AN ECONOMIC ANALYSIS OF THE GROWTH OF OKLAHOMA GRADE A DAIRY FARMS USING THE GROWTH SIMULATION TECHNIQUE

By

HOLLIS D. HALL

Bachelor of Science
South Dakota State University
Brookings, South Dakota
1956

Master of Science
South Dakota State University
Brookings, South Dakota
1964

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF PHILOSOPHY
August, 1969

AN ECONOMIC ANALYSIS OF THE GROWTH OF OKLAHOMA

GRADE A DAIRY FARMS USING THE

GROWTH SIMULATION

TECHNIQUE

Thesis Approved:

Odell L. Walker
Thesis Adviser

Luther G. Tweeten

Leo V. Blakley

Robert D. Morrison

Milton Wells

D. D. Durham
Dean of the Graduate College

PREFACE

I sincerely thank Dr. Odell L. Walker, graduate committee chairman, for his counsel and encouragement throughout this study and my entire graduate program. I appreciate the guidance received from graduate committee members, Dr. Leo V. Blakley, Dr. Luther G. Tweeten, Dr. Milton E. Wells, and Dr. Robert D. Morrison.

I wish to thank Dr. Clifford H. Burton and Dr. Curtis W. Richardson, Extension Dairy Specialists, for providing access to DHIA records and for reviewing data for this study. Thanks are due the eighty Oklahoma grade A dairy producers who provided information for the study. I am appreciative to my fellow graduate students for their suggestions and encouragement throughout my graduate program.

I am grateful to the Department of Agricultural Economics and the South Dakota Cooperative Extension Service for financial assistance during my graduate study.

To Dr. John T. Stone and Leonard Benning, South Dakota State University, I am thankful for their encouragement without which this effort would not have become a reality.

I thank Mrs. Roger Prunty for her typing skills in the preparation of preliminary and final drafts of this dissertation.

Finally, I am deeply thankful to my wife, Darleen, for her patience, encouragement, sacrifices and faith throughout my graduate program.

TABLE OF CONTENTS

Chapter | Page

Chapter		Page

LIST OF TABLES

Table Page

Table		Page

LIST OF FIGURES

Figure | Page

Figure Page

CHAPTER I

INTRODUCTION

The production of grade A milk requires a high degree of specialized investment when compared with other types of agricultural production enterprises. Consequently dairying does not lend itself to flexible physical organization nor does it possess characteristics that allow for unrestrained entrance and exit.

History is replete with examples of improperly organized production units that have failed to foster growth or units that could provide for the necessary net income withdrawals of family living and mandatory debt repayment only at the expense of reduced production assets. Long range planning information is essential for prospective dairymen or present dairymen planning their enterprise organization

Dairymen may easily become discouraged by a very slow early growth pattern if they have no insight into the future growth rates five or ten years hence. Also some dairymen may believe that they have an economically viable unit only to realize at some future point in time that they have "consumed" the assets by ignoring expenses incurred through depreciation. Original organization of the dairy farm should be based on a growth and income potential that will fulfill the goals of the dairyman. This study will supply information concerning the growth and income potential of dairy production firms.

Historical Changes in Dairy Farm Organization and Costs

Since the second World War, dairy production methods in the United States have undergone many far reaching transformations. Changes have occurred not only in production methods but also in marketing procedures which have added impetus to recent technological changes in the production of milk and milk products. More concentrated feed rations and automated feeding methods have given rise to "dry lot" handling of the dairy herd and to the substitution of purchased inputs for owned factors of production such as land and feed production equipment. The bulk handling of milk and the stall and herringbone milk parlors have brought about a substitution of capital for labor. The establishment of Milk Marketing Orders has contributed to milk price stability. More recently, provisions for supply control under a class I base plan have afforded methods of increasing and maintaining the grade A milk blend price.

The technological changes in the dairy industry have decreased the ease of entrance, exit, contraction, and expansion. What had historically been a farm income supplementing enterprise has now achieved the status of a primary production activity and, in instances, is the single enterprise on many modern farm units. Specialization within the dairy industry is reflected in the change in dairy farm and dairy cow numbers during the past quarter century. The number of cows kept for milk in the United States had decreased from a high of 27,770,000 in 1945 to 17,593,000 in 1964. The number of farms on which these cows were located decreased from 3,648,275 to 1,133,910 during the same time period [18, p. 35]. The United States Department of Agriculture estimate of the number of cows kept for milk in 1969 indicated a continued decrease to 14,123,000 [19, p. 6].

A review of the changes in the structure and number of commercial dairy farms reveals a trend toward fewer farms but an increase in total cow numbers. The number of commercial dairy farms decreased from 597,026 averaging 16.0 cows in the United States in 1950 [21, p. 1298] to 362,319 farms averaging 30.8 cows in 1964 [23, p. 1005]. During the same period commercial dairy farms in Oklahoma decreased from 8,308 averaging 14.0 cows [20, p. 294] to 3,353 averaging 35.6 cows [22, p. 251]. Even though the number of commercial farms has decreased sharply, the herd size has increased even faster to result in a greater number of cows on these farms.

