the size (in square feet) and age of the barn and whether the barn is wired and insulated or non-wired and non-insulated. Up to five barns can be included. (Question #6b Part I) indicates the size (in tons) and age of the hay storage buildings. Up to three hay storage buildings can be included. (Question #6c Part I) indicates the size (in bushels), age, and type (wood or steel) of grain storage buildings. Up to three grain storage buildings are allowed. (Question #6d Part I) indicates the size (in tons), age, and type (bunker, concrete, or sealed) of silos. Up to three silos are allowed.

The procedure employed in estimating the costs of these buildings can be segregated into three parts--namely, repair cost, depreciation cost, and investment cost.

All of the three cost calculations are performed on the current value of the particular buildings. The current value[16] is defined to be the present replacement value, less the depreciated value. The present replacement value of a barn or shed is calculated as the product of square footage of a barn and the current price per square foot (of an insulated and wired barn or a non-insulated and non-wired barn) found in (Question #8g Part II). The present replacement value of a hay storage building is calculated as the product of storage capacity in tons and current price per ton of storage space found in (Question #8g Part II). The present replacement value of a grain storage building is calculated as the product of storage capacity in bushels and current price per bushel of storage space (of a building made of wood or steel) found in (Question #8g Part II). The present replacement value of a silo is calculated as the product of storage capacity in tons and current price per ton of storage space (of a bunker silo, a concrete silo, or a sealed silo) found in (Question #8g Part II). According to the Farm Data Handbook, a 3 percent to 4 percent of one half of the new value of the buildings and equipment is

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[16]It should be noted that current value refers to value at the beginning of the year being analyzed. It is also assumed that all building purchases (or constructions) occur only at the beginning of the year and all building sales occur only at the end of the year. This avoids the complications involved in calculating the costs for buildings which are at an age which has a fraction.

required for repair and maintenance.[17] The repair cost of buildings is therefore calculated to be 3.5 percent of one half of the present replacement value. Depreciation is calculated on a straight-line basis--five percent of the present replacement value per year. (Life expectancy of a building is estimated to be 20 years). The investment cost is calculated to be the rate of interest on investment times the value of the building in the middle of the year. For each building the current value and the cost calculations associated with the building for the cow-calf enterprise are estimated as follows:

$$\text{(1) Current value} = \left[\text{Present replacement value}\right] - \left[\text{Present replacement value} \times \text{age} \times .05\right]$$

for buildings $<$ 20 years of age

$= 0$ for buildings $\geq$ 20 years of age

$$\text{(2) Repair cost} = \left[\frac{\text{Present replacement value}}{2}\right] \times 0.035$$

$$\text{(3) Depreciation cost} = \left[\text{Present replacement value}\right] \times .05$$

for buildings $<$ 20 years of age

$= 0$ for buildings $\geq$20 years of age

$$\text{(4) Investment cost} = \left[\text{Rate of interest on investment}\right] \times \left[\text{Current value} - \frac{\text{depreciation}}{2}\right]$$

[17] Manitoba Department of Agriculture, Farm Data Handbook (Winnipeg: Economics Branch, Manitoba Department of Agriculture, 1972), page III-38.

Rate of interest on investment is found in (Question #7 Part II).

2. Fences, Corrals, Pens, and Working Chutes

Fences, corrals, pens, and working chutes are handled in a manner similar to buildings.

(Question #7a Part I) indicates the perimeter length of fences (in miles) and the age[18] of the fences used by the cow-calf enterprise. Three sets of fences are allowed. Corrals, pens, and working chutes are grouped together since they are usually constructed of similar materials. (Question #7b Part I) indicates the perimeter length (in feet) and the age of corrals, pens, and working chutes used by the cow-calf enterprise. Three sets of corrals, pens, and working chutes are allowed.

The present replacement value of fences is calculated as the product of miles of fence and current price per mile found in (Question #8g Part II). The present replacement value of corrals, pens, and working chutes is calculated as the product of feet of corrals, pens, and working chutes and current price per foot found in (Question

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[18]It is assumed that all fence, corral, pen, or chute purchases (or constructions) occur only at the beginning of the year and all fence, corral, pen, or chute sales occur only at the end of the year. This avoids the complications involved in calculating the costs of fences, corrals, pens, and chutes which are at an age which has a fraction.

#8g Part II). For each set of fence, corral, pen, or working chute, the current value and the cost calculations associated with it for the cow-calf enterprise are estimated as follows:

(1) $\text{Current value} = \begin{bmatrix}\text{Present} \\ \text{replacement} \\ \text{value}\end{bmatrix} - \begin{bmatrix}\text{Present} \\ \text{replacement x age x .05} \\ \text{value}\end{bmatrix}$

for sets < 20 years of age

= 0 for sets ≥ 20 years of age

(2) $\text{Repair cost} = \left[\dfrac{\text{Present replacement value}}{2}\right] \text{x } 0.035$

(3) $\text{Depreciation cost} = \left[\text{Present replacement value}\right] \text{ x } .05$

for sets < 20 years of age

= 0 for sets ≥ 20 years of age

(4) $\text{Investment cost} = \begin{bmatrix}\text{Rate of interest} \\ \text{on investment}\end{bmatrix} \text{x} \begin{bmatrix}\text{current} \\ \text{value}\end{bmatrix} - \dfrac{\text{depreciation}}{2}\Bigg]$

Rate of interest on investment is found in (Question #7 Part II).

3. Machinery and Equipment

A different approach is followed by the simulation model to handle the machinery and equipment used in the cow-calf enterprise. Unlike buildings and fences, the user of the model must specify the description, age,[19] life,

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[19]It is again assumed that all machinery or equipment purchases occur only at the beginning of the year and all machinery or equipment sales occur only at the end of the year. This avoids the complications involved in calculating the costs of machinery and equipment which are at an age which has a fraction.

present replacement value, and portion used in the cow-calf enterprise in (Question #8 Part I). There are two reasons for adopting this approach. First, the types, makes, and sizes of machinery and equipment that could be used in a cow-calf enterprise are so numerous that it makes it difficult to incorporate all the possible machines and pieces of equipment and their respective prices in the simulation model. Secondly, the user quite often can provide the best estimate of present replacement value and the lifetime of each one of his specific machines and pieces of equipment. The portion used in the cow-calf enterprise is also required because it is quite possible that much of the machinery and equipment used in the cow-calf enterprise (such as tractors, front end attachments, pick-up trucks, waterers, and grain augers) are also used in other enterprises such as crop, forage, dairy, stocker-feeder, or hog enterprises. Only the portion used by the cow-calf enterprise must be considered as a cost to the cow-calf enterprise. This is possible only if the portion used by the cow-calf enterprise is known. (Question #8 Part I) allows ten possible items of machinery and equipment to be specified.

The costing of each piece of machinery and equipment is handled as follows. First, the present replacement value allocated to the cow-calf enterprise equals the present replacement value times the portion used in the cow-calf enterprise. Then, assuming a 10 percent salvage value and straight line depreciation the cost calculations are:

(1) $$\text{Current value of the piece of machinery or equipment allocated to the cow-calf enterprise} = \left[\text{Present replacement value allocated to the cow-calf enterprise}\right] - \left[\text{90\% of present replacement value allocated to the cow-calf enterprise} \times \frac{\text{age}}{\text{life}}\right]$$

(2) $$\text{Repair cost allocated to the cow-calf enterprise}^{20} = \left[\frac{\text{Present replacement value allocated to the cow-calf enterprise}}{2}\right] \times .035$$

(3) $$\text{Depreciation cost allocated to the cow-calf enterprise} = \frac{\text{90\% of present replacement value allocated to the cow-calf enterprise}}{\text{life}}$$

(4) $$\text{Investment cost allocated to the cow-calf enterprise} = \left[\text{Rate of interest on investment}\right] \times \left[\text{Current value allocated to the cow-calf enterprise} - \frac{\text{Depreciation cost allocated to the cow-calf enterprise}}{2}\right]$$

Rate of interest on investment is found in (Question #7 Part II).

4. <u>Feed</u>

Feed costs have been separated out into three major components. These three components are summer pasture, summer feed, and winter feed.

The first component, summer pasture, has four subcomponents--taxes, investment in land, rent, and fertilizer. (Question #14a Part I) indicates the number of acres of pasture, whether it is improved or unimproved, and whether

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[20]For this study, the repair costs of machinery and equipment is calculated in the same way as the repair cost of buildings.

it is owned or rented. (Question #14b Part I) indicates the fertilizer applied on the pasture. Up to four groups of pasture and five types of fertilizer are allowed. Since the taxes and the value of improved and unimproved land vary within the province, the user must specify the crop district in which his pasture is located in (Question #1b Part I). Then the taxes, investment cost, and rent per acre will be dependent upon the crop district in which the pasture is located. The simulation model obtains the taxes on improved and unimproved land per acre by crop district from (Questions #8m and #8n Part II), the value of improved and unimproved land per acre by crop district from (Questions #8k and #81 Part II), and the cost of various fertilizer types from (Question #8b Part II). (Question #7 Part II) indicates the rate of interest on investment. From the above information, the totals for each of the subcomponents of the summer pasture costs are calculated as follows:

(a) Taxes = (number of improved acres owned x taxes per improved acre) + (number of unimproved acres owned x taxes per unimproved acre).

(b) Investment in land[21] = (number of improved acres owned x rate of interest on investment x value of improved land per acre) + (number of unimproved acres owned x rate of interest on investment x value of unimproved land per acre).

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[21]Investment in land refers to the opportunity cost of owned land. It is essentially the average rate of interest on investments times the value of land.

(c) Rent = [(number of improved acres rented) x (rate of interest on investment x value of improved land per acre + taxes per improved acre)] + [(number of unimproved acres rented) x (rate of interest on investment x value of unimproved land per acre + taxes per unimproved acre)] .

(d) Fertilizer = $\sum_j \begin{bmatrix} \text{no. of tons of} \\ \text{fertilizer j} \\ \text{applied} \end{bmatrix} \times \begin{bmatrix} \text{cost per ton} \\ \text{of fertilizer j} \end{bmatrix}$

where j indicates the type of fertilizer.

It should be noted that taxes, investment in land, fertilizer, and rent for pasture are included as part of feed cost because land which is pastured does not have a direct physical return. Consequently, the cost of maintaining such land must be assigned to that sector of the total farm operation which uses that land which is the cow-calf enterprise in this case.

The second component, summer feed, has nine sub-components--tame hay, native hay, grain, supplement, silage, user defined feed #1, user defined feed #2, salt, and minerals. The cost of the first seven sub-components of summer feed is arrived at by multiplying the consumption of each of the sub-components by the corresponding price.

The simulation model first calculates the number of summer animal months for each of the following classes of animal: (1) bulls, (2) lactating cows, (3) gestating cows, (4) dry cows, (5) calves, (6) heifers (7-18 mos.), (7) heifers (over 18 mos.). The calculations are done as follows. In Section III-1 of this appendix, the number of bulls, cows, calves, heifers (7-18 mos.), and heifers (over 18 mos.) kept on the farm in each month have been calculated. It has also been assumed in a previous section that the summer season lasts for five months from May 31 to October 31. For bulls, calves, heifers (7-18 mos.), and heifers (over 18 mos.), the number of summer animal months is calculated as follows:

$$\text{Summer months for animal}_j = \sum_{j=6}^{10} \begin{bmatrix} \text{number of animal}_j \\ \text{kept in month}_i \end{bmatrix}$$

for j = 1, 5, 6, 7.

where i represents the months of the summer season (June, July, August, September, and October) and where j represents the classes of animal [bull, calves, heifers (7-18 mos.), and heifers (over 18 mos.)]. For cows, a further subdivision into lactating cows, gestating cows, and dry cows is required. (Question #4c Part II) indicates the month(s) that a lactation ration is fed during the summer. It is assumed that all cows who nurse a calf are fed this lactation ration during the months specified in (Question #4c Part II) since only these cows would need the special lactation ration for milk production to nurse their calf. Therefore, the number of summer months for lactating cows is equal to the sum of the number of calves on the farm in each month that a lactation ration is fed during the summer. The number of calves indicates the number of lactating cows since all calves in a cow-calf enterprise are being nursed. (Question #4d Part II) indicates the month(s) that a gestation ration is fed during the summer. It is assumed that all cows on the farm are fed the gestation ration during the month(s) specified in (Question #4d Part II).[22] Therefore, the number of summer months for gestating cows is equal to the sum of the number of cows on the farm in each month that a summer gestation ration is fed. A dry ration is provided when neither a gestation nor a lactation ration is fed. The number of summer months for dry cows is equal to the total number of summer months for cows minus the number of summer months for lactating cows minus the number of summer months for gestating cows.

Having obtained the number of summer animal months for each class of animal, the next step is to determine the total consumption of each of the first seven sub-components of feed in the summer months. (Question #16 Part I) indicates the daily summer rations fed to each of the classes of animal.[23] The total summer consumption of the first seven types of feed (in pounds) is then calculated as follows:

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[22] This assumption is based on the fact that all births are expected to occur during the same month. Therefore, a gestation ration which would be given to cows in the month(s) before calving would be given to all cows because only the cows expected to calve would normally be kept on the farm at that time.

[23] It should be noted that if no lactation ration is specified in (Question #16 Part I) the dry ration is fed during the lactation period. Similarly if no gestation ration is specified in (Question #16 Part I) the dry ration is fed during the gestation period.

$$\text{Consumption of feed}_i = \sum_{j=1}^{7} \left[\begin{pmatrix} \text{lbs. of} \\ \text{feed}_i \text{ in} \\ \text{ration} \\ \text{fed to} \\ \text{animal}_j \end{pmatrix} \times \begin{pmatrix} \text{summer} \\ \text{months} \\ \text{for} \\ \text{animal}_j \end{pmatrix} \times 30 \right]$$

for $i = 1, \ldots, 7$

where i represents the feed type and j represents the animal class. The constant 30 converts summer animal months into summer animal days.[24]

To calculate the cost of summer feed, the simulation model obtains the price per pound of each of the first seven feed types in (Question #8d Part II). Then the total cost of summer feed is calculated as follows:

$$\text{Cost of summer feed} = \sum_{i=1}^{7} \left[\begin{pmatrix} \text{Consumption} \\ \text{of feed}_i \end{pmatrix} \times \begin{pmatrix} \text{price of} \\ \text{feed}_i \end{pmatrix} \right]$$

where i represents the feed type. The two last feed types, namely, salt and minerals do form a part of the summer feed but they are not included as part of the summer feed or winter feed costs. Rather they appear as totals for the entire year. Salt and mineral consumption and costs are discussed in a later section.

The third component, winter feed is treated in a manner similar to summer feed. Winter feed also has nine sub-components--tame hay, native hay, grain, supplement, silage, user defined feed #1, user defined feed #2, salt, and minerals. The cost of the first seven sub-components

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[24] It is assumed that 30 days exist in each month.

of winter feed is arrived at by multiplying the consumption of each of the sub-components by the corresponding price.

The simulation model again calculates winter animal months for bulls, calves, heifers (7-18 mos.), and heifers (over 18 mos.) using the following formula which is similar to the one used for the summer animal months:

$$\text{Winter months for animal}_j = \sum_{i=1}^{5} \text{number of animal}_j \text{ kept in month}_i + \sum_{i=11}^{12} \text{number of animal}_j \text{ kept in month}_i$$

for j = 1, 5, 6, 7.

where i represents the months of the winter season (January, February, March, April, May, November, and December) and where j represents the classes of animal [bull, calves, heifers (7-18 mos.), and heifers (over 18 mos.)]. The cows are again subdivided into lactating cows, gestating cows, and dry cows. (Question #4a Part II) indicates the month(s) that a lactation ration is fed during the winter. It is assumed that all cows who nurse a calf are fed this lactation ration during the months specified in (Question #4a Part II) since only these cows would need the special lactation ration for milk production to nurse their calf. Therefore the number of winter months for lactating cows is equal to the sum of the number of calves on the farm in each month that a lactation ration is fed during the winter. The number of calves indicates the number of lactating cows since all calves in a cow-calf enterprise are being nursed.

(Question #4b Part II) indicates the month(s) that a gestation ration is fed during the winter. It is assumed that all cows on the farm are fed the gestation ration during the month(s) specified in (Question #4b Part II).[25] Therefore the number of winter months for gestating cows is equal to the sum of the number of cows on the farm in each month that a winter gestation ration is fed. A dry ration is provided when neither a gestation nor a lactation ration is fed. The number of winter months for dry cows is equal to the total number of winter months for cows minus the number of winter months for lactating cows minus the number of winter months for gestating cows.

Having obtained the number of winter animal months for each class of animal, the next step is to determine the total consumption of each of the first seven sub-components of feed in the winter months. (Question #15 Part I) indicates the daily winter rations fed to each of the classes of animal.[26] The total winter consumption of the first

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[25]This assumption is based on the fact that all births are expected to occur during the same month. Therefore, a gestation ration which would be given to cows in the month(s) before calving would be given to all cows because only the cows expected to calve would normally be kept on the farm at that time.

[26]It should again be noted that if no lactation ration is specified in (Question #15 Part I) the dry ration is fed during the lactation period. Similarly, if no gestation ration is specified in (Question #15 Part I) the dry ration is fed during the gestation period.

seven types of feed (in pounds) is then calculated as follows:

$$\text{Consumption of feed}_i = \sum_{j=1}^{7} \left[\begin{pmatrix} \text{lbs. of feed}_i \\ \text{in ration fed} \\ \text{to animal}_j \end{pmatrix} \times \begin{pmatrix} \text{winter months} \\ \text{for animal}_j \end{pmatrix} \times 30 \right]$$

for $i = 1, \ldots, 7$.

where i represents the feed type and j represents the animal class. The constant 30 again converts winter animal months into winter animal days.

To calculate the cost of winter feed, the simulation model again obtains the price per pound of each of the first seven feed types in (Question #8d Part II). Then the total cost of winter feed is calculated as follows:

$$\text{Cost of winter feed} = \sum_{i=1}^{7} \left[\begin{pmatrix} \text{Consumption} \\ \text{of feed}_i \end{pmatrix} \times \begin{pmatrix} \text{price of} \\ \text{feed}_i \end{pmatrix} \right]$$

where i represents the feed type. The two last feed types, namely, salt and minerals do form part of the winter feed but are not included as part of the winter feed costs. Rather they appear as totals for the entire year as discussed below.