Herd size characteristics have not been the only changes made by the grade A dairyman. A survey by the United States Department of Agriculture of commercial grade A dairy farms in the Central Northeast States and Eastern Wisconsin indicated an increase in cash expenditures of grade A dairy farms from 1950 to 1964 of 97.5 percent and 76.9 percent in each area respectively. The investment per farm increased 155.7 percent from 1950 to 1964 in Eastern Wisconsin and 91.2 percent in the Central Northeast States [16, pp. 7-12; 17, p. 32]. A survey of Oklahoma producers in 1959 indicated that the investment in dairy equipment, building, and livestock amounted to $24,470 for a 46-cow herd averaging 9,600 pounds of milk [3, p. 9]. The 1967 survey conducted as the empirical basis for this study indicated that equipment, building, and livestock values for a herd with the same size and production level amounted to $43,492 or an increase of 77.7 percent during the past eight years.

The Problem

The dairy farm has evolved from a small family operation to a large production firm employing increased amounts of non-family and non-farm supplied resources. The dairy production firm must compete with firms in other industries for off-farm resources, hired labor and borrowed capital. With the advent of the increased use of off-farm supplied resources, many costs heretofore considered fixed have become variable. This transformation to the purchase of production inputs necessitates the application of more rigor to resource allocation analysis by dairy producers.

Before entering into long-range contractual agreements for capital and labor, the dairyman must be able to plot the return and growth pattern of his firm as realistically as possible to determine the feasibility of his planned actions, given an initial state of available resources. Lending agencies may over or under extend farm loans without some insight as to the stability of the farm production unit being financed. Questions to be answered include the ability of the firm to (1) provide the desired family living income, (2) employ hired labor and borrowed capital productively, and (3) attain long-run economic or personal goals through herd growth, changes in technology, and gains in net worth. Provided with insight into the future of the dairy firm, present and prospective dairymen can determine with a greater degree of certainty the most feasible alternative uses of their initial resource base.

The Objectives

The primary objective is to determine the nature of management decisions necessary for Oklahoma grade A dairy operators to achieve specific goals subject to various initial farm organizations, resource and institutional restraints, and technology levels. More specifically the objective includes the determination of:

1. The present costs of producing milk on Oklahoma grade A dairy farms.
2. The growth rate of grade A dairy farms subject to various capital and labor costs.
3. The growth rate of grade A dairy farms subject to various levels of milk production.
4. The growth rate of grade A dairy farms subject to various class I milk marketing restraints.
5. The growth rate of grade A dairy farms subject to various family consumption functions.

A secondary objective of the study is to develop a dairy farm growth simulator to be used by lending agencies and dairymen to determine the stability of dairy production firms and the security of dairy loans. A simulation model was developed and applied to specific dairy farm organizations to determine the growth in net worth over a 10-year period of time.

Empirical Data

The empirical data for this study were obtained from 80 Oklahoma grade A dairy farms in the Oklahoma Metropolitan and North Texas Milk marketing areas. The farms surveyed were limited to those with 30 or more cows, the largest having 160 cows. The population from which the sample was drawn was composed of all grade A producers within the study area with herds of 30 or more cows. The restrictions of herd size and class of milk marketed placed the survey farms in the category of commercial dairy farms which was desirable for this study.

The Study Area

The study area was restricted to the Oklahoma Crop and Livestock Reporting Service districts numbers one, two, three, four, and five. Districts one and four were combined into one sampling area for this study because of similar farm organization, market area, and herd size distribution. Figure 1 indicates the boundries of the study areas. Districts six, seven, eight, and nine were eliminated from the study area because of small herd numbers and a small percentage of herd participation in the Dairy Herd Improvement Association (DHIA) program, a U.S.D.A. sponsored production and cost record system. The omitted districts had a participation rate in the record program of 4.6 percent while the rate in the districts studied was 15.7 percent. The sampling procedure is discussed in more detail in Appendix A.

Previous Research

The analysis of agricultural firm management through the techniques of computer simulation has gained usage only during the past