Salt and minerals are treated separately because it is difficult to estimate the number of pounds fed to each animal per day. Each of the rations in (Questions #15 and #16 of Part I) indicate whether salt was fed or was not fed and whether minerals were fed or were not fed. If salt and minerals are fed they are fed at the monthly levels indicated in (Question #9 Part II). With this information the simulation model can calculate the total pounds of salt and the total pounds of minerals as follows:

$$\text{Total lbs. of salt consumed} = \sum_{i=1}^{12}\left[\begin{pmatrix}\text{no. of heads of}\\ \text{category}_j \text{ given}\\ \text{salt in month}_i\end{pmatrix} \times \begin{pmatrix}\text{monthly levels}\\ \text{of salt given}\\ \text{to animals of}\\ \text{category}_j\end{pmatrix}\right]$$

$$\text{Total lbs. of minerals consumed} = \sum_{i=1}^{12}\left[\begin{pmatrix}\text{no. of heads of}\\ \text{category}_j \text{ given}\\ \text{minerals in}\\ \text{month}_i\end{pmatrix} \times \begin{pmatrix}\text{monthly levels}\\ \text{of minerals}\\ \text{given to animals}\\ \text{of category}_j\end{pmatrix}\right]$$

for j = 1, ..., 5.

where i represents the months and j represents the five categories of animals. To calculate the cost of salts and minerals the simulator obtains the price per pound of salt and the price per pound of minerals from (Question #8d Part II) and does the following calculation:

$$\text{Total cost of salt} = \begin{pmatrix}\text{total lbs. of salt}\\ \text{consumed}\end{pmatrix} \times \begin{pmatrix}\text{price per}\\ \text{pound of salt}\end{pmatrix}$$

$$\text{Total cost of minerals} = \begin{pmatrix}\text{total lbs. of}\\ \text{minerals con-}\\ \text{sumed}\end{pmatrix} \times \begin{pmatrix}\text{price per pound}\\ \text{of minerals}\end{pmatrix}$$

5. Bedding

The simulation model has two options for selecting the kind of bedding used. The bedding can either be straw or a user defined bedding. (Question #18 Part I) indicates which one is used.

To determine the total amount of bedding required during the year the simulator must know two things: (1) amount of bedding required per day for each category of animals and (2) total number of months of each category of animals which are kept inside. The first thing is obtained from (Question #5 Part II) which provides the amount of straw required per head per day per animal of each category. If a user defined bedding is used the parameter values of (Question #5 Part II) must be specified by the user. Part III of Appendix A explains how to change the value of any of the group II parameters. The second thing, that is, the total number of months of each category of animals which are kept inside is calculated as follows. It is assumed that all animals are kept inside and therefore require bedding in the seven winter months. During the five summer months, (Question #10c Part I) indicates which animal category is kept inside and therefore requires bedding. The number of animals of each category kept on the farm in each month has been generated by the simulator as explained in Section III-1 of this appendix. With this information, the simulation model calculates the total pounds of bedding required as follows:

$$\begin{matrix}\text{Total pounds} \\ \text{of bedding} \\ \text{required}\end{matrix} = \sum_{i=1}^{12} \sum_{j=1}^{5} \left[\begin{pmatrix}\text{number of} \\ \text{animals of} \\ \text{category}_j \\ \text{kept in-} \\ \text{side in} \\ \text{month}_i\end{pmatrix} \times \begin{pmatrix}\text{pounds of} \\ \text{bedding} \\ \text{required} \\ \text{per animal} \\ \text{of cate-} \\ \text{gory}_j \text{ per} \\ \text{day}\end{pmatrix} \times 30 \right]$$

where i represents the month of the year and j represents the 5 animal categories. The constant 30 again converts animal months to animal days.

The price per pound of bedding is found in (Question #8f Part II). The total cost of bedding is then simply calculated as follows:

$$\text{Total cost of bedding} = \begin{pmatrix}\text{total pounds of}\\ \text{bedding required}\end{pmatrix} \times \begin{pmatrix}\text{price per pound of}\\ \text{bedding}\end{pmatrix}$$

6. <u>Health Care</u>

Health care is divided into six components, namely, dehornings; castrations; vitamins injected (or fed apart from those provided in the regular rations); vaccinations; treatments for warbles, lice, and flies; veterinarian services and other medicinals.

Dehornings and castrations require only labor. They are costed out in the labor section which is detailed later on.

(Question #11 Part I) indicates the number of animals treated with any of the following vitamins: vitamin A, vitamin A, D, E, or a user defined vitamin. (Question #8h Part II) indicates the cost for one vitamin treatment of each kind. Total vitamin cost is calculated as follows:

$$\text{Total vitamin cost} = \sum_{i=1}^{3} \left[\begin{pmatrix}\text{no. of vitamin}\\ \text{treatments of}\\ \text{type}_i\end{pmatrix} \times \begin{pmatrix}\text{cost for one}\\ \text{vitamin treatment}\\ \text{of type}_i\end{pmatrix} \right]$$

where i represents the three types of vitamins.

(Question #12 Part I) indicates the number of vaccinations against: IBR, blackleg, malignant edema, 3-way, and a user defined vaccination. (Question #8i Part II) indicates the cost for one vaccination of each kind. Total vaccination cost is calculated as follows:

$$\text{Total vaccination cost} = \sum_{i=1}^{5} \left[\begin{pmatrix}\text{no. of vaccinations of}\\ \text{type}_i\end{pmatrix} \times \begin{pmatrix}\text{cost for one vaccination of type}_i\end{pmatrix} \right]$$

where i represents the five types of vaccinations.

Treatments for warbles, lice, and flies; veterinarian services, and other medicinals are included in the miscellaneous expenses component discussed below.

7. Artificial Insemination

(Question #13 Part I) indicates the number of cows bred with artificial insemination (A.I.) and (Question #8e Part II) indicates the average cost of artificial insemination per cow. The total cost for artificial insemination is simply the number of cows bred with artificial insemination multiplied by the average cost of artificial insemination per cow. It should be noted that if the cows are bred using bull(s) there are no artificial insemination costs but the breeding charge is reflected in the various costs of keeping the bull(s) on the farm.

8. Miscellaneous Expenses

The cost of miscellaneous articles is included in a miscellaneous expenses component. The miscellaneous expenses include: veterinarian services; treatment for warbles, lice, and flies; gas and oil; and miscellaneous overhead expenses such as hydro, telephone, fire insurance, accounting fees, bank charges, dues, box rentals, buying and selling fees, and others. (Question #8j Part II) provides the cost of miscellaneous expenses for one calendar year on a per cow basis. From the number of cows kept on the farm in each month of the year (calculated in Section III-1 of this appendix) the simulation model calculates the average number of cows kept on the farm during the year as follows:

$$\text{Average no. of cows kept on the farm during the year} = \frac{\sum_{i=1}^{12} \left(\text{no. of cows kept on the farm in month}_i\right)}{12}$$

where i represents the months of the year. Then the total cost of miscellaneous expenses is calculated as follows:

$$\text{Total cost of miscellaneous expenses} = \left(\text{average no. of cows kept on the farm during the year}\right) \times \left(\text{miscellaneous expenses per cow per year}\right)$$

9. Labor

The number of hours of labor required are calculated and reported on a monthly basis. This helps the user of the model to estimate the amount of labor which must be allocated or hired in each month of the year for the cow-calf enterprise being simulated.

The number of hours required in each month is arrived at by accumulating the number of hours of labor needed in each month for fence repair; maintenance of buildings, machinery, and equipment; administering health care; supervising the herd; feeding the cattle; and removing manure and bedding.

Labor required for fence repair is calculated separately because it is usually a major task in a cow-calf operation. The total perimeter length of fences (in miles) is obtained from (Question #7a Part I). The age is assumed to have no effect on the repair time required per mile of fence. (Question #2a Part II) indicates the number of man-hours required to repair one mile of fence and the month in which the fences are repaired. Therefore the total labor required for fence repair in the month indicated is simply the total length of fence (in miles) multiplied by the time required to repair one mile of fence.

Labor required for maintenance and repair of buildings, machinery, and equipment is included in the labor required for feeding and in the labor required for bedding and manure removal which are discussed below. The reason for this is that most buildings, machinery, and equipment in a cow-calf enterprise are used and maintained during the feeding or the bedding and manure removal process.

Labor required to administer health care in each month is composed of labor required for dehornings, castrations, vitamin treatments, and vaccinations. The time required for one dehorning is found in (Question #2b Part II). The number of dehornings is given as a percentage of calves born alive in (Question #2b Part II) and the month that the dehornings are done is also given in (Question #2b Part II). The total time required for dehornings in the month specified is simply the total number of dehornings multiplied by the time required for one dehorning. The total time required for castrations in the month specified is calculated in exactly the same way as dehornings by using the information given in (Question #2c Part II). It is assumed that only calves are dehorned or castrated in a cow-calf enterprise. Labor required for one vaccination or one vitamin treatment is given in (Question #2d Part II). The number of vitamin treatments by month is given in (Question #11 Part I). Then the total time by month for vitamin treatments is simply the number of vitamin treatments per month multiplied by the time required for one vitamin treatment. Similarly, the number of vaccinations by month is given in (Question #12 Part I). Then the total time by month for vaccinations is simply the number of vaccinations given in each month multiplied by the time required for one vaccination.

Labor required for supervising the herd is divided into two parts--namely, checking the herd during the winter and checking the herd while on pasture. The first part, that is, labor required to check the herd during the winter is assumed to be included in the labor required for feeding because the herd is usually supervised while being fed. The second part, that is, labor required per month to check the herd while on pasture is obtained from (Question #2e Part II). (Question #10a Part I) indicates whether or not the herd is sent to pasture during the summer months.

Labor required for feeding the cattle in each month depends on two things: (a) the feeding system used, and (b) whether the cattle are fed a ration (excluding pasture) during the summer. (Question #9a Part I) indicates whether the feeding system is (1) hand feeding, (2) self feeding, or (3) mechanized feeding. (Question #10b Part I) indicates which category of animals (if any) are fed a ration during the summer months. (Question #2f Part II) indicates the labor requirements for feeding one animal of each category of animals each month for each of the three systems. For each category of animals which are not fed a ration during the summer months, the feeding time for the months of June, July, August, September, and October is given a value of 0 by the simulation model. With this information, the simulation model calculates the labor required for feeding the animals for each month as follows:

$$\begin{array}{l}\text{Labor time}\\ \text{required}\\ \text{for feeding}\\ \text{in month}_i\end{array} = \sum_{j=1}^{5} \left[\begin{pmatrix}\text{no. of animals of}\\ \text{category}_j \text{ kept on}\\ \text{the farm and fed}\\ \text{a ration in month}_i\end{pmatrix} \times \begin{pmatrix}\text{feeding time re-}\\ \text{quired by the}\\ \text{specified system}\\ \text{to feed one ani-}\\ \text{mal of category}_j\\ \text{in month}_i\end{pmatrix} \right]$$

for $i = 1, \ldots, 12$.

where i represents the twelve months and j represents the five animal categories: bulls, cows, calves (0-6 mos.), heifers (7-18 mos.), and heifers (over 18 mos.). The number of animals by category kept on the farm in each month have been calculated in Section III-1 of this appendix.

The labor required for removing manure and bedding in each month also depends on two things: (a) the manure and bedding removal system used, and (b) whether the cattle are kept inside during the summer months. (Question #9b

Part I) indicates whether the manure and bedding removal system is (1) manual, or (2) mechanical. (Question #10c Part I) indicates which category of animals (if any) are kept inside during the summer months. (Question #2g Part II) indicates the volume (in cubic feet) of manure and bedding produced by one animal of each category per day. (Question #2g Part II) also indicates the time (in hours) required to remove 100 cu. ft. of manure and bedding with a manual system and the time (in hours) required to remove 100 cu. ft. of manure and bedding with a mechanical system. For each category of animals not kept inside during the summer months, the amount of manure and bedding produced by that category during the months of June, July, August, September, and October is given a value of 0 by the simulation model. With this information, the simulation model calculates the labor required for manure and bedding removal for each month as follows:

$$\begin{pmatrix}\text{Labor time}\\ \text{required to}\\ \text{remove manure}\\ \text{and bedding}\\ \text{in month}_i\end{pmatrix} = \left(\frac{\sum_{j=1}^{5} \left[\begin{pmatrix}\text{no. of ani-}\\ \text{mals of cate-}\\ \text{gory}_j \text{ kept on}\\ \text{the farm and}\\ \text{kept inside}\\ \text{in month}_i\end{pmatrix} \times \begin{pmatrix}\text{daily amount}\\ \text{of manure and}\\ \text{bedding pro-}\\ \text{duced by one}\\ \text{animal of}\\ \text{category}_j \text{ in}\\ \text{month}_i\end{pmatrix} \times 30 \right]}{100} \right) \times \begin{pmatrix}\text{time required to remove}\\ \text{100 cu. ft. of manure}\\ \text{and bedding with the}\\ \text{specified system}\end{pmatrix}$$

for $i = 1, \ldots, 12$.

where i represents the twelve months and j represents the five animal categories: bulls, cows, calves (0-6 mos.), heifers (7-18 mos.), and heifers (over 18 mos.). The number of animals by category kept on the farm in each month have been calculated in Section III-1 of this appendix. The constant 30 converts animal months to animal days.

By calculating the sum of the hours required in each month for fence repair, administering health care, checking the herd while on pasture, feeding the cattle, and removing manure and bedding, the simulation model obtains the total hours of labor required in each month.

By multiplying the total hours of labor by the wage rate given in (Question #8c Part II) the labor cost per month is obtained. The total annual hours of labor required is obtained by simply adding all the total monthly hours of labor. Similarly, the total annual cost of labor is obtained by adding all the total monthly labor costs.

10. Investment in Breeding Stock

One last cost must be included. An investment cost for the breeding stock and the replacement stock is included. No investment cost is required for calves since calves are treated as a product of the enterprise. An investment cost based on the monthly value of the breeding stock and replacement stock is calculated as follows:

$$\begin{pmatrix}\text{Value of breeding}\\ \text{stock and replace-}\\ \text{ment stock in}\\ \text{month}_i\end{pmatrix} = \begin{pmatrix}\text{no. of bulls}\\ \text{on the farm}\\ \text{in month}_i\end{pmatrix} \times \begin{pmatrix}\text{value of}\\ \text{one bull}\end{pmatrix}$$

$$+ \begin{pmatrix}\text{no. of cows}\\ \text{on the farm}\\ \text{in month}_i\end{pmatrix} \times \begin{pmatrix}\text{value of}\\ \text{one cow}\end{pmatrix}$$

$$+ \sum_{j=7}^{30} \left[\begin{pmatrix}\text{no. of replace-}\\ \text{ment heifers of}\\ \text{age}_j \text{ on the farm}\\ \text{in month}_i\end{pmatrix} \times \begin{pmatrix}\text{value of}\\ \text{one re-}\\ \text{placement}\\ \text{heifer of}\\ \text{age}_i\end{pmatrix} \right]$$

$$\begin{pmatrix}\text{Investment in}\\ \text{breeding stock}\\ \text{and replace-}\\ \text{ment stock}\end{pmatrix} = \left(\frac{\text{rate of interest on investment}}{12} \right) \left[\sum_{i=1}^{12} \begin{pmatrix}\text{value of breeding}\\ \text{stock and replacement}\\ \text{stock in month}_i\end{pmatrix} \right]$$

where i represents the twelve months of the year. The number of replacement heifers by age, the number of bulls, and the number of cows kept on the farm in each month have been calculated in Section III-1 of this appendix. The value of replacement heifers by age, the value of bulls, and the value of cows have been calculated in Section III-3 of this appendix. The annual rate of interest on investment is obtained from (Question #7 Part II).

No depreciation cost is calculated for growing animals or for mature animals. No depreciation cost is calculated for growing animals because they are gaining value as they grow. No depreciation cost is calculated for mature animals because it is assumed that the per head average value of the cows and bulls remain the same throughout the year. Some cows or bulls might be depreciating in value because they are getting older but some young cows or bulls might be gaining value because they are increasing weight or producing a higher calving percentage as they get older. Also, young replacement stock which enter the cow herd increase the value of the herd whereas older cattle decrease the value of the herd. Therefore, the average value of the herd remains constant and no depreciation cost is estimated. The cost of maintaining the average value of the herd is reflected in the cost of raising replacement stock minus the value of breeding stock which is culled.

This completes the calculations needed to generate the physcial characteristics and the associated costs of the inputs.

V. Calculations of Gross Returns

The gross returns of the cow-calf enterprise represents the net financial gain from both livestock transactions (i.e. sales, purchases, births, and deaths) and net inventory change. It should be noted that births and deaths are accounted for in the net inventory change. Therefore, gross returns is computed as the value of closing inventory, plus the value of sales, minus the value of purchases, minus the value of beginning inventory. The closing inventory, the sales, the purchases, and the beginning inventory by number, category, (and age)[27] have been calculated in Section III-1 of this appendix. The value of each animal by category (and age)[28] has been calculated in Section III-3 of this appendix. From this information the simulation model calculates gross returns as follows:

$$\text{Gross returns} = \begin{pmatrix}\text{Closing} \\ \text{inventory}\end{pmatrix} + \begin{pmatrix}\text{Sales}\end{pmatrix} - \begin{pmatrix}\text{Purchases}\end{pmatrix} - \begin{pmatrix}\text{Beginning} \\ \text{inventory}\end{pmatrix}$$

where

$$\begin{aligned}\text{Closing inventory} &= \begin{pmatrix}\text{number of bulls at} \\ \text{the end of the year}\end{pmatrix} \times \begin{pmatrix}\text{value of} \\ \text{one bull}\end{pmatrix} \\ &+ \begin{pmatrix}\text{number of cows at} \\ \text{the end of the year}\end{pmatrix} \times \begin{pmatrix}\text{value of} \\ \text{one cow}\end{pmatrix} \\ &+ \sum_{j=0}^{6} \left[\begin{pmatrix}\text{number of calves aged}_j \\ \text{months at the end of} \\ \text{the year}\end{pmatrix} \times \begin{pmatrix}\text{value of} \\ \text{one calf} \\ \text{of age}_j\end{pmatrix}\right]\end{aligned}$$

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[27] Age is required only for growing animals.

[28] Age is required only for growing animals.

$$+ \sum_{j=7}^{18} \left[\begin{pmatrix} \text{number of replacement} \\ \text{heifers aged}_j \text{ months} \\ \text{at the end of the} \\ \text{year} \end{pmatrix} \times \begin{pmatrix} \text{value of} \\ \text{one re-} \\ \text{placement} \\ \text{heifer of} \\ \text{age}_j \end{pmatrix} \right]$$

$$+ \sum_{j=19}^{30} \left[\begin{pmatrix} \text{number of replacement} \\ \text{heifers aged}_j \text{ months} \\ \text{at the end of the} \\ \text{year} \end{pmatrix} \times \begin{pmatrix} \text{value of} \\ \text{one re-} \\ \text{placement} \\ \text{heifer of} \\ \text{age}_j \end{pmatrix} \right]$$

$$\text{Sales} = \begin{pmatrix} \text{number of} \\ \text{bulls sold} \end{pmatrix} \times \begin{pmatrix} \text{value of} \\ \text{one bull} \end{pmatrix} + \begin{pmatrix} \text{number of bulls} \\ \text{sold as culls} \end{pmatrix}$$

$$\times \begin{pmatrix} \text{value of one} \\ \text{bull which} \\ \text{is culled} \end{pmatrix} + \begin{pmatrix} \text{number of} \\ \text{cows sold} \end{pmatrix} \times \begin{pmatrix} \text{value of} \\ \text{one cow} \end{pmatrix}$$

$$+ \begin{pmatrix} \text{number of} \\ \text{cows sold} \\ \text{as culls} \end{pmatrix} \times \begin{pmatrix} \text{value of one} \\ \text{cow which is} \\ \text{culled} \end{pmatrix}$$

$$+ \sum_{j=0}^{6} \left[\begin{pmatrix} \text{number of} \\ \text{calves aged}_j \\ \text{sold} \end{pmatrix} \times \begin{pmatrix} \text{value of one} \\ \text{calf of age}_j \end{pmatrix} \right]$$

$$+ \begin{pmatrix} \text{number of steer calves} \\ \text{sold at weaning} \end{pmatrix} \times \begin{pmatrix} \text{value of a steer} \\ \text{calf at weaning} \end{pmatrix}$$

$$+ \begin{pmatrix} \text{number of heifer calves} \\ \text{sold at weaning} \end{pmatrix} \times \begin{pmatrix} \text{value of a heifer} \\ \text{calf at weaning} \end{pmatrix}$$

$$+ \sum_{j=7}^{18} \left[\begin{pmatrix} \text{number of replace-} \\ \text{ment heifers aged}_j \\ \text{months sold} \end{pmatrix} \times \begin{pmatrix} \text{value of one} \\ \text{replacement} \\ \text{heifer of age}_j \end{pmatrix} \right]$$

$$+ \sum_{j=7}^{18} \left[\begin{pmatrix} \text{number of replace-} \\ \text{ment heifers aged}_j \\ \text{months sold as} \\ \text{culls} \end{pmatrix} \times \begin{pmatrix} \text{value of one re-} \\ \text{placement heifer} \\ \text{of age}_j \text{ which is} \\ \text{culled} \end{pmatrix} \right]$$

$$+ \sum_{j=19}^{30} \left[\begin{pmatrix} \text{number of replace-} \\ \text{ment heifers aged}_j \\ \text{months sold} \end{pmatrix} \times \begin{pmatrix} \text{value of one re-} \\ \text{placement heifer} \\ \text{of age}_j \end{pmatrix} \right]$$

$$+ \sum_{j=19}^{30} \left[\begin{pmatrix} \text{number of replace-} \\ \text{ment heifers aged}_j \\ \text{months sold as} \\ \text{culls} \end{pmatrix} \times \begin{pmatrix} \text{value of one re-} \\ \text{placement heifer} \\ \text{of age}_j \text{ which is} \\ \text{culled} \end{pmatrix} \right]$$

$$\text{Purchases} = \begin{pmatrix}\text{number of bulls}\\\text{purchased}\end{pmatrix} \times \begin{pmatrix}\text{value of}\\\text{one bull}\end{pmatrix} + \begin{pmatrix}\text{number of}\\\text{cows pur-}\\\text{chased}\end{pmatrix}$$

$$\times \begin{pmatrix}\text{value of}\\\text{one cow}\end{pmatrix} + \sum_{j=0}^{6}\left[\begin{pmatrix}\text{number of}\\\text{calves aged}_j\\\text{purchased}\end{pmatrix} \times \begin{pmatrix}\text{value of one}\\\text{calf of age}_j\end{pmatrix}\right]$$

$$+ \sum_{j=7}^{18}\left[\begin{pmatrix}\text{number of re-}\\\text{placement heifers}\\\text{aged}_j\text{ months pur-}\\\text{chased}\end{pmatrix} \times \begin{pmatrix}\text{value of one}\\\text{replacement}\\\text{heifer of}\\\text{age}_j\end{pmatrix}\right]$$

$$+ \sum_{j=19}^{30}\left[\begin{pmatrix}\text{number of re-}\\\text{placement heifers}\\\text{aged}_j\text{ months pur-}\\\text{chased}\end{pmatrix} \times \begin{pmatrix}\text{value of one}\\\text{replacement}\\\text{heifer of}\\\text{age}_j\end{pmatrix}\right]$$

$$\text{Beginning inventory} = \begin{pmatrix}\text{number of bulls}\\\text{at the beginning}\\\text{of the year}\end{pmatrix} \times \begin{pmatrix}\text{value of}\\\text{one bull}\end{pmatrix}$$

$$+ \begin{pmatrix}\text{number of cows}\\\text{at the beginning}\\\text{of the year}\end{pmatrix} \times \begin{pmatrix}\text{value of}\\\text{one cow}\end{pmatrix}$$

$$+ \sum_{j=0}^{6}\left[\begin{pmatrix}\text{number of calves}\\\text{aged}_j\text{ months at}\\\text{the beginning of}\\\text{the year}\end{pmatrix} \times \begin{pmatrix}\text{value of}\\\text{one calf}\\\text{of age}_j\end{pmatrix}\right]$$

$$+ \sum_{j=7}^{18}\left[\begin{pmatrix}\text{number of replace-}\\\text{ment heifers aged}_j\\\text{months at the be-}\\\text{ginning of the year}\end{pmatrix} \times \begin{pmatrix}\text{value of}\\\text{one re-}\\\text{placement}\\\text{heifer of}\\\text{age}_j\end{pmatrix}\right]$$

$$+ \sum_{j=19}^{30}\left[\begin{pmatrix}\text{number of re-}\\\text{placement heifers}\\\text{aged}_j\text{ months at}\\\text{the beginning of}\\\text{the year}\end{pmatrix} \times \begin{pmatrix}\text{value of}\\\text{one re-}\\\text{placement}\\\text{heifer of}\\\text{age}_j\end{pmatrix}\right]$$

VI. Outputs from the Simulation Model

The simulation model outputs the following information about the farm plan being simulated: (1) monthly cattle numbers summary, (2) annual cattle numbers summary, (3) summary of physical and dollar records, (4) management indicators, (5) labor requirements by month, and (6) an annual cash flow. A description of each of these outputs is given below. Appendix E gives three examples of each of these outputs, one for each of the three illustrative farm plans. A printout of the inputs is also given to check for any input data errors.

1. Monthly Cattle Numbers Summary

The first output from the model is a table of monthly cattle numbers generated by the simulation model. This table includes the beginning inventory, births, purchases, sales, deaths, and ending inventory for each category of animals for each month. This indicates the size of the cow-calf operation during each month of the year and the transactions that occurred during each month of the year.

2. Annual Cattle Numbers Summary

The second output from the model is a summary table of cattle numbers for the whole year. The table includes; the beginning inventory; the total number of births, purchases, sales, and deaths for the whole year; and the ending inventory. This gives an idea of the size of the cow-calf operation and indicates the total number of transactions which occurred during the year.

3. Summary of Physical and Dollar Record[29]

The third output contains the most detailed and complete results of the farm operation. It itemizes each cost component and each return component both in physical and in dollar terms. The cost components given are: (1) repairs, (2) feed, (3) bedding, (4) health care, (5) artificial insemination, (6) miscellaneous expenses, (7) labor, (8) investment, (9) depreciation, and (10) total costs. The return components given are: (1) beginning inventory, (2) sales, (3) purchases, (4) closing inventory, and (5) total gross returns.

4. Management Indicators

The fourth output is a list of management indicators. This list is broken down into (a) physical management indicators, and (b) overall financial management indicators.

The physical management indicators are (i) weaning weight, (ii) percent calves born alive, (iii) percent calf crop weaned, (iv) daily rate of gain of calves, heifers

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[29]This third output has a format similar to the format of the output for the cow-calf section of the livestock simulation model used in the evaluation of the Farm Development Program and described in Senkiw and Pokrant, op. cit.

(7-18 mos.), and heifers (over 18 mos.), (v) percent death loss of cows and bulls, calves, and heifers. An explanation of each of the above physical management indicators follows. The weaning weight is the average weight of the calves at six months of age. The percent calves born alive is calculated as:

$$\left(\frac{\text{number of calves born alive}}{\text{number of cows on the farm on the month that births occur}}\right) \times 100.$$

The percent of calf crop weaned is calculated as:

$$\left(\frac{\text{number of calves weaned}}{\text{number of calves born alive}}\right) \times 100.$$

The daily rate of gain of calves is obtained from (Question #3 Part II). The daily rate of gain of each category of the other growing animals is obtained from (Question #17 Part I). The percent death loss of each category of animals is calculated as:

$$\left[\frac{\text{number of deaths in category}_i}{\left(\sum_{j=1}^{12} \text{number of animals in category}_i \text{ in month}_j\right) \div 12} \times 100\right]$$

where j represents the months and i the various categories of animals. The bull and cow categories are combined into one group; and the heifers (7-18 mos.) and the heifers (over 18 mos.) are also combined into one group for this last physical management indicator.

The overall financial management indicators are: (i) overall returns to labor, investment, and management,

(ii) overall returns to labor and management and returns to labor and management per hour of labor, (iii) overall returns to investment and management and returns to investment and management expressed as a percent of total investments in the enterprise, and (iv) overall net returns to management. An explanation of each of the above financial management indicators starting with the last one follows.

Overall net returns to management is defined to be the difference between total gross returns and all total cost components. Total costs are computed as the sum of all cost components required to operate the cow-calf enterprise--investment, depreciation, and labor costs included. Overall returns to investment and management is defined to be gross returns minus all cost components except investment costs. Returns to investment and management expressed as a percent of total investments in the enterprise equals overall returns to investment and management divided by current value of all investments in the enterprise multiplied by 100. Overall returns to labor and management is defined to be gross returns minus all cost components except labor costs. Returns to labor and management expressed per hour of labor equals overall returns to labor and management divided by hours of labor required for the enterprise. Overall returns to labor, investment, and management is defined to be gross returns minus all cost components except labor and investment costs.

5. Labor Requirements by Month

The fifth output from the model is a table of total labor hours required for each task of the cow-calf operation in each month of the year. The number of hours required by month is indicated for each of the following tasks: (i) feeding, (ii) manure and bedding removal, (iii) health care, (iv) fence repair, and (v) checking the herd while on pasture. The total number of hours of labor required in each month is also indicated.

6. Annual Cash Flow

The sixth output from the simulation model is an annual cash flow of the cow-calf enterprise alone.[30] The annual cash flow consists of sales minus "out of pocket" costs (or expenses). The value of livestock sales has been calculated in Section V of this appendix. Sales of capital resources are obtained from the capital sale section shown in Appendix A Part III. The costs or expenses have been calculated in Section IV of this appendix. The "out of pocket" expenses which are included in the cash flow statement are (1) repairs, (2) feed (i.e. taxes, rent, and fertilizer on pasture, hay, grain, supplement, silage, salt, minerals, and other feeds), (3) bedding, (4) health care

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[30]It should be noted that this simulation model considers the cow-calf enterprise in isolation from the other enterprises of the farm as explained in Chapter III, p. 53.

treatments, (5) artificial insemination costs, (6) miscellaneous costs, and (7) cash purchases. The value of the livestock purchases has been calculated in Section V of this appendix. Purchases of capital resources are obtained from the capital purchase section shown in Appendix A Part III.

APPENDIX C

APPENDIX C

DATA SOURCES FOR GROUP TWO PARAMETERS[1]

In this appendix the sources of the initial values of the group two parameters utilized in the cow-calf simulation model are provided. The sources listed below provide either the numbers used or the figures from which the numbers used are obtained by indexing, adjusting, or averaging procedures (that is, the raw data for calculation of the numbers used). The numbers associated with each source below coincide with the question numbers found in Appendix A Part II where the initial values assumed by the model are given.

#1(a) Assumes deaths can occur at any age or month of year for growing animals and at any month of year for mature animals with equal probability.

#1(b) Chosen as reasonable month (i.e. just after breeding season).

#1(c)-#1(d) Taken from a suggested calendar list of management practices for the cow-calf operator found in: Manitoba Department of Agriculture, Beef Manual (Winnipeg: Economis Branch, Manitoba Department of Agriculture, 1971), pp. 101:38-101:42.

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[1]Ladue has also listed the sources of the values of the initialized model parameters in his model in Ladue, op. cit., pp. 487-492.

#1(e) Taken from the description of a typical Manitoba cow-calf operation found in: Principles and Practices of Commercial Farming (Fourth edition, Winnipeg: Faculty of Agriculture, University of Manitoba, 1974), p. 366.

#1(f) Chosen assuming all heifers remaining (i.e. not culled) are bred at approximately 15 months of age to calve as two year olds. They enter the cow herd three months after they are bred.

#1(g) Representative of typical practices on a cow-calf enterprise assuming one-half the calves weaned are male and one-half are females.

#2(a) Estimated from own experience.

#2(b)-#2(e) Labor requirements are estimated from own experience. The timing of dehornings and castrations are taken from a suggested calendar list of management practices for the cow-calf operator found in: Manitoba Department of Agriculture, Beef Manual (Winnipeg: Economics Branch, Manitoba Department of Agriculture, 1971), pp. 101:38-101:42.

#2(f) Derived from Roy N. Van Arsdal, "Resource Requirements, Investment Costs, and Expected Returns" from Selected Beef-Feeding and Beef-Raising Enterprises, AE-4075, Illinois Agricultural Experiment Station, Urbana, 1965, Table B-23, p. 24.

#2(g) Labor requirements are estimated from own experience and from discussion with colleagues. The table of volume of manure and bedding produced is derived from Principles and Practices of Commercial Farming (Fourth edition, Winnipeg: Faculty of Agriculture, University of Manitoba, 1974), Table 17.1, p. 569 (Canadian Code of Farm Buildings, 1970, Associated Committee on the National Building Code, National Research Council of Canada, Ottawa).

#3 Derived from Principles and Practices of Commercial Farming (Fourth edition, Winnipeg: Faculty of Agriculture, University of Manitoba, 1974), pp. 366-367.

#4 Estimated to be representative of feeding practices on good cow-calf enterprises.

#5 Derived from Manitoba Department of Agriculture, Beef Manual (Winnipeg: Economics Branch, Manitoba Department of Agriculture, 1971), p. 101:51.

#6 Estimated average figures.

#7 Chosen as typical values for rates of return on various investments.

#8(a) All prices except for prices of culled animals are taken from: Manitoba Department of Agriculture, Manitoba Agriculture, 1975 Yearbook, printed by R. S. Evans--Queens's Printer for Province of Manitoba, 1975, p. 28. Price per hundredweight of culled heifers is assumed to be 10 percent less than the price per hundredweight of heifers over 550 pounds. Similarly, price per hundredweight of culled bulls is assumed to be 10 percent less than the price per hundredweight of bulls. Price of culled cows is assumed to be the price of D4 cows. Price of other cows is assumed to be the price of D3 cows.

#8(b) Manitoba Department of Agriculture, Farm Data Handbook (Winnipeg: Economics Branch, Manitoba Department of Agriculture, 1972), p. II-8.

#8(c) Manitoba Department of Agriculture, Manitoba Agriculture, 1974 Yearbook and 1975 Yearbook, printed by R. S. Evans--Queen's Printer for Province of Manitoba, 1974 and 1975 respectively, p. 41.

#8(d) Derived from Manitoba Department of Agriculture, Manitoba Agriculture, 1975 Yearbook, printed by R. S. Evans--Queen's Printer for Province of Manitoba, 1975, pp. 50-54, 60, 70, 72, and Manitoba Department of Agriculture, Farm Data Handbook (Winnipeg: Economics Branch, Manitoba Department of Agriculture, 1972), p. IV-12. Tame hay is assumed to contain 51 percent TDN and 15.2 percent protein (as fed). Native hay is assumed to contain 50 percent TDN and 7.8 percent protein (as fed). Grain is composed of one half oats, one fourth barley, and one fourth wheat by weight. Silage is composed of corn silage.

#8(e) The 1973 figure was estimated in consultation with Dr. C. H. McNaughton of the Agricultural Services Complex, Manitoba Department of Agriculture. The 1974 and 1975 figures are updated according to the artificial insemination price indexes obtained from Statistics Canada, Farm Input Price Index, Catalogue Number 62-004, 1975 and 1976 Quarterlies (Ottawa: Queen's Printer for Canada, 1975 and 1976), p. 7.

#8(f) Derived from Manitoba Department of Agriculture, Manitoba Agriculture, 1975 Yearbook, printed by R. S. Evans--Queen's Printer for Province of Manitoba, 1975, p. 70.

#8(g) The 1972 figures are derived from Manitoba Department of Agriculture, Farm Data Handbook (Winnipeg: Economics Branch, Manitoba Department of Agriculture, 1972). The 1973, 1974, and 1975 figures for fences, pens, corrals, and working chutes are updated according to the fence construction and repairs price index. The 1973, 1974, and 1975 figures for all the buildings are updated according to the building replacement price index. The indexes were obtained from Statistics Canada, Farm Input Price Index, Catalogue Number 62-004, 1975 and 1976 Quarterlies (Ottawa: Queen's Printer for Canada, 1975 and 1976), p. 4.

#8(h)-#8(i) The 1974 figures were estimated with information obtained from Gardo Products Limited, Winnipeg. The 1973 and 1975 figures were calculated by adjusting the 1974 figure according to the manufacturers of pharmaceuticals and medicines prices index obtained from Statistics Canada, Prices and Price Indexes, Catalogue Number 62-002, Monthly, December 1975 (Ottawa: Queen's Printer for Canada, 1975), p. 38.

#8(j) The 1972 figure is estimated or calculated from the miscellaneous expenses figures found in: (i) Manitoba Department of Agriculture, Farm Data Handbook (Winnipeg: Economics Branch, Manitoba Department of Agriculture, 1972), pp. IV-28--IV-39, and (ii) Manitoba Department of Agriculture, Beef Manual (Winnipeg: Economics Branch, Manitoba Department of Agriculture, 1971), p. 101:54. The 1973, 1974, and 1975 figures were updated according to the total farm inputs price index for Western Canada (1961=100) obtained from Manitoba Department of Agriculture, Manitoba Agriculture, 1975 Yearbook, printed by R. S. Evans--Queen's Printer for Province of Manitoba, 1975, p. 103.

#8(k)-#8(l) The value of improved land per acre for each crop district was obtained using the following equation:

$$\text{Value of improved land in a crop district} = \frac{\text{Value of land in a crop district x total number of acres in a crop district}}{\text{Number of improved acres in a crop district x 1/3 (number of unimproved acres in a crop district)}}$$

where the value of land in a crop district is the value of farm land including buildings per acre in a crop district obtained from Manitoba Department of Agriculture, Manitoba Agriculture, 1975 Yearbook, printed by R. S. Evans--Queen's Printer for Province of Manitoba, 1975, p. 40, and, the total number of acres, the number of improved and unimproved acres in a crop district, and the new breaking per crop district per year are obtained from Manitoba Department of Agriculture, Manitoba Agriculture, 1973, 1974, and 1975 Yearbooks, printed by R. S. Evans--Queen's Printer for Province of Manitoba, 1973, 1974, and 1975 respectively, pp. 38-39. As the number of improved and unimproved acres change within a crop district due to additional breaking, the number of improved and unimproved acres were adjusted in each year accordingly. The value of unimproved land was assumed to be worth 1/3 of the improved land in each crop district.