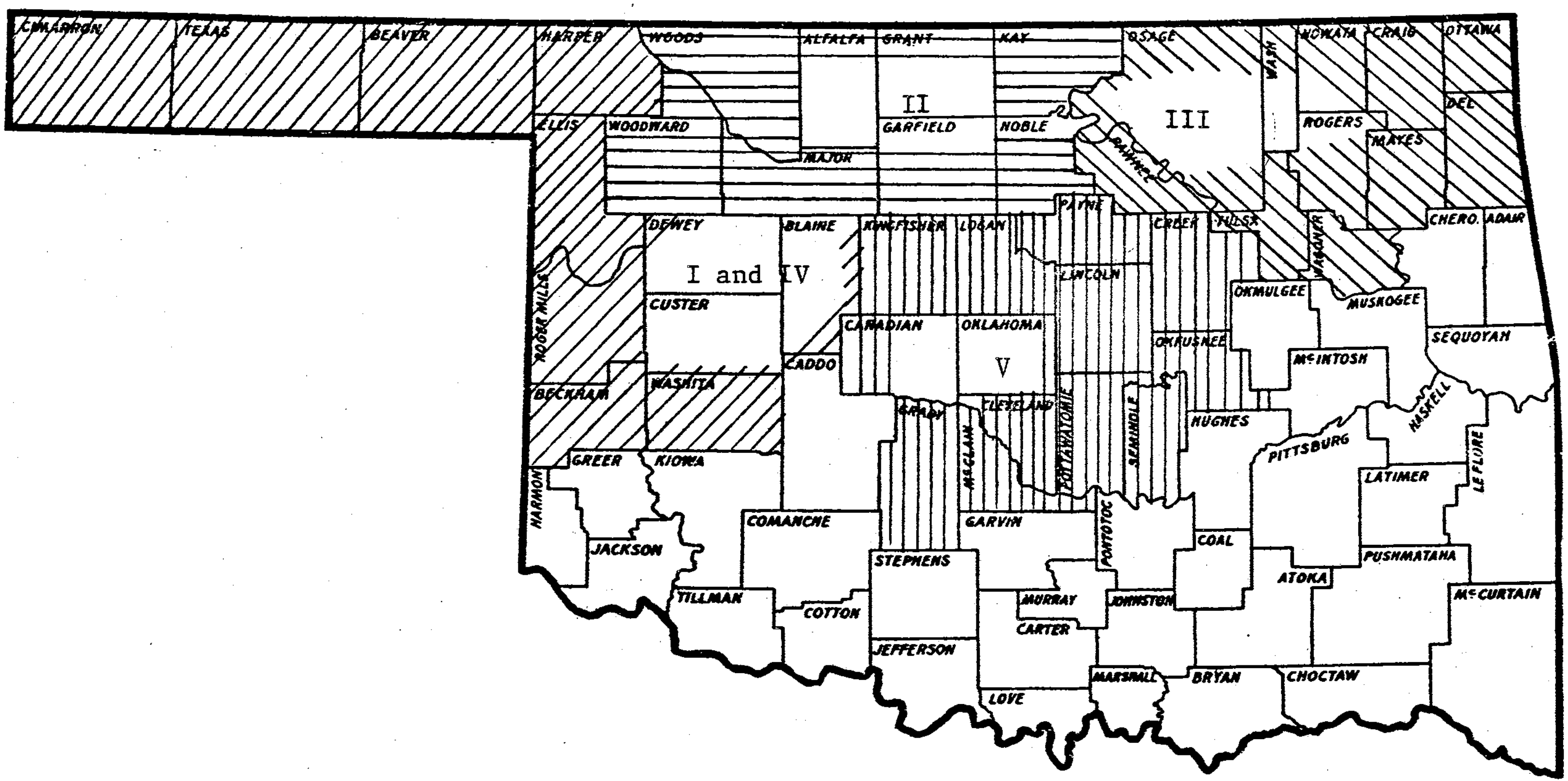

Figure 1. Map of Oklahoma Showing The Crop and Livestock Reporting Districts Included in This Study

decade; yet the concept of simulation is not new. Military strategists have employed the technique of simulation for centuries, but it has only been recently with the aid of computers that simulation has been applied to individual firm actions subject to the uncertainties of the business world.

Mathematical simulation is a process of studying the actions and reactions of a number of variables within a model composed of functional relationships that describe reality. A simulation model can operate within either a certainty or an uncertainty framework; however, if the model is to depict aspects of reality, the element of uncertainty usually must be present. To introduce uncertainty into the simulation, Monte Carlo or gaming methods may be applied. The Monte Carlo approach embodies probability theory while gaming, which may also embody probability theory, includes players or decision makers whose actions within the simulated model framework can be observed by the researcher [14, p. 134]. When employing the Monte Carlo approach, each individual solution derived from a particular spectrum of random values is highly specific and should be viewed as a single experiment performed on the model. The results of a large number of repetitive runs of the simulation reveal a pattern of behavior [9, p. 893].

In general, simulation can be employed in a number of different manners. Orcutt [9, pp. 895-897] suggests uses of simulation in (1) training personnel, (2) designing engineering systems, (3) testing the operations of systems, and (4) forecasting. Shubik [13, pp. 912-913] relates that contributions from simulation of the firm are (1) econometric devices to provide models derived from empirical data,

(2) computational aids and alternatives to analysis in theory construction, (3) devices for data organization, and (4) tools for anticipation and planning.

Suttor [14, pp. 1342-1344] relates several advantages and disadvantages of simulation. The most important advantage is that the simulation model can be more complex and relate more nearly the real system than can conventional mathematical models. The technique of simulation allows the economist to perform several experiments changing only specific variables from experiment to experiment. The results of simulation are quite easily understood by technically untrained persons. Even though results of simulation may be easily understood, a primary disadvantage is that the model is often very complex, difficult to explain, specific, costly, and capable of harboring the researchers' biases.

Simulation techniques recently have been applied to a variety of agricultural economic problems. One of the early applications was in the management of agri-business firms. Glickstein [4] in 1962 employed simulation in the determination of procurement policies of cheese manufacturing plants. In 1968 Tyner and Tweeten [15] employed simulation to portray the operations of an economic model of the U.S. agricultural industry from 1930 to 1960 with respect to farm programs.

Recent applications of simulation to farm firm problems include the evaluation of large scale ranch management policies by Halter and Dean [5] based on various weather and price conditions. Zusman and Amiad [24] employed simulation techniques to arrive at crop rotations and livestock inventories in an arid region of Israel characterized by variable rainfall amounts.

In 1966 Hutton [6] developed a complex detailed simulation of dairy farm management decisions. This simulation dealt with the replacement animal policy within a herd. The policies analyzed were (1) buying all replacement, (2) raising all replacements, and (3) buying replacements only if the number of raised replacements was less than the number of existing cows. Hutton has since developed a general farm simulator [7].

Outline of Following Chapters

The order of presentation for the remainder of this dissertation is as follows:

Chapter II describes the simulation environment. The models, data, and assumptions employed in the simulation, and the output information concerning the performance of the dairy production firm under specified situations are explained.

Chapter III includes the budgeted dairy farm initial investments and costs and returns based on empirical data. The functions, derived from the budgets and empirical data and used in the simulation routine, are presented.

Chapter IV presents the effects of three interest rates and three wage rates on firm growth at three different initial milk production levels. Firm growth and adjustments within the firm under various capital and labor costs are interpreted.

Chapter V presents the effects of the amount of class I milk marketings and the price of class I milk base on firm growth at three different initial milk production levels. The implications of acquiring additional class I milk base are explored.

Chapter VI presents a comparison of growth patterns under three different family consumption functions at three different initial milk production levels. The implications of deferred family consumption and constant, but limited, family consumption are discussed.

Chapter VII summarizes the results of the study and presents the conclusions and their implications.

CHAPTER II

SIMULATION PROCEDURE

The purpose of this chapter is to define the setting within which the dairy production firms were simulated. The goals, objectives, limits and restraints embodied in this simulation are explained as well as the assumptions affecting the course of the firm's movement over time. A discussion of the models used to arrive at initial input data and applied within the simulation is also included.

It would be difficult if not impossible to arrive at a set of decision strategies that would be identical for all managers faced with the same problems. However, to analyze the effects of key variables it is necessary to accept a standard decision pattern. Such standard decision patterns as retaining a certain percentage of the heifer calves for replacement animals, debt restrictions for capital borrowing, herd expansion limits, family living levels and debt repayment schedules were employed in this study. The simulator is designed to depict the growth movement of the firm subject to the above standard decision criteria and manipulated key variables.

The three basic components of the dairy production firm growth simulator are (1) the initial and yearly resource bases, (2) a set of yearly business operational activities, and (3) the year end report. In order to trace the course of the firm's growth over time, it is first necessary to describe the original organization in terms of resource base and level of technology. The resource base for each year except the first is obtained from the year ending resource inventory of the preceeding year; thus, the process is dynamic in time. Initial resource bases were determined through linear programming methods explained later in this chapter.

Second, it is necessary to define the objectives of the firm and the technical and economic limits and conditions within which the firm must operate. The firm's actions are guided by goals and objectives which may be singular or complex. Restraints may be self imposed by the firm and reflect multiple objectives and restrictions such as family living, firm expansion, asset expansion and debt limits. Some restraints or conditions are imposed from outside the firm through product prices, market shares, and supply conditions for productive resources. Other conditions may be the result of natural and uncontrollable events such as livestock death losses and adverse weather conditions. The yearly operation is governed by various cost, return and investment functions; stochastic occurrences; income withdrawals for family living and debt repayment; business expansion functions; and debt restrictions.

Finally, it is necessary to observe the results of the business operations for each year. The annual year end report presents an income statement; net worth statement; livestock inventory; and average cost, returns and investment relationships. The year end report provides a summary, a basis for analysis and a starting point for the succeeding year.

Initial Resource Base Organization

This study illustrates the growth over a 10-year period of a dairy production firm that commences operation with specific labor and capital constraints. Only the grade A milk production enterprise was included in the study. It was assumed that all feed was purchased and the cows were confined to dry lot feeding; therefore, the only real estate requirements were for buildings and cattle lots. It was also assumed that all owner labor would be employed in the production of milk and that additional labor could be hired in 600 hour increments.

Linear programming was employed to obtain the initial resource base organization required to maximize net income over the 10-year period. Since only the dairy enterprise was considered, the resources were composed only of cows and replacements. The initial organization was determined for average annual milk production levels of 9,000, 11,000 and 13,000 pounds.