#8(m)-#8(n) Calculated from figures found in Manitoba Department of Agriculture, Manitoba Agriculture, 1973, 1974, and 1975 Yearbooks, printed by R. S. Evans--Queen's Printer for Province of Manitoba, 1973, 1974, and 1975 respectively, pp. 38-39 and from the provincial operating tax figures supplied by M. Daciw, Agricultural Statistician, Planning Secretariat, Manitoba Department of Agriculture, Winnipeg.

#9 Derived from Manitoba Department of Agriculture, Farm Data Handbook (Winnipeg: Economics Branch, Manitoba Department of Agriculture, 1972), p. IV-12. [F. B. Morrison, Feeds and Feeding (22nd edition, New York: Ithaca, Morrison Publishing Company)].

APPENDIX D

APPENDIX D

SAMPLE INPUTS TO THE SIMULATION MODEL

This appendix serves two purposes. First, it shows how to fill out the input forms required for the simulation model. Secondly, it describes in detail the three alternative illustrative cow-calf farm plans being made in 1973 for the 1974 operation which were presented in Chapter IV.

Three sample inputs are filled out in this appendix. These sample inputs serve as examples to show how to fill out the input forms of the simulation model. They also describe the three alternative farm plans presented in Chapter IV since the first sample input is the input required by the simulation model to describe plan #1, the second sample input is for plan #2, and the third sample input is for plan #3. The input forms are straightforward. The information given on these forms combined with the adjusted values given to the group two parameters describe the three farm plans to be simulated.

The input format is divided into two parts. Part A consists of the required inputs for the simulation model. Part B consists of the changes made to the initial values assigned to the group two parameters given in Appendix A, Part II (including any changes made to the buying or selling pattern). The information given on these forms is ready to be keypunched and attached to the computerized simulation model. The card numbers are indicated and underlined on the forms and the column numbers are given in brackets below the spaces provided on the forms for the pieces of information.

Appendix E will indicate the forecasts of the three illustrative farm plans submitted.

The three sample inputs are given in the following pages. Part A and Part B of the input forms are given for each sample input.

INPUT FORM FOR THE COW-CALF SIMULATION MODEL

Sample Input #1

(Inputs for plan #1)

PART A-- Required Input Data (Group one data) Form[1]

Card 1

1. General Information

a) Name Hypothetical Farm
(1-25)

b) Crop District 04
(26-27)

2. Output Header Information

a) No. of alternative plans to be simulated is 03 (28-29) of which this is the 01 (30-31) (1st, 2nd, 3rd, or other).

b) Other identifying information to be printed:

Plan #1--No change in cow-calf operation
(32-80)

Card 2

3. Year of Operation

The operation of calendar year 19 74 (1-2) is being simulated.

4. Year of Prices and Costs

Prices and costs from year 19 73 (3-4) are to be used.

5. Livestock Numbers Information

a) Beginning Inventory (Number on Jan. 1st by category)

No. of bulls 004
(5-7)

No. of cows 100
(8-10)

---

[1]This form should be filled for each farm plan to be simulated.

No. of calves by age (months)

Age	0	1	2	3	4	5	6
Number	0	0	0	0	0	0	0
	(11-13)	(14-16)	(17-19)	(20-22)	(23-25)	(26-28)	(29-31)

No. of replacement heifers by age (months)

Age	7	8	9	10	11	12	13	14
Number	0	21	0	0	0	0	0	0
	(32-34)	(35-37)	(38-40)	(41-43)	(44-46)	(47-49)	(50-52)	(53-55)

Card 3

Age	15	16	17	18	19	20	21	22
Number	0	0	0	0	0	0	0	0
	(1-3)	(4-6)	(7-9)	(10-12)	(13-15)	(16-18)	(19-21)	(22-24)

Age	23	24	25	26	27	28	29	30
Number	0	0	0	0	0	0	0	0
	(25-27)	(28-30)	(31-33)	(34-36)	(37-39)	(40-42)	(43-45)	(46-48)

b) Natural Occurrence Expected

Category of Livestock	Number Born Alive	Number of Deaths	No. of Culls (sold)
Bulls	X	0 (49-51)	0 (52-54)
Cows	X	4 (55-57)	12 (58-60)
Calves (0-6 mos.)	90 (61-63)	6 (64-66)	X
Replacement Heifers	X	1 (67-69)	4 (70-72)

Card 4

6. Buildings Used for the Cow-Calf Enterprise

a) Sheds or Barns

Size (sq. ft.)	Age[2]	Wired and Insulated[3]
4820 (1-5)	10 (6-7)	1 (8)
(9-13)	(14-15)	(16)
(17-21)	(22-23)	(24)
(25-29)	(30-31)	(32)
(33-37)	(38-39)	(40)

---

[2] Age refers to the age at the beginning of the year.

[3] Put a "1" if building is wired and insulated and a "2" if building is not wired or not insulated.

b) Hay Storage Facilities

Size (tons)	Age
(41-45)	(46-47)
(48-52)	(53-54)
(55-59)	(60-61)

Card 5

c) Grain Storage Facilities

Size (bu.)	Age	Type code[4]
1600 (1-5)	10 (6-7)	2 (8)
800 (9-13)	10 (14-15)	2 (16)
(17-21)	(22-23)	(24)

d) Silos

Size (tons)	Age	Type code[5]
(25-29)	(30-31)	(32)
(33-37)	(38-39)	(40)
(41-45)	(46-47)	(48)

[4] Codes are 1--wood, 2--steel.

[5] Codes are 1--bunker, 2--concrete, 3--sealed.

Card 6

7. Fences, Pens, Corrals, and Working Chutes Used for the Cow-Calf Enterprise

a) Fences

Perimeter length (mi.)	Age
3.6 (1-6)	10 (7-8)
(9-14)	(15-16)
(17-22)	(23-24)

b) Pens, Corrals, and Working Chutes

Perimeter length (ft.)	Age
400 (25-32)	10 (33-34)
(35-42)	(43-44)
(45-52)	(53-54)

8. Machinery and Equipment

	Description[6]	Age (years)	Life (years)	Present Replacement Value[7] ($)	Portion Used in the Cow-Calf Enterprise (fraction)
Card 7	Manure Spreader	01	20	2000.00	1.00
Card 8	Tractor	10	20	5000.00	.30
Card 9	Pick-up truck	10	20	2400.00	.30
Card 10	Front-end Loader	10	20	1058.00	.50
Card 11	Feeding equipment	10	20	1550.00	1.00
Card 12	Loading chute	0	20	50.00	1.00
Card 13	Grain auger	10	20	500.00	.30
Card 14					
Card 15					
Card 16					
	(1-20)	(21-22)	(23-24)	(25-32)	(33-36)

Card 17

9. Systems (choose the most suitable number)

a) Feeding System: (1. Hand feeding; 2. Self feeding; 3. Mechanized feeding) 2 (1)

---

[6]Description of machinery or equipment should be given using less than 20 letters.

[7]Present Replacement Value refers to the current cost of replacing the machine or piece of equipment with a new machine or piece of equipment of the same size and type.

b) Manure and Bedding Removal System:

(1. Manual
2. Mechanical) 2
(2)

10. Summer Activities (indicate with 1 for yes and 0 for no).

Category	a) Sent to pasture during summer	b) Fed a ration during summer	c) Kept inside during summer
Bulls	1 (3)	0 (4)	0 (5)
Cows	1 (6)	0 (7)	0 (8)
Calves (0-6 mos.)	1 (9)	0 (10)	0 (11)
Heifers (7-18 mos.)	1 (12)	0 (13)	0 (14)
Heifers (over 18 mos.)	1 (15)	0 (16)	0 (17)

11. Vitamins (injected or fed apart from those provided in the regular rations given below in Questions #15 and #16.)

No. of treatments	Month given	Vitamin code[8]
100 (18-20)	2 (21-22)	2 (23)
100 (24-26)	11 (27-28)	2 (29)
21 (30-32)	11 (33-34)	1 (35)

[8]Vitamin codes: 1--vitamin A,D,E (for growing animals),
2--vitamin A,D,E (for mature animals),
3--user defined vitamin.

12. Vaccinations

No. of vaccinations	Month given	Vaccination code[9]
90	5	2
(36-38)	(39-40)	(41)
21	10	2
(42-44)	(45-46)	(47)
21	10	3
(48-50)	(51-52)	(53)
(54-56)	(57-58)	(59)
(60-62)	(63-64)	(65)

13. Artifical Insemination

No. of cows bred with A.I. 0 (66-68)

Card 18

14. Pasturing Practices

a) Pasture Resources Available for the Cow-Calf Enterprise

No. of acres	Improved--1 Unimproved--2	Owned--1 Rented--2
264	1	1
(1-4)	(5)	(6)
(7-10)	(11)	(12)
(13-16)	(17)	(18)
(19-22)	(23)	(24)

[9]Vaccination Codes: 1--IBR; 2--Blackleg; 3--Malignant Edema; 4-- 3-way; 5--user defined vaccination.

b) Fertilizer Applied on Pasture Grazed by the Cow-Calf Herd

Code[10]	Total No. of tons
(25)	(26-32)
(33)	(34-40)
(41)	(42-48)
(49)	(50-56)
(57)	(58-60)

---

[10]Fertilizer Codes:

1. 11-55-0
2. 11-48-0
3. 34-0-0
4. 46-0-0
5. 24-0-0
6. User defined fertilizer.

Cards 19-26

15. Winter Rations (in pound per day)

CARD	Feed	Bulls	Lac-tating Cows	Ges-tating Cows	Dry Cows	Calves (0-6 mos.)	Re-place-ment Heifers (7-18 mos.)	Re-place-ment Heifers (over 18 mos.)
19	Tame Hay	20	23	18	18		12	
20	Native Hay							
21	Grain	4	5				4	
22	Supple-ment							
23	Silage							
24	User Defined feed #1							
25	User Defined feed #2							
26	Salt and Miner-als Code[11]	4	4	4	4	4	4	
		(1-5)	(6-10)	(11-15)	(16-20)	(21-25)	(26-30)	(31-35)

[11]Salt and Minerals Code: 1--No salt, no minerals
2--Salt, no minerals
3--Minerals, no salt
4--Salt and minerals.

Cards 27-34

16. Summer Rations (in pound per day) Excluding Pasture

CARD	Feed	Bulls	Lac-tating Cows	Ges-tating Cows	Dry cows	Calves (0-6 mos.)	Re-place-ment Heifers (7-18 mos.)	Re-place-ment Heifers (over 18 mos.)
27	Tame Hay							
28	Native Hay							
29	Grain							
30	Supple-ment							
31	Silage							
32	User Defined feed #1							
33	User Defined feed #2							
34	Salt and Minerals Code[12]	4	4	4	4	4	4	
		(1-5)	(6-10)	(11-15)	(16-20)	(21-25)	(26-30)	(31-35)

[12]Salt and Minerals Code: 1--No salt, no minerals
2--Salt, no minerals
3--Minerals, no salt
4--Salt and minerals.

Card 35

17. Expected Rates of Gain (in lbs. per day)

a) Average rate of gain expected for heifers (7-18 mos.) 1.50 (1-4).

b) Average rate of gain expected for heifers (over 18 mos.) ______ (5-8).

18. Bedding Used

Straw -- (Yes = 1; No = 0) 1 (9).

User defined -- (Yes = 1; No = 0) 0 (10).

PART B-- Form for Making Changes to Group II Data

Card 36

1	2	3	4	5	6	7	8	9	10
0	1	1	0	8			3	.	0

← column number

Note: Labor required for fence repair is 3.0 hours per mile.

Card 37

1	2	3	4	5	6	7	8	9	10
0	1	3	0	5		1	.	8	0

← column number

Note: Non-creep fed calves gain 1.80 pounds per day.

Card 38

1	2	3	4	5	6	7	8	9	10
0	4	3			5	0	.	0	0

← column number

Note: A loading chute costing $50.00 is purchased.

Card 39

1	2	3	4	5	6	7	8	9	10
0	1	3	9	7		.	0	4	6

← column number

Note: Cost of grain is 4.6 cents per pound.

Card 40

1	2	3	4	5	6	7	8	9	10

← column number

Note: __________

Card 41

1	2	3	4	5	6	7	8	9	10

← column number

Note: __________

(add more pages if required)

INPUT FORM FOR THE COW-CALF SIMULATION MODEL

Sample Input #2

(Inputs for plan #2)

PART A-- Required Input Data (Group one data) Form[1]

Card 1

1. General Information

   a) Name Hypothetical Farm
   (1-25)

   b) Crop District 04
   (26-27)

2. Output Header Information

   a) No. of alternative plans to be simulated is 03 (28-29) of which this is the 02 (30-31) (1st, 2nd, 3rd, or other).

   b) Other identifying information to be printed: Plan #2--No replacement stock; increase cows by 10%
   (32-80)

Card 2

3. Year of Operation

   The operation of calendar year 19 74 (1-2) is being simulated.

4. Year of Prices and Costs

   Prices and costs from year 19 73 (3-4) are to be used.

5. Livestock Numbers Information

   a) Beginning Inventory (Number on Jan. 1st by category)

   No. of bulls 004
   (5-7)

   No. of cows 100
   (8-10)

---

[1]This form should be filled for each farm plan to be simulated.

No. of calves by age (months)

Age	0	1	2	3	4	5	6
Number	0	0	0	0	0	0	0
	(11-13)	(14-16)	(17-19)	(20-22)	(23-25)	(26-28)	(29-31)

No. of replacement heifers by age (months)

Age	7	8	9	10	11	12	13	14
Number	0	21	0	0	0	0	0	0
	(32-34)	(35-37)	(38-40)	(41-43)	(44-46)	(47-49)	(50-52)	(53-55)

Card 3

Age	15	16	17	18	19	20	21	22
Number	0	0	0	0	0	0	0	0
	(1-3)	(4-6)	(7-9)	(10-12)	(13-15)	(16-18)	(19-21)	(22-24)

Age	23	24	25	26	27	28	29	30
Number	0	0	0	0	0	0	0	0
	(25-27)	(28-30)	(31-33)	(34-36)	(37-39)	(40-42)	(43-45)	(46-48)

b) Natural Occurrence Expected

Category of Livestock	Number Born Alive	Number of Deaths	No. of Culls (sold)
Bulls	X	0 (49-51)	0 (52-54)
Cows	X	4 (55-57)	12 (58-60)
Calves (0-6 mos.)	99 (61-63)	7 (64-66)	X
Replacement Heifers	X	0 (67-69)	0 (70-72)

Card 4

6. Buildings Used for the Cow-Calf Enterprise

a) Sheds or Barns

Size (sq. ft.)	Age[2]	Wired and Insulated[3]
4820 (1-5)	10 (6-7)	1 (8)
(9-13)	(14-15)	(16)
(17-21)	(22-23)	(24)
(25-29)	(30-31)	(32)
(33-37)	(38-39)	(40)

---

[2]Age refers to the age at the beginning of the year.

[3]Put a "1" if building is wired and insulated and a "2" if building is not wired or not insulated.

b) Hay Storage Facilities

Size (tons)	Age
(41-45)	(46-47)
(48-52)	(53-54)
(55-59)	(60-61)

Card 5

c) Grain Storage Facilities

Size (bu.)	Age	Type code[4]
1600	10	2
(1-5)	(6-7)	(8)
800	10	2
(9-13)	(14-15)	(16)
(17-21)	(22-23)	(24)

d) Silos

Size (tons)	Age	Type code[5]
(25-29)	(30-31)	(32)
(33-37)	(38-39)	(40)
(41-45)	(46-47)	(48)

[4]Codes are 1--wood, 2--steel.

[5]Codes are 1--bunker, 2--concrete, 3--sealed.

Card 6

7. Fences, Pens, Corrals, and Working Chutes Used for the Cow-Calf Enterprise

a) Fences

Perimeter length (mi.)	Age
3.6 (1-6)	10 (7-8)
(9-14)	(15-16)
(17-22)	(23-24)

b) Pens, Corrals, and Working Chutes

Perimeter length (ft.)	Age
400 (25-32)	10 (33-34)
(35-42)	(43-44)
(45-52)	(53-54)

8. Machinery and Equipment

	Description[6]	Age (years)	Life (years)	Present Replacement Value[7] ($)	Portion Used in the Cow-Calf Enterprise (fraction)
Card 7	Manure Spreader	01	20	2000.00	1.00
Card 8	Tractor	10	20	5000.00	.30
Card 9	Pick-up Truck	10	20	2400.00	.30
Card 10	Front-end Loader	10	20	1058.00	.50
Card 11	Feeding Equipment	10	20	1550.00	1.00
Card 12	Loading Chute	0	20	50.00	1.00
Card 13	Grain Auger	10	20	500.00	.30
Card 14					
Card 15					
Card 16					
	(1-20)	(21-22)	(23-24)	(25-32)	(33-36)

Card 17

9. Systems (choose the most suitable number)

a) Feeding System: (1. Hand feeding 2. Self feeding 3. Mechanized feeding) 2 (1)

---

[6]Description of machinery or equipment should be given using less than 20 letters.

[7]Present Replacement Value refers to the current cost of replacing the machine or piece of equipment with a new machine or piece of equipment of the same size and type.

b) Manure and Bedding Removal System:

(1. Manual
2. Mechanical) 2
(2)

10. Summer Activities (indicate with 1 for yes and 0 for no).

Category	a) Sent to pasture during summer	b) Fed a ration during summer	c) Kept inside during summer
Bulls	1 (3)	0 (4)	0 (5)
Cows	1 (6)	0 (7)	0 (8)
Calves (0-6 mos.)	1 (9)	0 (10)	0 (11)
Heifers (7-18 mos.)	1 (12)	0 (13)	0 (14)
Heifers (over 18 mos.)	1 (15)	0 (16)	0 (17)

11. Vitamins (injected or fed apart from those provided in the regular rations given below in Questions #15 and #16.)

No. of treatments	Month given	Vitamin code[8]
110 (18-20)	2 (21-22)	2 (23)
110 (24-26)	11 (27-28)	2 (29)
(30-32)	(33-34)	(35)

[8]Vitamin codes: 1--vitamin A,D,E (for growing animals),
2--vitamin A,D,E (for mature animals),
3--user defined vitamin.