The resource base linear programming model contained the following activities (cow to replacement animal ratios): 1:0, 1:.1, 1:.2, 1:.3, 1:.4, 1:.5, and 1:.6. The replacements included yearling heifers and heifer calves. For example, the ratio of 1:.2 was one cow plus .2 each of yearling heifers and heifer calves. Resource restrictions placed on the problem were labor at a maximum of 2,950 hours the first year, of which 2,267 hours were fixed to the dairy enterprise, and an initial investment of no more than $50,000, of which $15,000 was fixed to the enterprise in the form of real estate, buildings, and equipment. The fixed labor and capital were those amounts that did not vary as cow numbers varied. Further restrictions on net income were that the initial yearly income for family living must be at least $4,500, the undiscounted total family living income for the first two years must be at least $9,000, and the undiscounted total family living income for the first three years must be at least $18,000. In other words, the annual family living income for each of the first three years must never be less than $4,500 and must average at least $6,000 during the three-year period. It was assumed for purposes of the linear programming problem that future investment expenditures due to cow number expansion were extracted from annual income.

Given these objectives, restrictions, and activities the necessary conditions can be expressed as:

(1) The objective function to maximize discounted net returns as:

$$Z = \sum_j DC_j X_j, j = 1,2,\cdots n, \text{ with } X_j \geq 0$$

where DC_j is the discounted net return per jth cow-replacement combination and X_j is the number of jth cow-replacement combinations.

(2) The income requirements are as follows:

(a) First year

$$\sum_j C_j X_j \geq 4,500$$

where C_j is the net income from each jth, cow-replacement combination during the first year.

(b) Second year

$$\sum_j C_j X_j \geq 9,000$$

C_j is the net income from each jth cow-replacement combination in the first two years.

(c) Third year

$$\sum_j C_j X_j \geq 18000$$

C_j is the net income from each jth cow-replacement combination in the first three years.

(3) The resource restrictions are:

(a) $\sum_j I_j X_j \leq K$

where K is the maximum variable capital available, \$35,000, and I_j is the necessary initial investment for the jth cow-replacement combination.

(b) $\sum_j L_j X_j \leq TL$

where TL is the maximum variable labor available, 683 hours for the initial year, and L_j is the required labor for the jth cow-replacement combination.

Application of the model indicated no feasible solution for the 9,000 pound level that would yield an average annual family living income of \$6,000 without the sale of assets (cows) during the third year. The relaxation of the labor constraint to allow for the hiring of 600 hours of labor allowed the number of cows to increase to 36 at which point the capital constraint was reached, but there was still no feasible solution providing a \$6,000 average annual family living income. In fact, the average annual net income would have been approximately \$5,600 with 36 cows and 600 hours of hired labor. The annual net income requirement was relaxed to \$5,800 and the solution became feasible.

When the average annual income value was relaxed to $5,800 instead of $6,000, the linear programming results revealed that at the 9,000 pound production level the optimum combination was 32.484 units of one cow to .2 replacement animals (32.484 cows and 6.4968 replacements). Rounding to 32 cows left enough labor and capital in excess to increase the replacements to seven yearlings and seven heifer calves.

The linear programming results were somewhat different for the 11,000 pound level, but after rounding to integer values the resultant number of animals was the same. The optimum combinations for the 11,000 pound level was 10.096 cows with no replacements and 22.394 cows with .3 replacements (32.490 cows and 6.7182 replacements). When the cow numbers were rounded down to 32, excess capital and labor allowed the replacement numbers to increase to seven. The optimum combination for the 13,000 pound level was 4.514 units of a cow and .4 replacements plus 20.864 units of a cow and .6 replacements (25.378 cows and 14.324 replacements). Rounding the cow numbers down to 25 did not allow enough excess labor and capital to increase the replacements to the next highest integer value; therefore, the combination used was 25 cows, 14 yearling heifers and 14 replacement calves.

Fewer cows and more replacement animals than those revealed as optimum yielded a greater discounted net return but this type of organization did not provide sufficient family income in the early years of operation. The optimum linear programming solutions, therefore, reflected the minimum number of cows necessary to conform to the yearly net income requirements stated in the linear programming model.

Simulation Operational Setting

The dairy production firm simulation model is directed by goals and objectives for the firm. It operates within a technical and economic environment subject to basic assumptions, and indicates the growth of the firm over a specified time period. Technical and economic relationships were transformed into operational mathematical functions.

Goals and Objectives of Grade A Dairy Production Firms

In this study it is assumed that maximum net worth over time is the primary objective of the firm. A minimum family living level constraint also has to be met. Thus, the objective of the firm is net worth maximization over time subject to minimum family living restrictions.

The maximization of net worth over time requires that the firm expand through the acquisition of productive resources either by internal growth or external purchase. The expansion of assets can be achieved only through the reinvestment of firm profits or the use of loans on prior accumulations. Therefore net worth maximization over time becomes essentially synonomous with profit maximization in a dynamic model.