12. Vaccinations

No. of vaccinations	Month given	Vaccination code[9]
99	5	2
(36-38)	(39-40)	(41)
(42-44)	(45-46)	(47)
(48-50)	(51-52)	(53)
(54-56)	(57-58)	(59)
(60-62)	(63-64)	(65)

13. Artifical Insemination

No. of cows bred with A.I. 0 (66-68)

Card 18

14. Pasturing Practices

a) Pasture Resources Available for the Cow-Calf Enterprise

No. of acres	Improved--1 Unimproved--2	Owned--1 Rented--2
264	1	1
(1-4)	(5)	(6)
(7-10)	(11)	(12)
(13-16)	(17)	(18)
(19-22)	(23)	(24)

[9]Vaccination Codes: 1--IBR; 2--Blackleg; 3--Malignant Edema; 4-- 3-way; 5--user defined vaccination.

b) Fertilizer Applied on Pasture Grazed by the Cow-Calf Herd

Code[10]	Total No. of tons
(25)	(26-32)
(33)	(34-40)
(41)	(42-48)
(49)	(50-56)
(57)	(58-60)

[10]Fertilizer Codes:
1. 11-55-0
2. 11-48-0
3. 34-0-0
4. 46-0-0
5. 24-0-0
6. User defined fertilizer.

Cards 19-26

15. Winter Rations (in pound per day)

CARD	Feed	Bulls	Lactating Cows	Gestating Cows	Dry Cows	Calves (0-6 mos.)	Replacement Heifers (7-18 mos.)	Replacement Heifers (over 18 mos.)
19	Tame Hay	20	23	18	18		12	
20	Native Hay							
21	Grain	4	5				4	
22	Supplement							
23	Silage							
24	User Defined feed #1							
25	User Defined feed #2							
26	Salt and Minerals Code[11]	4	4	4	4	4	4	
		(1-5)	(6-10)	(11-15)	(16-20)	(21-25)	(26-30)	(31-35)

[11]Salt and Minerals Code:
1--No salt, no minerals
2--Salt, no minerals
3--Minerals, no salt
4--Salt and minerals.

Cards 27-34

16. Summer Rations (in pound per day) Excluding Pasture

CARD	Feed	Bulls	Lactating Cows	Gestating Cows	Dry cows	Calves (0-6 mos.)	Replacement Heifers (7-18 mos.)	Replacement Heifers (over 18 mos.)
27	Tame Hay							
28	Native Hay							
29	Grain							
30	Supplement							
31	Silage							
32	User Defined feed #1							
33	User Defined feed #2							
34	Salt and Minerals Code[12]	4	4	4	4	4	4	
		(1-5)	(6-10)	(11-15)	(16-20)	(21-25)	(26-30)	(31-35)

[12]Salt and Minerals Code: 1--No salt, no minerals
2--Salt, no minerals
3--Minerals, no salt
4--Salt and minerals.

Card 35

17. Expected Rates of Gain (in lbs. per day)

a) Average rate of gain expected for heifers (7-18 mos.) 1.50 (1-4).

b) Average rate of gain expected for heifers (over 18 mos.) ______ (5-8).

18. Bedding Used

Straw -- (Yes = 1; No = 0) 1 (9).

User defined -- (Yes = 1; No = 0) 0 (10).

PART B-- Form for Making Changes to Group II Data

Card 36

0	1	1	0	8			3	.	0
1	2	3	4	5	6	7	8	9	10 ← column number

Note: Labor required for fence repair is 3.0 hours per mile.

Card 37

0	1	3	0	5		1	.	8	0
1	2	3	4	5	6	7	8	9	10 ← column number

Note: Non-creep fed calves gain 1.80 pounds per day.

Card 38

0	2	0	1	2			0	1	0
1	2	3	4	5	6	7	8	9	10 ← column number

Note: Purchases 10 D3-cows on Jan. 31, 1974.

Card 39

0	2	1	0	4	1	8	0	1	6
1	2	3	4	5	6	7	8	9	10 ← column number

Note: Purchases 16 eighteen month old replacement heifers on October 31, 1974.

Card 40

0	3	0	1	4	0	9	0	2	1
1	2	3	4	5	6	7	8	9	10 ← column number

Note: Sells the 21 replacement heifers on Jan. 31, 1974.

Card 41

0	1	1	0	5					0
1	2	3	4	5	6	7	8	9	10 ← column number

Note: No heifer calves are kept for replacement stock.

(continued)

(add more pages if required)

PART B-- Form for Making Changes to Group II Data

Card 42

1	2	3	4	5	6	7	8	9	10
0	1	1	0	6			.	5	0

← column number

Note: All heifer calves are sold at weaning.

Card 43

1	2	3	4	5	6	7	8	9	10
0	4	3			5	0	.	0	0

← column number

Note: A loading chute costing $50.00 is purchased

Card 44

1	2	3	4	5	6	7	8	9	10
0	1	3	9	7		.	0	4	6

← column number

Note: Cost of grain is 4.6 cents per pound.

Card 45

1	2	3	4	5	6	7	8	9	10

← column number

Note:

Card 46

1	2	3	4	5	6	7	8	9	10

← column number

Note:

Card 47

1	2	3	4	5	6	7	8	9	10

← column number

Note:

(add more pages if required)

INPUT FORM FOR THE COW-CALF SIMULATION MODEL

Sample Input #3

(Inputs for plan #3)

PART A-- Required Input Data (Group one data) Form[1]

Card 1

1. General Information

a) Name Hypothetical Farm
(1-25)

b) Crop District 04
(26-27)

2. Output Header Information

a) No. of alternative plans to be simulated is 03 (28-29) of which this is the 03 (30-31) (1st, 2nd, 3rd, or other).

b) Other identifying information to be printed: Plan #3--Expand operation by 50%.
(32-80)

Card 2

3. Year of Operation

The operation of calendar year 19 74 (1-2) is being simulated.

4. Year of Prices and Costs

Prices and costs from year 19 73 (3-4) are to be used.

5. Livestock Numbers Information

a) Beginning Inventory (Number on Jan. 1st by category)

No. of bulls 004 (5-7)

No. of cows 100 (8-10)

---

[1]This form should be filled for each farm plan to be simulated.

No. of calves by age (months)

Age	0	1	2	3	4	5	6
Number	0	0	0	0	0	0	0
	(11-13)	(14-16)	(17-19)	(20-22)	(23-25)	(26-28)	(29-31)

No. of replacement heifers by age (months)

Age	7	8	9	10	11	12	13	14
Number	0	21	0	0	0	0	0	0
	(32-34)	(35-37)	(38-40)	(41-43)	(44-46)	(47-49)	(50-52)	(53-55)

Card 3

Age	15	16	17	18	19	20	21	22
Number	0	0	0	0	0	0	0	0
	(1-3)	(4-6)	(7-9)	(10-12)	(13-15)	(16-18)	(19-21)	(22-24)

Age	23	24	25	26	27	28	29	30
Number	0	0	0	0	0	0	0	0
	(25-27)	(28-30)	(31-33)	(34-36)	(37-39)	(40-42)	(43-45)	(46-48)

b) Natural Occurrence Expected

Category of Livestock	Number Born Alive	Number of Deaths	No. of Culls (sold)
Bulls	X	0 (49-51)	0 (52-54)
Cows	X	6 (55-57)	18 (58-60)
Calves (0-6 mos.)	135 (61-63)	9 (64-66)	X
Replacement Heifers	X	2 (67-69)	6 (70-72)

Card 4

6. Buildings Used for the Cow-Calf Enterprise

a) Sheds or Barns

Size (sq. ft.)	Age[2]	Wired and Insulated[3]
4820 (1-5)	10 (6-7)	1 (8)
2385 (9-13)	0 (14-15)	1 (16)
(17-21)	(22-23)	(24)
(25-29)	(30-31)	(32)
(33-37)	(38-39)	(40)

[2]Age refers to the age at the beginning of the year.

[3]Put a "1" if building is wired and insulated and a "2" if building is not wired or not insulated.

b) Hay Storage Facilities

Size (tons)	Age
(41-45)	(46-47)
(48-52)	(53-54)
(55-59)	(60-61)

Card 5

c) Grain Storage Facilities

Size (bu.)	Age	Type code[4]
1600 (1-5)	10 (6-7)	2 (8)
800 (9-13)	10 (14-15)	2 (16)
1200 (17-21)	0 (22-23)	2 (24)

d) Silos

Size (tons)	Age	Type code[5]
(25-29)	(30-31)	(32)
(33-37)	(38-39)	(40)
(41-45)	(46-47)	(48)

[4]Codes are 1--wood, 2--steel.

[5]Codes are 1--bunker, 2--concrete, 3--sealed.

Card 6

7. Fences, Pens, Corrals, and Working Chutes Used for the Cow-Calf Enterprise

a) Fences

Perimeter length (mi.)	Age
3.6	10
(1-6)	(7-8)
1.8	10
(9-14)	(15-16)
(17-22)	(23-24)

b) Pens, Corrals, and Working Chutes

Perimeter length (ft.)	Age
400	10
(25-32)	(33-34)
200	0
(35-42)	(43-44)
(45-52)	(53-54)

8. Machinery and Equipment

	Description[6]	Age (years)	Life (years)	Present Replacement Value[7] ($)	Portion Used in the Cow-Calf Enterprise (fraction)
Card 7	Manure Spreader	01	20	2,000.00	1.00
Card 8	Tractor	10	20	5000.00	.30
Card 9	Pick-up Truck	10	20	2400.00	.30
Card 10	Front-end Loader	10	20	1058.00	.50
Card 11	Feeding Equipment	10	20	1550.00	1.00
Card 12	Loading chute	0	20	50.00	1.00
Card 13	Grain auger	10	20	500.00	.30
Card 14	Feeding Equipment	0	20	1000.00	1.00
Card 15					
Card 16					
	(1-20)	(21-22)	(23-24)	(25-32)	(33-36)

Card 17

9. Systems (choose the most suitable number)

a) Feeding System: (1. Hand feeding 2. Self feeding 3. Mechanized feeding) 2 (1)

---

[6]Description of machinery or equipment should be given using less than 20 letters.

[7]Present Replacement Value refers to the current cost of replacing the machine or piece of equipment with a new machine or piece of equipment of the same size and type.

b) Manure and Bedding Removal System:

(1. Manual
2. Mechanical) 2
(2)

10. Summer Activities (indicate with 1 for yes and 0 for no).

Category	a) Sent to pasture during summer	b) Fed a ration during summer	c) Kept inside during summer
Bulls	1 (3)	0 (4)	0 (5)
Cows	1 (6)	0 (7)	0 (8)
Calves (0-6 mos.)	1 (9)	0 (10)	0 (11)
Heifers (7-18 mos.)	1 (12)	0 (13)	0 (14)
Heifers (over 18 mos.)	1 (15)	0 (16)	0 (17)

11. Vitamins (injected or fed apart from those provided in the regular rations given below in Questions #15 and #16.)

No. of treatments	Month given	Vitamin code[8]
150 (18-20)	2 (21-22)	2 (23)
150 (24-26)	11 (27-28)	2 (29)
32 (30-32)	11 (33-34)	1 (35)

[8]Vitamin codes: 1--vitamin A,D,E (for growing animals), 2--vitamin A,D,E (for mature animals), 3--user defined vitamin.

12. Vaccinations

No. of vaccinations	Month given	Vaccination code[9]
135	5	2
(36-38)	(39-40)	(41)
32	10	2
(42-44)	(45-46)	(47)
32	10	3
(48-50)	(51-52)	(53)
(54-56)	(57-58)	(59)
(60-62)	(63-64)	(65)

13. Artifical Insemination

No. of cows bred with A.I. 0 (66-68)

Card 18

14. Pasturing Practices

a) Pasture Resources Available for the Cow-Calf Enterprise

No. of acres	Improved--1 Unimproved--2	Owned--1 Rented--2
264	1	1
(1-4)	(5)	(6)
133	1	2
(7-10)	(11)	(12)
(13-16)	(17)	(18)
(19-22)	(23)	(24)

[9]Vaccination Codes: 1--IBR; 2--Blackleg; 3--Malignant Edema; 4-- 3-way; 5--user defined vaccination.

b) Fertilizer Applied on Pasture Grazed by the Cow-Calf Herd

Code[10]	Total No. of tons
(25)	(26-32)
(33)	(34-40)
(41)	(42-48)
(49)	(50-56)
(57)	(58-60)

---

[10] Fertilizer Codes:
1. 11-55-0
2. 11-48-0
3. 34-0-0
4. 46-0-0
5. 24-0-0
6. User defined fertilizer.

Cards 19-26

15. Winter Rations (in pound per day)

CARD	Feed	Bulls	Lactating Cows	Gestating Cows	Dry Cows	Calves (0-6 mos.)	Replacement Heifers (7-18 mos.)	Replacement Heifers (over 18 mos.)
19	Tame Hay	20	23	18	18		12	
20	Native Hay							
21	Grain	4	5				4	
22	Supplement							
23	Silage							
24	User Defined feed #1							
25	User Defined feed #2							
26	Salt and Minerals Code[11]	4	4	4	4	4	4	
		(1-5)	(6-10)	(11-15)	(16-20)	(21-25)	(26-30)	(31-35)

---

[11] Salt and Minerals Code:
1--No salt, no minerals
2--Salt, no minerals
3--Minerals, no salt
4--Salt and minerals.

Cards 27-34

16. Summer Rations (in pound per day) Excluding Pasture

CARD	Feed	Bulls	Lactating Cows	Gestating Cows	Dry cows	Calves (0-6 mos.)	Replacement Heifers (7-18 mos.)	Replacement Heifers (over 18 mos.)
27	Tame Hay							
28	Native Hay							
29	Grain							
30	Supplement							
31	Silage							
32	User Defined feed #1							
33	User Defined feed #2							
34	Salt and Minerals Code[12]	4	4	4	4	4	4	
		(1-5)	(6-10)	(11-15)	(16-20)	(21-25)	(26-30)	(31-35)

[12]Salt and Minerals Code:
1--No salt, no minerals
2--Salt, no minerals
3--Minerals, no salt
4--Salt and minerals.

Card 35

17. Expected Rates of Gain (in lbs. per day)

a) Average rate of gain expected for heifers (7-18 mos.) 1.50 (1-4).

b) Average rate of gain expected for heifers (over 18 mos.) ______ (5-8).

18. Bedding Used

Straw -- (Yes = 1; No = 0) 1 (9).

User defined -- (Yes = 1; No = 0) 0 (10).

PART B-- Form for Making Changes to Group II Data

Card 36

0	1	1	0	8			3	.	0	
1	2	3	4	5	6	7	8	9	10	←column number

Note: Labor required for fence repair is 3.0 hours per mile.

Card 37

0	1	3	0	5		1	.	8	0	
1	2	3	4	5	6	7	8	9	10	←column number

Note: Non-creep fed calves gain 1.80 pounds per day.

Card 38

0	2	0	1	2			0	5	0	
1	2	3	4	5	6	7	8	9	10	←column number

Note: Purchases 50 D3-cows on Jan. 31, 1974.

Card 39

0	2	0	1	1			0	0	2	
1	2	3	4	5	6	7	8	9	10	←column number

Note: Purchases 2 bulls on Jan. 31, 1974.

Card 40

0	2	0	1	4	0	9	0	1	1	
1	2	3	4	5	6	7	8	9	10	←column number

Note: Purchases 11 nine month old replacement heifers on Jan. 31, 1974.

Card 41

0	1	1	1	7			3	.	0	
1	2	3	4	5	6	7	8	9	10	←column number

Note: Labor required to check herd while on pasture is 3.0 hours per month.

(continued)

(add more pages if required)

PART B-- Form for Making Changes to Group II Data

Card 42

1	2	3	4	5	6	7	8	9	10
0	4	3			5	0	.	0	0

← column number

Note: A loading chute costing $50.00 is purchased.

Card 43

1	2	3	4	5	6	7	8	9	10
0	4	2		2	2	0	.	0	0

← column number

Note: A corral costing $220.00 is constructed.

Card 44

1	2	3	4	5	6	7	8	9	10
0	4	3	1	0	0	0	.	0	0

← column number

Note: Feeding equipment costing $1000.00 is purchased.

Card 45

1	2	3	4	5	6	7	8	9	10
0	4	1		4	0	8	.	0	0

← column number

Note: A grain bin costing $408.00 is purchased.

Card 46

1	2	3	4	5	6	7	8	9	10
0	4	1	9	4	9	2	.	3	0

← column number

Note: A barn costing $9492.30 is constructed.

Card 47

1	2	3	4	5	6	7	8	9	10
0	1	3	9	7		.	0	4	6

← column number

Note: Cost of grain is 4.6 cents per pound.

(add more pages if required)

APPENDIX E

APPENDIX E

SAMPLE OUTPUTS FROM THE SIMULATION MODEL

This appendix also serves two purposes. First, it displays the outputs which one obtains from the computerized cow-calf simulation model. Secondly, it provides the simulated results of the three alternative plans submitted for the illustrative cow-calf enterprise discussed in Chapter IV.

Three sample outputs from the computerized cow-calf simulation model are given in this appendix. Each output contains: (1) a monthly cattle numbers summary, (2) an annual cattle numbers summary, (3) a physical and dollar record summary, (4) a list of management indicators, (5) a labor requirements by month table, and (6) an annual cash flow.

The first sample output corresponds to the results of farm plan #1, the second to farm plan #2, and the third to farm plan #3. The three sample outputs are given one by one in the pages which follow.