Even though profit maximization defines the strategy; the level of output that is indicated by maximum profit is not always attainable within a specified time period. Growth restrictions imposed on the firm can prevent the attainment of the level of output characterizing profit maximization. One such restriction has already been mentioned, a minimum family living level. Other restrictions to be discussed later include debt restrictions and technology levels.

Family Consumption Levels

The minimum level for family consumption will vary, depending on whether the minimum level is to be sustained for several years or if for only a short period of time with prospects for a higher income in the near future. For purposes of this study a minimum of $4,500 in any year was assumed. The amount set aside for family living was exclusive of all income and social security taxes and long-term debt payments. The amounts withdrawn from net income for family living was subjected to further limits discussed below.

Three family living criteria were simulated in the study. One of the family living criteria, referred to hereafter as the rigid consumption function, was based on a lower limit of $4,500, an upper limit of $7,500, and an average over any three year period of no less than $6,000. If the lower limit were not met by the dairy operation, cows were sold to maintain the necessary family living level. If the resultant net income after taxes and long-term debt payment was greater than $7,500, the excess was reinvested in intermediate debt payment, herd expansion, or personal saving.

The second family living criterion, referred to hereafter as the equity-labor return consumption function, included an amount for family labor at the existing wage rate plus the prevailing savings interest rate on owner equity in the business. The lower limit under this situation was the return to owner capital and family labor minus $1,500, while the upper limit was the return to owner capital and family labor plus $1,500. In no instance was the family living allowed to drop below the minimum of $4,500. Again cows were sold to maintain the necessary family living level.

The third family living criterion employed a consumption function developed by Raup as follows: $C = 22.961^{0.59} S^{0.163}$, where C is the family consumption, I is the net income after taxes, social security and long-term debt retirement; and S is the number of family members [11, p. 17]. A lower limit of $4,500 in any given year was imposed on the family living amount. As with the previous consumption functions cows were sold to maintain the necessary family living level. Excess of net income above consumption was used for intermediate debt repayment, business expansion, or personal saving as in the previous family living criteria.

Technical Environment

The physical relationships between resource inputs and output in the production of a product are defined by a production function. The production function defines the relationship of output to inputs as

$$Y = f\ (X_1,\ X_2,\ \cdots X_n)$$

where Y is the product produced and X_i $(i=1,n)$ are the inputs. The output depends on the quantity of inputs and the functional relationship between inputs and output.

Resource inputs may be categorized as fixed or variable inputs. Fixed inputs as the name implies are not allowed to vary from a specified level, while variable inputs are increased and the quantity of output observed. The functional relationship between output and inputs can be changed only by changing the quantity of fixed resources, changing the quality of variable inputs, or changing technology. In this study the quality of variable inputs (cows) was varied for the observation of firm growth patterns. It was assumed that, given a fixed amount of capital and labor, the firm could commence operation with cows producing average annual quantities of 9,000, 11,000, or 13,000 pounds of 3.5 percent butter fat tested milk.

Technical factors that affected the dairy production function included calving intervals, death and culling rates, and hereditary improvement over time. Calving intervals and hereditary improvements were assumed to be at the same rates in all simulated firm growth patterns. The culling and death rates were assumed not to be known with certainty, and were allowed to occur randomly within a specific simulated growth observation. Stochastic elements of the study will be reviewed more completely later in this chapter.

The results of the survey of Oklahoma grade A dairy farms mentioned in Chapter I provided the basis for technical relationships used in this study. The survey yielded building space requirements, equipment organization, livestock values, decision practices, individual goals and objectives, current operating costs, labor practices, labor requirements, and livestock exit rates through culling and death.

Most of the buildings and equipment on the farms were constructed and installed more than five years in the past, and many of the buildings in use on the farms had been converted from original construction purposes. The dairymen's estimate of building and equipment value and replacement costs did not reflect current construction and equipment costs; therefore, it was necessary to introduce current cost data collected from contractors, agricultural engineers, and equipment suppliers. Through the technique of engineering modeling, dairy production systems for various herd sizes and production levels were constructed. Budgets were developed from the synthesized dairy production units for herd sizes of 40, 62, 87, and 130 cows with average annual milk production per cow of 9,000, 11,000, and 13,000 pounds. These production levels reflect below average, average, and above average management. The budgets provided a basis for many of the computational formulas used in the simulation model.

Economic Environment

The economic environment included the prices paid for resources and the prices received for products. The size of the firm and equity position is also of concern when viewing the economic environment. Prices of many inputs and outputs were specified so that the effects of key variables on firm growth could be observed.

An uncertain knowledge setting was assumed for feed costs and cull and surplus animal prices, allowing these price values to occur randomly within a prescribed probability distribution. The class I and surplus prices of milk were held constant throughout all simulation runs, but the percentage of milk marketed under a class I base was varied in specific simulation runs allowing the blend price of milk to vary. The blend price of milk was one of the key variables employed in analyzing firm growth. The prices of labor, capital and class I base were also allowed to vary for firm growth observations.