OUTPUT FROM THE COW-CALF SIMULATION MODEL

Sample Output #1

(Output for Plan #1)

OUTPUTS FROM THE COW-CALF SIMULATION MODEL

NAME:HYPOTHETICAL FARM

CROP DISTRICT: 4

PLAN NUMBER 1 OF 3 ALTERNATIVE PLANS HAS BEEN SIMULATED

HEADER INFORMATION: PLAN NUMBER 1 - NO CHANGE IN COW-CALF OPERATION

YEAR OF OPERATION IS: 1974

PRICES AND COSTS FROM YEAR 1973 ARE TO BE USED

PLAN NUMBER 1

1. 1974 MONTHLY LIVESTOCK NUMBERS TABLE

ANIMAL CATEGORY	BEGINNING	BORN	BOUGHT	SOLD	DIED	END
--- JANUARY ---						
BULLS	4	0	0	0	0	4
COWS	100	0	0	0	0	100
CALVES (0-6MOS)	0	0	0	0	0	0
HEIFERS (7-18MOS)	21	0	0	0	0	21
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- FEBRUARY ---						
BULLS	4	0	0	0	0	4
COWS	100	0	0	0	1	99
CALVES (0-6MOS)	0	0	0	0	0	0
HEIFERS (7-18MOS)	21	0	0	0	0	21
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- MARCH ---						
BULLS	4	0	0	0	0	4
COWS	99	0	0	0	0	99
CALVES (0-6MOS)	0	0	0	0	0	0
HEIFERS (7-18MOS)	21	0	0	0	0	21
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- APRIL ---						
BULLS	4	0	0	0	0	4
COWS	99	0	0	0	0	99
CALVES (0-6MOS)	0	90	0	0	0	90
HEIFERS (7-18MOS)	21	0	0	0	1	20
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- MAY ---						
BULLS	4	0	0	0	0	4
COWS	99	0	0	0	1	98
CALVES (0-6MOS)	90	0	0	0	1	89
HEIFERS (7-18MOS)	20	0	0	4	0	16
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- JUNE ---						
BULLS	4	0	0	0	0	4
COWS	98	0	0	0	0	98
CALVES (0-6MOS)	89	0	0	0	1	88
HEIFERS (7-18MOS)	16	0	0	0	0	16
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- JULY ---						
BULLS	4	0	0	0	0	4
COWS	98	0	0	0	0	98
CALVES (0-6MOS)	88	0	0	0	1	87
HEIFERS (7-18MOS)	16	0	0	0	0	16
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- AUGUST ---						
BULLS	4	0	0	0	0	4
COWS	98	0	0	0	1	97
CALVES (0-6MOS)	87	0	0	0	1	86
HEIFERS (7-18MOS)	16	0	0	0	0	16
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- SEPTEMBER ---						
BULLS	4	0	0	0	0	4
COWS	97	0	0	0	0	97
CALVES (0-6MOS)	86	0	0	0	1	85
HEIFERS (7-18MOS)	16	0	0	0	0	16
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- OCTOBER ---						
BULLS	4	0	0	0	0	4
COWS	97	0	0	12	0	101
CALVES (0-6MOS)	85	0	0	63	1	0
HEIFERS (7-18MOS)	16	0	0	0	0	21
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- NOVEMBER ---						
BULLS	4	0	0	0	0	4
COWS	101	0	0	0	1	100
CALVES (0-6MOS)	0	0	0	0	0	0
HEIFERS (7-18MOS)	21	0	0	0	0	21
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- DECEMBER ---						
BULLS	4	0	0	0	0	4
COWS	100	0	0	0	0	100
CALVES (0-6MOS)	0	0	0	0	0	0
HEIFERS (7-18MOS)	21	0	0	0	0	21
HEIFERS (OVER 18MOS)	0	0	0	0	0	0

PLAN NUMBER 1

2. 1974 ANNUAL LIVESTOCK NUMBERS TABLE

ANIMAL CATEGORY	BEGINNING	BORN	BOUGHT	SOLD	DIED	END
BULLS	4	0	0	0	0	4
COWS	100	0	0	12	4	100
CALVES(0-6MOS)	0	90	0	63	6	0
HEIFERS(7-18MOS)	21	0	0	4	1	21
HEIFERS(OVER18MOS)	0	0	0	0	0	0

PLAN NUMBER 1

3. 1974 SUMMARY OF PHYSICAL AND DOLLAR RECORD (1973$)

	PHYSICAL RECORD		DOLLAR RECORD	
INPUTS				
BUILDINGS				
-BARN # 1	- REPLACEMENT VALUE -	19183.60		
	- CURRENT VALUE -	9591.80		
	- REPAIR COST -		335.71	
-GRAIN BIN# 1	- REPLACEMENT VALUE -	544.00		
	- CURRENT VALUE -	272.00		
	- REPAIR COST -		9.52	
-GRAIN BIN# 2	- REPLACEMENT VALUE -	272.00		
	- CURRENT VALUE -	136.00		
	- REPAIR COST -		4.76	
	TOTAL REPAIR COST OF BUILDINGS			349.99
FENCES AND CORRALS				
-FENCE # 1	- REPLACEMENT VALUE -	2792.88		
	- CURRENT VALUE -	1396.44		
	- REPAIR COST -		48.88	
-CORRAL # 1	- REPLACEMENT VALUE -	440.00		
	- CURRENT VALUE -	220.00		
	- REPAIR COST -		7.70	
	TOTAL REPAIR COST OF FENCES AND CORRALS			56.58
MACHINERY AND EQUIPMENT				
-MANURE SPREADER	- REPLACEMENT VALUE -	2000.00		
	- CURRENT VALUE -	1910.00		
	- PORTION USED -	1.00		
	- REPAIR COST -		35.00	
-TRACTOR	- REPLACEMENT VALUE -	5000.00		
	- CURRENT VALUE -	2750.00		
	- PORTION USED -	0.30		
	- REPAIR COST -		26.25	
-PICK-UP TRUCK	- REPLACEMENT VALUE -	2400.00		
	- CURRENT VALUE -	1320.00		
	- PORTION USED -	0.30		
	- REPAIR COST -		12.60	
-FRONT-END LOADER	- REPLACEMENT VALUE -	1058.00		

(continued)

	- CURRENT VALUE -	581.90				
	- PORTION USED -	0.50				
	- REPAIR COST -				9.26	
-FEEDING EQUIPMENT	- REPLACEMENT VALUE -	1550.00				
	- CURRENT VALUE -	852.50				
	- PORTION USED -	1.00				
	- REPAIR COST -				27.13	
-LOADING CHUTE	- REPLACEMENT VALUE -	50.00				
	- CURRENT VALUE -	50.00				
	- PORTION USED -	1.00				
	- REPAIR COST -				0.88	
-GRAIN AUGER	- REPLACEMENT VALUE -	500.00				
	- CURRENT VALUE -	275.00				
	- PORTION USED -	0.30				
	- REPAIR COST -				2.63	
TOTAL REPAIR COST OF MACHINERY AND EQUIPMENT						113.73
FEED						
-UNIMPROVED PASTURE	- TAXES -	0	ACRES X	0.42=	0.00	
	- RENT -	0	ACRES X	5.38=	0.00	
-IMPROVED PASTURE	- TAXES -	264	ACRES X	1.26=	332.64	
	- RENT -	0	ACRES X	16.14=	0.00	
-FERTILIZER		0.000	TONS	=	0.00	
-SUMMER FEED	- TAME HAY -	0.0	LBS X	0.015=	0.00	
	- NATIVE HAY -	0.0	LBS X	0.011=	0.00	
	- GRAIN -	0.0	LBS X	0.046=	0.00	
	- SUPPLEMENT -	0.0	LBS X	0.043=	0.00	
	- SILAGE -	0.0	LBS X	0.006=	0.00	
	- USER DEFINED FEED#1 -	0.0	LBS X	0.000=	0.00	
	- USER DEFINED FEED#2 -	0.0	LBS X	0.000=	0.00	
-WINTER FEED	- TAME HAY -	459780.0	LBS X	0.015=	6896.70	
	- NATIVE HAY -	0.0	LBS X	0.011=	0.00	
	- GRAIN -	34380.0	LBS X	0.046=	1581.48	
	- SUPPLEMENT -	0.0	LBS X	0.043=	0.00	
	- SILAGE -	0.0	LBS X	0.006=	0.00	
	- USER DEFINED FEED#1 -	0.0	LBS X	0.000=	0.00	
	- USER DEFINED FEED#2 -	0.0	LBS X	0.000=	0.00	
-SALTS		3490.8	LBS X	0.027=	94.25	
-MINERALS		6954.2	LBS X	0.072=	500.70	
TOTAL COST OF FEED						9405.77
BEDDING	- STRAW -	211320.0	LBS X	0.008=	1690.56	

(continued)

	- USER DEFINED BEDDING -	0.0 LBS		0.00		
TOTAL COST OF BEDDING					1690.56	
HEALTH CARE						
-VITAMINS	- A,D,E (GROWING ANIMALS) -	21 TREATMENTS X	0.07=	1.47		
	- A,D,E (MATURE ANIMALS) -	200 TREATMENTS X	0.17=	34.00		
	- USER DEFINED -	0 TREATMENTS	=	0.00		
-VACCINATIONS	- IBR -	0 TREATMENTS X	0.17=	0.00		
	- BLACKLEG -	111 TREATMENTS X	0.13=	14.43		
	- MALIGNANT EDEMA -	21 TREATMENTS X	0.11=	2.31		
	- 3-WAY -	0 TREATMENTS X	0.41=	0.00		
	- USER DEFINED -	0 TREATMENTS	=	0.00		
TOTAL HEALTH CARE COST					52.21	
ARTIFICIAL INSEMINATION		0 SERVICES X	10.75=		0.00	
MISCELLANEOUS EXPENSES		99 COWS X	5.61=		555.39	
LABOR						
-FEEDING		1137.1 HOURS X	2.10 =	2387.93		
-MANURE AND BEDDING REMOVAL		306.8 HOURS X	2.10 =	644.36		
- 221 VITAMIN TREATMENTS		22.1 HOURS X	2.10 =	46.41		
- 132 VACCINATIONS		13.2 HOURS X	2.10 =	27.72		
- 90 DEHORNINGS		22.5 HOURS X	2.10 =	47.25		
- 45 CASTRATIONS		11.3 HOURS X	2.10 =	23.63		
-REPAIR 3.6 MILES OF FENCE		10.8 HOURS X	2.10 =	22.68		
-CHECKING HERD ON PASTURE		10.0 HOURS X	2.10 =	21.00		
TOTAL LABOR COSTS					3220.98	
DEPRECIATION						
-BUILDINGS				999.98		
-FENCES AND CORRALS				161.64		
-MACHINERY AND EQUIPMENT				292.45		
TOTAL DEPRECIATION COSTS					1454.08	
INVESTMENT						
-BUILDINGS				854.98		
-FENCES AND CORRALS				138.21		
-MACHINERY AND EQUIPMENT				383.46		
-PASTURE				3927.53		
-LIVESTOCK				4220.21		
TOTAL INVESTMENT COST					9524.39	
TOTAL COSTS						26423.66

(continued)

OUTPUTS OR GROSS RETURNS

BEGINNING INVENTORY	4 BULLS	2022.80		
	100 COWS	39935.98		
	0 CALVES (0-6MOS)	0.00		
	21 HEIFERS (7-18MOS)	4645.22		
	0 HEIFERS (OVER18MOS)	0.00		
TOTAL VALUE OF BEGINNING INVENTORY			-46604.00	
SALES	0 BULLS	0.00		
	12 COWS	4340.16		
	63 CALVES (0-6MOS)	13850.36		
	4 HEIFERS (7-18MOS)	1075.01		
	0 HEIFERS (OVER18MOS)	0.00		
TOTAL VALUE OF SALES			19265.52	
PURCHASES	0 BULLS	0.00		
	0 COWS	0.00		
	0 CALVES (0-6MOS)	0.00		
	0 HEIFERS (7-18MOS)	0.00		
	0 HEIFERS (OVER18MOS)	0.00		
TOTAL VALUE OF PURCHASES			0.00	
ENDING INVENTORY	4 BULLS	2022.80		
	100 COWS	39935.98		
	0 CALVES (0-6MOS)	0.00		
	21 HEIFERS (7-18MOS)	4645.22		
	0 HEIFERS (OVER18MOS)	0.00		
TOTAL VALUE OF CLOSING INVENTORY			46604.00	
TOTAL GROSS RETURNS				19265.52

NOTE : TOTAL VALUE OF BEGINNING INVENTORY IS GIVEN A NEGATIVE VALUE BECAUSE IN CALCULATING TOTAL GROSS RETURNS NET INVENTORY IS REQUIRED. NET INVENTORY EQUALS ENDING INVENTORY MINUS BEGINNING INVENTORY.

PLAN NUMBER 1

4. 1974 MANAGEMENT INDICATORS TABLE

A. PHYSICAL MANAGEMENT INDICATORS

1. WEANING WEIGHT (LBS)		404.00
2. % CALVES BORN ALIVE (%)		90.91
3. % CALF CROP WEANED (%)		93.33
4. DAILY RATE OF GAIN OF	CALVES (LBS)	1.80
	HEIFERS (7-18 MOS) (LBS)	1.50
	HEIFERS (OVER 18 MOS) (LBS)	0.00
5. % DEATH LOSS OF	COWS AND BULLS (%)	3.89
	CALVES (%)	13.71
	HEIFERS (%)	5.31

B. OVERALL FINANCIAL MANAGEMENT INDICATORS (1973$)

1. RETURNS TO LABOR, INVESTMENT, AND MANAGEMENT	5587.23
2. (A) RETURNS TO LABOR AND MANAGEMENT	-3937.16
(B) RETURNS TO LABOR AND MANAGEMENT (PER HOUR OF LABOR)	-2.57
3. (A) RETURNS TO INVESTMENT AND MANAGEMENT	2366.25
(B) RETURNS TO INVESTMENT AND MANAGEMENT (AS A % OF INV.)	2.24
4. NET RETURNS TO MANAGEMENT	-7158.14

PLAN NUMBER 1

5. 1974 LABOR REQUIREMENTS BY MONTH TABLE

MONTH	HOURS OF LABOR REQUIRED					
	FEEDING	MANURE AND BEDDING REMOVAL	HEALTH CARE	FENCE REPAIR	CHECKING HERD WHILE ON PASTURE	TOTAL
JANUARY	179.5	42.8	0.0	0.0	0.0	222.3
FEBRUARY	149.0	42.8	10.0	0.0	0.0	201.8
MARCH	200.3	42.4	0.0	0.0	0.0	242.8
APRIL	158.3	42.4	0.0	0.0	0.0	200.7
MAY	172.0	50.3	42.8	10.8	0.0	275.8
JUNE	0.0	0.0	0.0	0.0	2.0	2.0
JULY	0.0	0.0	0.0	0.0	2.0	2.0
AUGUST	0.0	0.0	0.0	0.0	2.0	2.0
SEPTEMBER	0.0	0.0	0.0	0.0	2.0	2.0
OCTOBER	0.0	0.0	4.2	0.0	2.0	6.2
NOVEMBER	128.4	43.2	12.1	0.0	0.0	183.6
DECEMBER	149.7	42.8	0.0	0.0	0.0	192.5
TOTAL	1137.1	306.8	69.0	10.8	10.0	1533.8

PLAN NUMBER 1

6. 1974 ANNUAL CASH FLOW OF THE COW-CALF ENTERPRISE (1973$)

EXPENSES

REPAIRS	520.30	
FEED - TAXES	332.64	
- RENT	0.00	
- FERTILIZER	0.00	
- TAME HAY	6896.70	
- NATIVE HAY	0.00	
- GRAIN	1581.48	
- SUPPLEMENT	0.00	
- SILAGE	0.00	
- USER DEFINED FEED#1	0.00	
- USER DEFINED FEED#2	0.00	
- SALTS	94.25	
- MINERALS	500.70	
BEDDING	1690.56	
HEALTH CARE	52.21	
ARTIFICIAL INSEMINATION	0.00	
MISCELLANEOUS EXPENSES	555.39	
CASH PURCHASES - LIVESTOCK	0.00	
- BUILDINGS	0.00	
- FENCES AND CORRALS	0.00	
- MACHINERY AND EQUIPMENT	50.00	
- PASTURE	0.00	
TOTAL EXPENSES		12274.21

SALES

LIVESTOCK	19265.52	
BUILDINGS	0.00	
FENCES AND CORRALS	0.00	
MACHINERY AND EQUIPMENT	0.00	
PASTURE	0.00	
TOTAL SALES		19265.52

NET CASH STATEMENT

NET CASH STATEMENT	6991.30

OUTPUT FROM THE COW-CALF SIMULATION MODEL

Sample Output #2

(Output for Plan #2)

OUTPUTS FROM THE COW-CALF SIMULATION MODEL

NAME:HYPOTHETICAL FARM

CROP DISTRICT: 4

PLAN NUMBER 2 OF 3 ALTERNATIVE PLANS HAS BEEN SIMULATED

HEADER INFORMATION: PLAN # 2 NO REPLACEMENT STOCK ; INCREASE COWS 10%

YEAR OF OPERATION IS: 1974

PRICES AND COSTS FROM YEAR 1973 ARE TO BE USED

PLAN NUMBER 2

1. 1974 MONTHLY LIVESTOCK NUMBERS TABLE

ANIMAL CATEGORY	BEGINNING	BORN	BOUGHT	SOLD	DIED	END
--- JANUARY ---						
BULLS	4	0	0	0	0	4
COWS	100	0	10	0	0	110
CALVES (0-6MOS)	0	0	0	0	0	0
HEIFERS (7-18MOS)	21	0	0	21	0	0
HEIFERS (OVER18MOS)	0	0	0	0	0	0
--- FEBRUARY ---						
BULLS	4	0	0	0	0	4
COWS	110	0	0	0	1	109
CALVES (0-6MOS)	0	0	0	0	0	0
HEIFERS (7-18MOS)	0	0	0	0	0	0
HEIFERS (OVER18MOS)	0	0	0	0	0	0
--- MARCH ---						
BULLS	4	0	0	0	0	4
COWS	109	0	0	0	0	109
CALVES (0-6MOS)	0	0	0	0	0	0
HEIFERS (7-18MOS)	0	0	0	0	0	0
HEIFERS (OVER18MOS)	0	0	0	0	0	0
--- APRIL ---						
BULLS	4	0	0	0	0	4
COWS	109	0	0	0	0	109
CALVES (0-6MOS)	0	99	0	0	0	99
HEIFERS (7-18MOS)	0	0	0	0	0	0
HEIFERS (OVER18MOS)	0	0	0	0	0	0
--- MAY ---						
BULLS	4	0	0	0	0	4
COWS	109	0	0	0	1	108
CALVES (0-6MOS)	99	0	0	0	1	98
HEIFERS (7-18MOS)	0	0	0	0	0	0
HEIFERS (OVER18MOS)	0	0	0	0	0	0
--- JUNE ---						
BULLS	4	0	0	0	0	4
COWS	108	0	0	0	0	108
CALVES (0-6MOS)	98	0	0	0	1	97
HEIFERS (7-18MOS)	0	0	0	0	0	0
HEIFERS (OVER18MOS)	0	0	0	0	0	0
--- JULY ---						
BULLS	4	0	0	0	0	4
COWS	108	0	0	0	0	108
CALVES (0-6MOS)	97	0	0	0	1	96
HEIFERS (7-18MOS)	0	0	0	0	0	0
HEIFERS (OVER18MOS)	0	0	0	0	0	0
--- AUGUST ---						
BULLS	4	0	0	0	0	4
COWS	108	0	0	0	1	107
CALVES (0-6MOS)	96	0	0	0	1	95
HEIFERS (7-18MOS)	0	0	0	0	0	0
HEIFERS (OVER18MOS)	0	0	0	0	0	0
--- SEPTEMBER---						
BULLS	4	0	0	0	0	4
COWS	107	0	0	0	0	107
CALVES (0-6MOS)	95	0	0	0	1	94
HEIFERS (7-18MOS)	0	0	0	0	0	0
HEIFERS (OVER18MOS)	0	0	0	0	0	0
--- OCTOBER ---						
BULLS	4	0	0	0	0	4
COWS	107	0	0	12	0	111
CALVES (0-6MOS)	94	0	0	92	2	0
HEIFERS (7-18MOS)	0	0	16	0	0	0
HEIFERS (OVER18MOS)	0	0	0	0	0	0
--- NOVEMBER ---						
BULLS	4	0	0	0	0	4
COWS	111	0	0	0	1	110
CALVES (0-6MOS)	0	0	0	0	0	0
HEIFERS (7-18MOS)	0	0	0	0	0	0
HEIFERS (OVER18MOS)	0	0	0	0	0	0
--- DECEMBER ---						
BULLS	4	0	0	0	0	4
COWS	110	0	0	0	0	110
CALVES (0-6MOS)	0	0	0	0	0	0
HEIFERS (7-18MOS)	0	0	0	0	0	0
HEIFERS (OVER18MOS)	0	0	0	0	0	0

PLAN NUMBER 2

2. 1974 ANNUAL LIVESTOCK NUMBERS TABLE

ANIMAL CATEGORY	BEGINNING	BORN	BOUGHT	SOLD	DIED	END
BULLS	4	0	0	0	0	4
COWS	100	0	10	12	4	110
CALVES (0-6MOS)	0	99	0	92	7	0
HEIFERS (7-18MOS)	21	0	16	21	0	0
HEIFERS (OVER 18MOS)	0	0	0	0	0	0

PLAN NUMBER 2

3. 1974 SUMMARY OF PHYSICAL AND DOLLAR RECORD (1973$)

	PHYSICAL RECORD		DOLLAR RECORD	
INPUTS				
BUILDINGS				
-BARN # 1	- REPLACEMENT VALUE -	19183.60		
	- CURRENT VALUE -	9591.80		
	- REPAIR COST -		335.71	
-GRAIN BIN# 1	- REPLACEMENT VALUE -	544.00		
	- CURRENT VALUE -	272.00		
	- REPAIR COST -		9.52	
-GRAIN BIN# 2	- REPLACEMENT VALUE -	272.00		
	- CURRENT VALUE -	136.00		
	- REPAIR COST -		4.76	
	TOTAL REPAIR COST OF BUILDINGS			349.99
FENCES AND CORRALS				
-FENCE # 1	- REPLACEMENT VALUE -	2792.88		
	- CURRENT VALUE -	1396.44		
	- REPAIR COST -		48.88	
-CORRAL # 1	- REPLACEMENT VALUE -	440.00		
	- CURRENT VALUE -	220.00		
	- REPAIR COST -		7.70	
	TOTAL REPAIR COST OF FENCES AND CORRALS			56.58
MACHINERY AND EQUIPMENT				
-MANURE SPREADER	- REPLACEMENT VALUE -	2000.00		
	- CURRENT VALUE -	1910.00		
	- PORTION USED -	1.00		
	- REPAIR COST -		35.00	
-TRACTOR	- REPLACEMENT VALUE -	5000.00		
	- CURRENT VALUE -	2750.00		
	- PORTION USED -	0.30		
	- REPAIR COST -		26.25	
-PICK-UP TRUCK	- REPLACEMENT VALUE -	2400.00		
	- CURRENT VALUE -	1320.00		
	- PORTION USED -	0.30		
	- REPAIR COST -		12.60	
-FRONT-END LOADER	- REPLACEMENT VALUE -	1058.00		

(continued)

Item	Component	Quantity	Rate	Cost	Total
	- CURRENT VALUE -	581.90			
	- PORTION USED -	0.50			
	- REPAIR COST -			9.26	
-FEEDING EQUIPMENT	- REPLACEMENT VALUE -	1550.00			
	- CURRENT VALUE -	852.50			
	- PORTION USED -	1.00			
	- REPAIR COST -			27.13	
-LOADING CHUTE	- REPLACEMENT VALUE -	50.00			
	- CURRENT VALUE -	50.00			
	- PORTION USED -	1.00			
	- REPAIR COST -			0.88	
-GRAIN AUGER	- REPLACEMENT VALUE -	500.00			
	- CURRENT VALUE -	275.00			
	- PORTION USED -	0.30			
	- REPAIR COST -			2.63	
TOTAL REPAIR COST OF MACHINERY AND EQUIPMENT					113.73
FEED					
-UNIMPROVED PASTURE	- TAXES -	0 ACRES	X 0.42=	0.00	
	- RENT -	0 ACRES	X 5.38=	0.00	
-IMPROVED PASTURE	- TAXES -	264 ACRES	X 1.26=	332.64	
	- RENT -	0 ACRES	X 16.14=	0.00	
-FERTILIZER		0.000 TONS	=	0.00	
-SUMMER FEED	- TAME HAY -	0.0 LBS	X 0.015=	0.00	
	- NATIVE HAY -	0.0 LBS	X 0.011=	0.00	
	- GRAIN -	0.0 LBS	X 0.046=	0.00	
	- SUPPLEMENT -	0.0 LBS	X 0.043=	0.00	
	- SILAGE -	0.0 LBS	X 0.006=	0.00	
	- USER DEFINED FEED#1 -	0.0 LBS	X 0.000=	0.00	
	- USER DEFINED FEED#2 -	0.0 LBS	X 0.000=	0.00	
-WINTER FEED	- TAME HAY -	448530.0 LBS	X 0.015=	6727.95	
	- NATIVE HAY -	0.0 LBS	X 0.011=	0.00	
	- GRAIN -	20730.0 LBS	X 0.046=	953.58	
	- SUPPLEMENT -	0.0 LBS	X 0.043=	0.00	
	- SILAGE -	0.0 LBS	X 0.006=	0.00	
	- USER DEFINED FEED#1 -	0.0 LBS	X 0.000=	0.00	
	- USER DEFINED FEED#2 -	0.0 LBS	X 0.000=	0.00	
-SALTS		3454.0 LBS	X 0.027=	93.26	
-MINERALS		6875.4 LBS	X 0.072=	495.03	
TOTAL COST OF FEED					8602.45
BEDDING	- STRAW -	204300.0 LBS	X 0.008=	1634.40	

(continued)

	- USER DEFINED BEDDING -	0.0 LBS	0.00		
	TOTAL COST OF BEDDING			1634.40	
HEALTH CARE					
-VITAMINS	- A,D,E (GROWING ANIMALS) -	0 TREATMENTS X 0.07=	0.00		
	- A,D,E (MATURE ANIMALS) -	220 TREATMENTS X 0.17=	37.40		
	- USER DEFINED -	0 TREATMENTS =	0.00		
-VACCINATIONS	- IBP -	0 TREATMENTS X 0.17=	0.00		
	- BLACKLEG -	99 TREATMENTS X 0.13=	12.87		
	- MALIGNANT EDEMA -	0 TREATMENTS X 0.11=	0.00		
	- 3-WAY -	0 TREATMENTS X 0.41=	0.00		
	- USER DEFINED -	0 TREATMENTS =	0.00		
	TOTAL HEALTH CARE COST			50.27	
ARTIFICIAL INSEMINATION		0 SERVICES X 10.75=		0.00	
MISCELLANEOUS EXPENSES		108 COWS X 5.61=		605.88	
LABOR					
-FEEDING		1144.5 HOURS X 2.10 =	2403.50		
-MANURE AND BEDDING REMOVAL		303.0 HOURS X 2.10 =	636.30		
- 220 VITAMIN TREATMENTS		22.0 HOURS X 2.10 =	46.20		
- 99 VACCINATIONS		9.9 HOURS X 2.10 =	20.79		
- 99 DEHORNINGS		24.8 HOURS X 2.10 =	51.98		
- 50 CASTRATIONS		12.4 HOURS X 2.10 =	25.99		
-REPAIR 3.6 MILES OF FENCE		10.8 HOURS X 2.10 =	22.68		
-CHECKING HERD ON PASTURE		10.0 HOURS X 2.10 =	21.00		
	TOTAL LABOR COSTS			3228.43	
DEPRECIATION					
-BUILDINGS			999.98		
-FENCES AND CORRALS			161.64		
-MACHINERY AND EQUIPMENT			292.45		
	TOTAL DEPRECIATION COSTS			1454.08	
INVESTMENT					
-BUILDINGS			854.98		
-FENCES AND CORRALS			138.21		
-MACHINERY AND EQUIPMENT			383.46		
-PASTURE			3927.53		
-LIVESTOCK			4101.91		
	TOTAL INVESTMENT COST			9406.09	
TOTAL COSTS					25501.89

(continued)

OUTPUTS OR GROSS RETURNS

BEGINNING INVENTORY	4 BULLS	2022.80		
	100 COWS	39935.98		
	0 CALVES(0-6MOS)	0.00		
	21 HEIFERS(7-18MOS)	4645.22		
	0 HEIFERS(OVER18MOS)	0.00		
	TOTAL VALUE OF BEGINNING INVENTORY		-46604.00	
SALES	0 BULLS	0.00		
	12 COWS	4340.16		
	92 CALVES(0-6MOS)	19830.16		
	21 HEIFERS(7-18MOS)	5079.36		
	0 HEIFERS(OVER18MOS)	0.00		
	TOTAL VALUE OF SALES		29249.68	
PURCHASES	0 BULLS	0.00		
	10 COWS	3993.60		
	0 CALVES(0-6MOS)	0.00		
	16 HEIFERS(7-18MOS)	6299.92		
	0 HEIFERS(OVER18MOS)	0.00		
	TOTAL VALUE OF PURCHASES		-10293.52	
ENDING INVENTORY	4 BULLS	2022.80		
	110 COWS	43929.58		
	0 CALVES(0-6MOS)	0.00		
	0 HEIFERS(7-18MOS)	0.00		
	0 HEIFERS(OVER18MOS)	0.00		
	TOTAL VALUE OF CLOSING INVENTORY		45952.38	
TOTAL GROSS RETURNS				18304.54

NOTE : TOTAL VALUE OF BEGINNING INVENTORY IS GIVEN A NEGATIVE VALUE BECAUSE IN CALCULATING TOTAL GROSS RETURNS NET INVENTORY IS REQUIRED. NET INVENTORY EQUALS ENDING INVENTORY MINUS BEGINNING INVENTORY.

PLAN NUMBER 2

4. 1974 MANAGEMENT INDICATORS TABLE

A. PHYSICAL MANAGEMENT INDICATORS

1. WEANING WEIGHT (LBS)	404.00
2. % CALVES BORN ALIVE (%)	90.83
3. % CALF CROP WEANED (%)	92.93
4. DAILY RATE OF GAIN OF CALVES (LBS)	1.80
HEIFERS (7-18 MOS) (LBS)	1.50
HEIFERS (OVER 18 MOS) (LBS)	0.00
5. % DEATH LOSS OF COWS AND BULLS (%)	3.57
CALVES (%)	14.51
HEIFERS (%)	0.00

B. OVERALL FINANCIAL MANAGEMENT INDICATORS (1973$)

1. RETURNS TO LABOR, INVESTMENT, AND MANAGEMENT	5437.17
2. (A) RETURNS TO LABOR AND MANAGEMENT	-3968.92
(B) RETURNS TO LABOR AND MANAGEMENT (PER HOUR OF LABOR)	-2.58
3. (A) RETURNS TO INVESTMENT AND MANAGEMENT	2208.74
(B) RETURNS TO INVESTMENT AND MANAGEMENT (AS A % OF INV.)	2.11
4. NET RETURNS TO MANAGEMENT	-7197.35

PLAN NUMBER 2

5. 1974 LABOR REQUIREMENTS BY MONTH TABLE

MONTH	HOURS OF LABOR REQUIRED					
	FEEDING	MANURE AND BEDDING REMOVAL	HEALTH CARE	FENCE REPAIR	CHECKING HERD WHILE ON PASTURE	TOTAL
JANUARY	179.5	42.8	0.0	0.0	0.0	222.3
FEBRUARY	150.8	42.0	11.0	0.0	0.0	203.8
MARCH	205.5	41.6	0.0	0.0	0.0	247.2
APRIL	159.8	41.6	0.0	0.0	0.0	201.4
MAY	174.9	50.5	47.0	10.8	0.0	283.3
JUNE	0.0	0.0	0.0	0.0	2.0	2.0
JULY	0.0	0.0	0.0	0.0	2.0	2.0
AUGUST	0.0	0.0	0.0	0.0	2.0	2.0
SEPTEMBER	0.0	0.0	0.0	0.0	2.0	2.0
OCTOBER	0.0	0.0	0.0	0.0	2.0	2.0
NOVEMBER	126.4	42.4	11.0	0.0	0.0	179.7
DECEMBER	147.6	42.0	0.0	0.0	0.0	189.6
TOTAL	1144.5	303.0	69.0	10.8	10.0	1537.3

PLAN NUMBER 2

6. 1974 ANNUAL CASH FLOW OF THE COW-CALF ENTERPRISE (1973$)

EXPENSES

REPAIRS	520.30	
FEED - TAXES	332.64	
- RENT	0.00	
- FERTILIZER	0.00	
- TAME HAY	6727.95	
- NATIVE HAY	0.00	
- GRAIN	953.58	
- SUPPLEMENT	0.00	
- SILAGE	0.00	
- USER DEFINED FEED#1	0.00	
- USER DEFINED FEED#2	0.00	
- SALTS	93.26	
- MINERALS	495.03	
BEDDING	1634.40	
HEALTH CARE	50.27	
ARTIFICIAL INSEMINATION	0.00	
MISCELLANEOUS EXPENSES	605.88	
CASH PURCHASES - LIVESTOCK	10293.52	
- BUILDINGS	0.00	
- FENCES AND CORRALS	0.00	
- MACHINERY AND EQUIPMENT	50.00	
- PASTURE	0.00	
TOTAL EXPENSES		21756.81

SALES

LIVESTOCK	29249.68	
BUILDINGS	0.00	
FENCES AND CORRALS	0.00	
MACHINERY AND EQUIPMENT	0.00	
PASTURE	0.00	
TOTAL SALES		29249.68

NET CASH STATEMENT	7492.87

OUTPUT FROM THE COW-CALF SIMULATION MODEL

Sample Output #3

(Output for Plan #3)

OUTPUTS FROM THE COW-CALF SIMULATION MODEL

NAME:HYPOTHETICAL FARM

CROP DISTRICT: 4

PLAN NUMBER 3 OF 3 ALTERNATIVE PLANS HAS BEEN SIMULATED

HEADER INFORMATION: PLAN NUMBER 3 - EXPAND BY 50%

YEAR OF OPERATION IS: 1974

PRICES AND COSTS FROM YEAR 1973 ARE TO BE USED

PLAN NUMBER 3

1. 1974 MONTHLY LIVESTOCK NUMBERS TABLE

ANIMAL CATEGORY	BEGINNING	BORN	BOUGHT	SOLD	DIED	END
--- JANUARY ---						
BULLS	4	0	2	0	0	6
COWS	100	0	50	0	0	150
CALVES (0-6MOS)	0	0	0	0	0	0
HEIFERS (7-18MOS)	21	0	11	0	1	31
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- FEBRUARY ---						
BULLS	6	0	0	0	0	6
COWS	150	0	0	0	1	149
CALVES (0-6MOS)	0	0	0	0	0	0
HEIFERS (7-18MOS)	31	0	0	0	0	31
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- MARCH ---						
BULLS	6	0	0	0	0	6
COWS	149	0	0	0	0	149
CALVES (0-6MOS)	0	0	0	0	0	0
HEIFERS (7-18MOS)	31	0	0	0	0	31
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- APRIL ---						
BULLS	6	0	0	0	0	6
COWS	149	0	0	0	1	148
CALVES (0-6MOS)	0	135	0	0	0	135
HEIFERS (7-18MOS)	31	0	0	0	0	31
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- MAY ---						
BULLS	6	0	0	0	0	6
COWS	148	0	0	0	0	148
CALVES (0-6MOS)	135	0	0	0	1	134
HEIFERS (7-18MOS)	31	0	0	6	0	25
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- JUNE ---						
BULLS	6	0	0	0	0	6
COWS	148	0	0	0	1	147
CALVES (0-6MOS)	134	0	0	0	2	132
HEIFERS (7-18MOS)	25	0	0	0	0	25
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- JULY ---						
BULLS	6	0	0	0	0	6
COWS	147	0	0	0	0	147
CALVES (0-6MOS)	132	0	0	0	1	131
HEIFERS (7-18MOS)	25	0	0	0	0	25
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- AUGUST ---						
BULLS	6	0	0	0	0	6
COWS	147	0	0	0	1	146
CALVES (0-6MOS)	131	0	0	0	2	129
HEIFERS (7-18MOS)	25	0	0	0	0	25
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- SEPTEMBER ---						
BULLS	6	0	0	0	0	6
COWS	146	0	0	0	0	146
CALVES (0-6MOS)	129	0	0	0	1	128
HEIFERS (7-18MOS)	25	0	0	0	0	25
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- OCTOBER ---						
BULLS	6	0	0	0	0	6
COWS	146	0	0	18	1	151
CALVES (0-6MOS)	128	0	0	94	2	0
HEIFERS (7-18MOS)	25	0	0	0	1	32
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- NOVEMBER ---						
BULLS	6	0	0	0	0	6
COWS	151	0	0	0	0	151
CALVES (0-6MOS)	0	0	0	0	0	0
HEIFERS (7-18MOS)	32	0	0	0	0	32
HEIFERS (OVER 18MOS)	0	0	0	0	0	0
--- DECEMBER ---						
BULLS	6	0	0	0	0	6
COWS	151	0	0	0	1	150
CALVES (0-6MOS)	0	0	0	0	0	0
HEIFERS (7-18MOS)	32	0	0	0	0	32
HEIFERS (OVER 18MOS)	0	0	0	0	0	0

PLAN NUMBER 3

2. 1974 ANNUAL LIVESTOCK NUMBERS TABLE

ANIMAL CATEGORY	BEGINNING	BORN	BOUGHT	SOLD	DIED	END
BULLS	4	0	2	0	0	6
COWS	100	0	50	18	6	150
CALVES (0-6MOS)	0	135	0	94	9	0
HEIFERS (7-18MOS)	21	0	11	6	2	[illegible]
HEIFERS (OVER 18MOS)	0	0	0	0	0	0

PLAN NUMBER 3

3. 1974 SUMMARY OF PHYSICAL AND DOLLAR RECORD (1973$)

	PHYSICAL RECORD		DOLLAR RECORD	
INPUTS				
BUILDINGS				
-BARN # 1	- REPLACEMENT VALUE -	19183.60		
	- CURRENT VALUE -	9591.80		
	- REPAIR COST -		335.71	
-BARN # 2	- REPLACEMENT VALUE -	9492.30		
	- CURRENT VALUE -	9492.30		
	- REPAIR COST -		166.12	
-GRAIN BIN# 1	- REPLACEMENT VALUE -	544.00		
	- CURRENT VALUE -	272.00		
	- REPAIR COST -		9.52	
-GRAIN BIN# 2	- REPLACEMENT VALUE -	272.00		
	- CURRENT VALUE -	136.00		
	- REPAIR COST -		4.76	
-GRAIN BIN# 3	- REPLACEMENT VALUE -	408.00		
	- CURRENT VALUE -	408.00		
	- REPAIR COST -		7.14	
	TOTAL REPAIR COST OF BUILDINGS			523.25
FENCES AND CORRALS				
-FENCE # 1	- REPLACEMENT VALUE -	2792.88		
	- CURRENT VALUE -	1396.44		
	- REPAIR COST -		48.88	
-FENCE # 2	- REPLACEMENT VALUE -	1396.44		
	- CURRENT VALUE -	698.22		
	- REPAIR COST -		24.44	
-CORRAL # 1	- REPLACEMENT VALUE -	840.00		
	- CURRENT VALUE -	220.00		
	- REPAIR COST -		7.70	
-CORRAL # 2	- REPLACEMENT VALUE -	220.00		
	- CURRENT VALUE -	220.00		
	- REPAIR COST -		3.85	
	TOTAL REPAIR COST OF FENCES AND CORRALS			84.86
MACHINERY AND EQUIPMENT				