The firm growth patterns were observed subject to three specific values of class I base percentages, three class I base prices, three interest rates, and three wage rates.

Basic Assumptions Employed in the Simulation

Several assumptions germane to all simulations in this study could be relaxed if the simulation were conducted for a specific dairy producer. All of the simulated farms commenced operation with $20,000 owner equity. Each farm organization within a specific original average herd production level possessed the same livestock numbers even though capital was available for more livestock when class I base values were decreased. The same herd organizations were introduced for comparative growth analysis.

Several assumptions were employed concerning the production of individual cows in the dairy herd. A normal distribution about an average production was assumed with the corresponding coefficients of variation and average production levels shown in Table I [10, p. 22-23]. It was also assumed that the dairyman had records of the production of all cows so that herd improvement culling would apply to the lowest producing cows. In this simulation, herd expansion was possible through the purchase of young cows just prior to calving. It was presumed that the production potential of purchased cows was the same as the average for the existing herd. An annual production improvement factor of 1 percent was used. This production increase was due to genetic improvement of the herd [8, p. 16]. It was assumed that artificial breeding to proven sires was practiced. As the primary breed of dairy cattle in Oklahoma is Holstein, all production related costs and returns were based on 3.5 percent butter fat test milk. An average cow weight of 1,300 pounds was used in this study.

TABLE I

AVERAGE ANNUAL HERD MILK PRODUCTION LEVELS AND CORRESPONDING COEFFICIENTS OF VARIATION

Average Herd Production Level (Pounds)	Coefficient of Variation
<9,500	0.1756
9,500-10,499	0.1734
10,500-11,499	0.1712
11,500-12,499	0.1688
12,500-13,499	0.1666
13,500-14,499	0.1644
14,500-15,499	0.1622
15,500-16,499	0.1600
16,500-17,499	0.1576
≥17,500	0.1554

Based on data from the farm survey, 0.3 heifer calf was retained for replacement and herd expansion each year for each cow in the herd. The number of surplus calves for sale was that number above replacements and death loss. The Oklahoma DHIA records indicate that each cow averages 0.94 calves per year. This calving rate included all calves born; therefore, calf death rates included still births as well as calf deaths after birth.

The surveys revealed that the majority of the dairymen fed both milk and milk replacer to the calves. The average amount of milk fed was 188 pounds and the average amount of milk replacer was 10 pounds on a per cow basis. Therefore, it was assumed for this study that 188 pounds of milk from each cow's production was fed to calves during the year; hence the marketable milk from each cow was her production minus 188 pounds.

All feed including pasture was purchased off the farm or from crop enterprises on the farm. For this reason, the land value reported in the farm assets included only the land physically required for lots and buildings. No silage was included in the feeding program.

At no time during the simulation was the dairy firm allowed to draw upon depreciation for living expenses. The amount set aside for depreciation could, however, be applied to debt retirement and expansion activities.

A tax and insurance cost combined was assumed at 0.75 per cent of the total undepreciated asset value. Even though large variation was present concerning this cost item on the farm surveys; consultation with tax officials and insurance companies substantiated the coefficient used.

The milk prices used for the simulation were current class I and surplus prices for the Oklahoma metropolitan milk market. The net prices for class I and surplus milk after the deduction of hauling costs and association fees were $6.46 and $3.83 per hundred pounds respectively.

It was assumed in the study that the farm family would consist of four members. The family members would contribute 2,950 hours of annual labor to the dairy enterprise. Of the 2,950 hours the manager would contribute 50 weeks of six eight-hour days each for a total of 2,400 hours, while other family members would contribute 550 hours per year. The results of the survey indicated slightly higher contributions from family labor of 3,654 hours per year. The families in the survey averaged more than four members, 4.5 members, and a major complaint of dairy farmers was that their family had to work too hard with no days off. The small labor contribution assumed in the study was an attempt to more nearly comply with the "desirable" rather than the now existing family work load. It was assumed that hired labor was obtainable in units not smaller than 600 hours per year. This assumption would allow, for example, to hire labor for one two-hour milking period per day for a total of 600 hours annually.

Restrictions of the Model

Other restrictions were imposed on the simulation model concerning limits of growth, purchase of inputs and debt limits. The maximum number of cows to which the firm was allowed to grow was 160. Empirical data were not available for herds of greater cow numbers. Once the 160 cow herd size was attained excess income above family living and debt payment was directed to personal savings. At no time during the simulation was the firm allowed to acquire long-term or intermediate-term debts greater than 60 percent of the long or intermediate-term assets. If the ratio became greater than 60 percent the firm was forced to sell cows on the market and apply the revenue to debt reduction. Herd expansion through livestock purchases was foregone until the total debt to asset ratio was 50 percent or less.

Horizon of the Study

Because of the possibility of future dairy industry changes and because of uncertainty of dairy producers' plans far into the future, the simulation was conducted no further into the future than 10 years. Simulations of a greater time period would have increased the computer cost proportionately. An analysis of the 10-year period clearly presents patterns of growth that can be a basis for further projection through means other than simulation.