(continued)

-MANURE SPREADER	- REPLACEMENT VALUE -	2000.00				
	- CURRENT VALUE -	1910.00				
	- PORTION USED -	1.00				
	- REPAIR COST -				35.00	
-TRACTOR	- REPLACEMENT VALUE -	5000.00				
	- CURRENT VALUE -	2750.00				
	- PORTION USED -	0.30				
	- REPAIR COST -				26.25	
-PICK-UP TRUCK	- REPLACEMENT VALUE -	2400.00				
	- CURRENT VALUE -	1320.00				
	- PORTION USED -	0.30				
	- REPAIR COST -				12.60	
-FRONT-END LOADER	- REPLACEMENT VALUE -	1058.00				
	- CURRENT VALUE -	581.90				
	- PORTION USED -	0.50				
	- REPAIR COST -				9.26	
-FEEDING EQUIPMENT#1	- REPLACEMENT VALUE -	1550.00				
	- CURRENT VALUE -	852.50				
	- PORTION USED -	1.00				
	- REPAIR COST -				27.13	
-LOADING CHUTE	- REPLACEMENT VALUE -	50.00				
	- CURRENT VALUE -	50.00				
	- PORTION USED -	1.00				
	- REPAIR COST -				0.88	
-GRAIN AUGER	- REPLACEMENT VALUE -	500.00				
	- CURRENT VALUE -	275.00				
	- PORTION USED -	0.30				
	- REPAIR COST -				2.63	
-FEEDING EQUIPMENT#2	- REPLACEMENT VALUE -	1000.00				
	- CURRENT VALUE -	1000.00				
	- PORTION USED -	1.00				
	- REPAIR COST -				17.50	
	TOTAL REPAIR COST OF MACHINERY AND EQUIPMENT					131.23
FEED						
-UNIMPROVED PASTURE	- TAXES -	0 ACRES	X	0.42=	0.00	
	- RENT -	0 ACRES	X	5.38=	0.00	
-IMPROVED PASTURE	- TAXES -	264 ACRES	X	1.26=	332.64	
	- RENT -	133 ACRES	X	16.14=	2146.22	
-FERTILIZER		0.000 TONS		=	0.00	
-SUMMER FEED	- TAME HAY -	0.0 LBS	X	0.015=	0.00	
	- NATIVE HAY -	0.0 LBS	X	0.011=	0.00	

(continued)

	- GRAIN -	0.0 LBS X	0.046=	0.00	
	- SUPPLEMENT -	0.0 LBS X	0.043=	0.00	
	- SILAGE -	0.0 LBS X	0.006=	0.00	
	- USER DEFINED FEED#1 -	0.0 LBS X	0.000=	0.00	
	- USER DEFINED FEED#2 -	0.0 LBS X	0.000=	0.00	
-WINTER FEED	- TAME HAY -	658410.0 LBS X	0.015=	9876.15	
	- NATIVE HAY -	0.0 LBS X	0.011=	0.00	
	- GRAIN -	50130.0 LBS X	0.046=	2305.98	
	- SUPPLEMENT -	0.0 LBS X	0.043=	0.00	
	- SILAGE -	0.0 LBS X	0.006=	0.00	
	- USER DEFINED FEED#1 -	0.0 LBS X	0.000=	0.00	
	- USER DEFINED FEED#2 -	0.0 LBS X	0.000=	0.00	
-SALTS		5128.0 LBS X	0.027=	138.46	
-MINERALS		10214.2 LBS X	0.072=	735.42	
TOTAL COST OF FEED					15534.86
BEDDING	- STRAW -	302940.0 LBS X	0.008=	2423.52	
	- USER DEFINED BEDDING -	0.0 LBS		0.00	
TOTAL COST OF BEDDING					2423.52
HEALTH CARE					
-VITAMINS	- A,D,E (GROWING ANIMALS) -	32 TREATMENTS X	0.07=	2.24	
	- A,D,E (MATURE ANIMALS) -	300 TREATMENTS X	0.17=	51.00	
	- USER DEFINED -	0 TREATMENTS	=	0.00	
-VACCINATIONS	- IBR -	0 TREATMENTS X	0.17=	0.00	
	- BLACKLEG -	167 TREATMENTS X	0.13=	21.71	
	- MALIGNANT EDEMA -	32 TREATMENTS X	0.11=	3.52	
	- 3-WAY -	0 TREATMENTS X	0.41=	0.00	
	- USER DEFINED -	0 TREATMENTS	=	0.00	
TOTAL HEALTH CARE COST					78.47
ARTIFICIAL INSEMINATION		0 SERVICES X	10.75=		0.00
MISCELLANEOUS EXPENSES		144 COWS X	5.61=		807.84
LABOR					
-FEEDING		1618.1 HOURS X	2.10 =	3397.96	
-MANURE AND BEDDING REMOVAL		439.3 HOURS X	2.10 =	922.57	
- 332 VITAMIN TREATMENTS		33.2 HOURS X	2.10 =	69.72	
- 199 VACCINATIONS		19.9 HOURS X	2.10 =	41.79	
- 135 DEHORNINGS		33.8 HOURS X	2.10 =	70.89	
- 68 CASTRATIONS		16.9 HOURS X	2.10 =	35.44	
-REPAIR 5.4 MILES OF FENCE		16.2 HOURS X	2.10 =	34.02	
-CHECKING HERD ON PASTURE		15.0 HOURS X	2.10 =	31.50	
TOTAL LABOR COSTS					4603.87

(continued)

DEPRECIATION					
-BUILDINGS			1494.99		
-FENCES AND CORRALS			242.47		
-MACHINERY AND EQUIPMENT			337.45		
	TOTAL DEPRECIATION COSTS			2074.91	
INVESTMENT					
-BUILDINGS			1723.73		
-FENCES AND CORRALS			217.21		
-MACHINERY AND EQUIPMENT			471.44		
-PASTURE			3927.53		
-LIVESTOCK			6177.14		
	TOTAL INVESTMENT COST			12517.05	
TOTAL COSTS					38779.86

OUTPUTS OR GROSS RETURNS

BEGINNING INVENTORY		4	BULLS	2022.80	
		100	COWS	39935.98	
		0	CALVES (0-6MOS)	0.00	
		21	HEIFERS (7-18MOS)	4645.22	
		0	HEIFERS (OVER18MOS)	0.00	
	TOTAL VALUE OF BEGINNING INVENTORY				-46604.00
SALES		0	BULLS	0.00	
		18	COWS	6510.24	
		94	CALVES (0-6MOS)	20648.40	
		6	HEIFERS (7-18MOS)	1612.51	
		0	HEIFERS (OVER18MOS)	0.00	
	TOTAL VALUE OF SALES				28771.15
PURCHASES		2	BULLS	1011.40	
		50	COWS	19967.99	
		0	CALVES (0-6MOS)	0.00	
		11	HEIFERS (7-18MOS)	2660.61	
		0	HEIFERS (OVER18MOS)	0.00	
	TOTAL VALUE OF PURCHASES				-23640.00
ENDING INVENTORY		6	BULLS	3034.20	
		150	COWS	59903.98	
		0	CALVES (0-6MOS)	0.00	
		32	HEIFERS (7-18MOS)	7078.43	
		0	HEIFERS (OVER18MOS)	0.00	

(continued)

TOTAL VALUE OF CLOSING INVENTORY 70016.56

TOTAL GROSS RETURNS 28543.71

NOTE : TOTAL VALUE OF BEGINNING INVENTORY IS GIVEN A NEGATIVE VALUE BECAUSE IN CALCULATING TOTAL GROSS RETURNS NET INVENTORY IS REQUIRED. NET INVENTORY EQUALS ENDING INVENTORY MINUS BEGINNING INVENTORY.

PLAN NUMBER 3

4. 1974 MANAGEMENT INDICATORS TABLE

A. PHISICAL MANAGEMENT INDICATORS

1. WEANING WEIGHT (LBS)	404.00
2. % CALVES BORN ALIVE (%)	90.60
3. % CALF CROP WEANED (%)	93.33
4. DAILY RATE OF GAIN OF CALVES (LBS)	1.80
HEIFERS (7-18 MOS) (LBS)	1.50
HEIFERS (OVER 18 MOS) (LBS)	0.00
5. % DEATH LOSS OF COWS AND BULLS (%)	4.00
CALVES (%)	13.69
HEIFERS (%)	7.19

B. OVERALL FINANCIAL MANAGEMENT INDICATORS (1973$)

1. RETURNS TO LABOR, INVESTMENT, AND MANAGEMENT	6884.76
2.(A) RETURNS TO LABOR AND MANAGEMENT	-5632.29
(B) RETURNS TO LABOR AND MANAGEMENT (PER HOUR OF LABOR)	-2.57
3.(A) RETURNS TO INVESTMENT AND MANAGEMENT	2280.89
(B) RETURNS TO INVESTMENT AND MANAGEMENT (AS A % OF INV.)	1.64
4. NET RETURNS TO MANAGEMENT	-10236.16

PLAN NUMBER 3

5. 1974 LABOR REQUIREMENTS BY MONTH TABLE

MONTH	HOURS OF LABOR REQUIRED					
	FEEDING	MANURE AND BEDDING REMOVAL	HEALTH CARE	FENCE REPAIR	CHECKING HERD WHILE ON PASTURE	TOTAL
JANUARY	179.5	42.8	0.0	0.0	0.0	222.3
FEBRUARY	223.3	64.1	15.0	0.0	0.0	302.4
MARCH	301.1	63.7	0.0	0.0	0.0	364.9
APRIL	237.8	63.7	0.0	0.0	0.0	301.6
MAY	257.9	75.5	64.1	16.2	0.0	413.8
JUNE	0.0	0.0	0.0	0.0	3.0	3.0
JULY	0.0	0.0	0.0	0.0	3.0	3.0
AUGUST	0.0	0.0	0.0	0.0	3.0	3.0
SEPTEMBER	0.0	0.0	0.0	0.0	3.0	3.0
OCTOBER	0.0	0.0	6.4	0.0	3.0	9.4
NOVEMBER	192.3	64.7	18.2	0.0	0.0	275.2
DECEMBER	226.3	64.7	0.0	0.0	0.0	290.9
TOTAL	1618.1	439.3	103.7	16.2	15.0	2192.3

PLAN NUMBER 3

6. 1974 ANNUAL CASH FLOW OF THE COW-CALF ENTERPRISE (1973$)

EXPENSES

REPAIRS	739.34	
FEED - TAXES	332.64	
- RENT	2146.22	
- FERTILIZER	0.00	
- TAME HAY	9876.15	
- NATIVE HAY	0.00	
- GRAIN	2305.98	
- SUPPLEMENT	0.00	
- SILAGE	0.00	
- USER DEFINED FEED#1	0.00	
- USER DEFINED FEED#2	0.00	
- SALTS	138.46	
- MINERALS	735.42	
BEDDING	2423.52	
HEALTH CARE	78.47	
ARTIFICIAL INSEMINATION	0.00	
MISCELLANEOUS EXPENSES	807.84	
CASH PURCHASES - LIVESTOCK	23640.00	
- BUILDINGS	9900.30	
- FENCES AND CORRALS	220.00	
- MACHINERY AND EQUIPMENT	1050.00	
- PASTURE	0.00	
TOTAL EXPENSES		54394.34

SALES

LIVESTOCK	28771.15	
BUILDINGS	0.00	
FENCES AND CORRALS	0.00	
MACHINERY AND EQUIPMENT	0.00	
PASTURE	0.00	
TOTAL SALES		28771.15

NET CASH STATEMENT	-25623.18

BIBLIOGRAPHY

BIBLIOGRAPHY

Anderson, J. R. "Simulation: Methodology and Application in Agricultural Economics," Review of Marketing and Agricultural Economics, Volume 42, Number 1, pp. 3-55, March 1974.

ARDA III, Manitoba/Canada Agriculture and Rural Development Agreement, Description and Progress Report, 1972 and 1973, published under the authority of Honourable Samuel Uskiw, Minister of Agriculture, Province of Manitoba and the Honourable Don Jamieson, Minister of Regional Economic Expansion, Government of Canada.

Blackie, M. J., and J. B. Dent. "Analyzing Hog Production Strategies with a Simulation Model," American Journal of Agricultural Economics, Volume 58, Number 1, pp. 39-46, February 1976.

Candler, W., M. Boehlje, and R. Saathoff. "Computer Software for Farm Management Extension," American Journal of Agricultural Economics, Volume 52, Number 1, pp. 71-80, February 1970.

Charlton, P. J. "Computer Languages for System Simulation," Systems Analysis in Agricultural Management. Edited by J. B. Dent and J. R. Anderson. Sydney: John Wiley, 1971.

Craddock, W. J. "Interpretation and Use of the Results Obtained with National and Regional Economic Models," National and Regional Economic Models of Agriculture. Edited by R. K. Eyvindson. Ottawa: Canada Department of Agriculture, 1972.

Dent, J. B. "Livestock Performance and Capital Investment in Farm Enterprises," Systems Analysis in Agricultural Management. Edited by J. B. Dent and J. R. Anderson. Sydney: John Wiley, 1971.

Donaldson, G. F., and J. P. G. Webster. "A Simulation Approach to the Selection and Combination of Farm Enterprises," Farm Economist, Volume 11, Number 6, pp. 219-229, 1968.

Driver, H. C. "Discussion: Simulation Models in the Study of National and Regional Economies," National and Regional Economic Models of Agriculture. Economics Branch Publication Number 72/9, edited by R. K. Eyvindson. Ottawa: Canada Department of Agriculture, 1972.

Ford, D. O., M. Senkiw, C. F. Framingham, and J. A. MacMillan. "An Evaluation of the Farm Diversification Program in the Interlake Region of Manitoba." Draft Research Bulletin, University of Manitoba, Department of Agricultural Economics, 1976.

Government of Manitoba. Beef Producers' Income Assurance Plan, Queen's Printer for the Province of Manitoba, 1975.

Hackett, B. A. 1965 Alberta Cow-Calf Enterprise Analysis. Publication Number 816-420-2. Alberta: Economics Division and Animal Industry Division, Alberta Department of Agriculture, [1966].

Halter, A. N. "Simulation Models in the Study of National and Regional Economies," National and Regional Economic Models of Agriculture. Economics Branch Publication Number 72/9, edited by R. K. Eyvindson. Ottawa: Canada Department of Agriculture, 1972.

Halter, A. N., and G. W. Dean. Simulation of a California Range-Feedlot Operation. Davis: University of California Agricultural Experiment Station, Giannini Foundation Research Report Number 282, 1965.

Hardaker, J. B. "The Use of Simulation Techniques in Farm Management Research," Farm Economist, Volume 11, Number 4, pp. 162-171, 1967.

Hermann, C. F. "Validation Problems in Games and Simulation with Special Reference to Models of International Politics," Behavioural Science, Volume 12, Number 3, pp. 216-231, May 1967.

Huffman, W. E. "Decision Making: The Role of Education," American Journal of Agricultural Economics, Volume 56, Number 1, pp. 85-97, February 1974.

Ladue, E. L. "A Computerized Farm Business Simulator for Research and Farm Planning." Unpublished Ph.D. Thesis, Michigan State University, Department of Agricultural Economics, 1971.

Manderscheid, L. V., and G. L. Nelson. "A Framework for Viewing Simulation," Canadian Journal of Agricultural Economics, Volume 17, Number 1, pp. 33-41, February 1969.

Manitoba Department of Agriculture. Beef Manual, Economics Branch, Manitoba Department of Agriculture, Winnipeg, 1971.

Manitoba Department of Agriculture. Farm Data Handbook, Economics Branch, Manitoba Department of Agriculture, Winnipeg, 1972.

Manitoba Department of Agriculture. Farm Diversification Program, published and distributed by the Manitoba Department of Agriculture under the Manitoba-Canada ARDA III Agreement, 1974.

Manitoba Department of Agriculture. Manitoba Agriculture, 1973, 1974, and 1975 Yearbooks, Queen's Printer for Province of Manitoba, Winnipeg, 1973, 1974, and 1975 respectively.

Mize, J. H., and J. G. Cox. Essentials of Simulation. Englewood Cliffs: Prentice-Hall, 1968.

Müller, J. "On Sources of Measured Technical Efficiency: The Impact of Information," American Journal of Agricultural Economics, Volume 56, Number 4, pp. 730-738, November 1974.

Naylor, T. H. Computer Simulation Experiments with Models of Economic Systems. New York: John Wiley and Sons, Inc., 1971.

Naylor, T. H., and J. M. Finger. "Verification of Computer Simulation Models," Management Science, Volume 14, Number 2, pp. B-92-B-101, October 1967.

The Province of Manitoba. Guidelines for the Seventies: Introduction and Economic Analysis, Volume 1, Queen's Printer for Province of Manitoba, Winnipeg, March 1973.

Ryan, T. J. "A Beef Feedlot Simulation Model," Journal of Agricultural Economics, Volume 25, Number 3, pp. 267-276, September 1974.

Sanderson, K. T., and A. T. G. McArthur. Computer Methods for Development Budgets, Agricultural Economics Research Unit Publication Number 45. Lincoln College, Agricultural Economics Research Unit, 1967.

Senkiw, M., and A. Pokrant. "A Cost/Return Simulator for Dairy, Cow/Calf and Stocker/Feeder Enterprises." Unpublished Paper, University of Manitoba, Department of Agricultural Economics, 1976.

Statistics Canada. Farm Cash Receipts, Catalogue Number 21-201, Annuals, Ottawa, 1970-1975.

Statistics Canada. Farm Input Price Index, Catalogue Number 62-004, Quarterlies, Ottawa, 1975 and 1976.

Statistics Canada. Prices and Price Indexes, Catalogue Number 62-002, Monthly, December 1975, Ottawa, 1975.

Trebeck, D. B. Simulation of Extensive Beef Production in the Clarence Region of New South Wales, Miscellaneous Bulletin Number 16, edited by G. Mason. New South Wales Department of Agriculture, Division of Marketing and Economics, 1972.

University of Manitoba. Principles and Practices of Commercial Farming, Faculty of Agriculture, University of Manitoba, Fourth edition, Winnipeg, 1974.

Van Arsdal, R. N. "Resource Requirements, Investment Costs, and Expected Returns" from Selected Beef-Feeding and Beef-Raising Enterprises, AE-4075, Illinois Agricultural Experiment Station, Urbana, 1965.