Source of Simulator Computational Formulas

The computational formulas for labor requirements, miscellaneous expenses, livestock, and real estate investment values were obtained from survey data while the equipment and building investment formulas were obtained from dairy farm budgets based on farm, equipment supplier, and building contractor surveys. The feed requirements for the milking herd were derived from Oklahoma DHIA records, while the feed requirements for replacement stock was obtained from recommendations by the Oklahoma State University Cooperative Extension Service /12/. The formulas with the exception of the replacement stock feed requirements were derived by least-square regressions procedures.

The capital investments involved in the simulated dairy production units were for buildings, equipment, land, livestock, and class I milk base. Capital investment requirements were derived by least squares methods from the previously mentioned dairy budgets. Of the income and expense functions applied in the simulation, only those concerning miscellaneous expenses, labor requirements, and the cow feed requirements were derived by least-squares regressions. Other functions were derived from currently available management recommendations. Specific functions will be presented in the following chapter concerning diary production costs and returns.

Stochastic Elements

Several elements which in reality occur randomly were stochasticized in the dairy firm growth simulator. To introduce uncertainty into the simulation model it was necessary to allow these variables to assume values from a probability distribution at random. The stochastic elements included feed prices, calf and cull cow prices, death rates, and necessary herd culling rates. A frequency distribution was derived for each of the elements as a basis for distribution throughout each 10-year simulation over 40 replications. Through the use of a computerized random number generator, 10 unique sets of 40 were selected for each stochasticized variable. The sequence and level of each variable remained the same throughout each 10-year simulated run.

The basis for the range and frequency distribution of feed and livestock prices was a report of prices paid and received by Oklahoma farmers from 1954 through 1967 [1, pp. 90-91]. The prices over the 14-year period yielded the frequency distribution shown in Appendix B.

The cow and calf prices were not independently selected. The cattle market prices were selected in a manner such that when the cow price variable assumed a specific value the calf price variable assumed a comparable value.

The grain mix price values used in the simulator were the result of a least-cost linear programming procedure. The prices of the grain mix ingredients were randomly selected in the same manner that the values of other stochastic elements were selected. The grain mix ingredients, which became the activities or nutrient sources for the least-cost ration problem included salt, steamed bone meal, dicalium phosphate, ground limestone, soybean oil meal, cotton seed meal, barley, corn, sorghum, and oats.

The constraints of the least-cost ration problem include salt, equal to 1.0 percent; net energy, greater than or equal to 73.0 percent; crude protein, greater than or equal to 14.0 percent; digestible protein, greater than or equal to 10.0 percent; fat, greater than or equal to 2.5 percent; crude fiber, less than or equal to 8.0 percent; calcium, greater than or equal to 0.4 percent; and phosphorous, greater than or equal to 0.6 percent. Ten sets of 40 grain mix price values, determined by the least-cost method, were then used in the 40 replications of each of 10 years in the dairy firm growth simulator.

Estimates of culling and death rates were obtained from the dairy farm surveys. Even though the distribution varied somewhat between herd sizes, statistical tests indicated that the variation was not significantly different. The distributions of culling and death rates are shown in Appendix B.

The mean value of the 400 values of each stochastic variable was compared with the expected values obtained from the variable frequency distribution. This comparison is illustrated in Table II.

TABLE II

COMPARISON OF MEAN VALUE OF RANDOMLY SELECTED VARIABLES WITH EXPECTED VALUES

	Cow Price Per Head	Calf Price Per Head	Cow Cull-ing Rate	Cow Death Rate	Year-ling Death Rate	Calf Death Rate	Alfalfa Hay Per Ton	Grain Mix Per Cwt.
	$	$	%	%	%	%	$	$
Mean Value	182.89	35.80	12.60	2.70	1.06	8.28	29.47	2.49
Expected Value	181.50	35.70	13.00	2.75	1.05	8.1	29.50	2.50*

*Least-cost ration price obtained from the expected value of all ingredients.

Net Income Withdrawals

Several firm growth studies of the past have failed to consider many of the important cash withdrawals from net income [2, p. 769]. Income taxes, social security, mandatory long-term debt repayment and family living expenses can account for most or all of the net income in the early years of firm life; consequently, leaving little or no reserve for capital expansion. Taxes and long-term debt repayments are easily determined through simple mathematics, but family living withdrawals require some stringent assumptions to enable computation. The assumptions employed in this study in relation to family living withdrawals have been previously reviewed in this chapter.

Even though tax withdrawals are mathematically determinable, the procedure becomes detailed when including such items as allowable livestock, building and equipment depreciation; the allowance for capital gain or loss to include sale of depreciable stock and livestock death losses; and personal family deductions and exemptions. All of the above deductions and allowances were included in tax computations in this study.

For simplicity all depreciation schedules were straight-line. Purchased cows were on a five-year depreciation with a $100 salvage value; equipment was depreciated at 10 percent per year for 10 years, while buildings were depreciated at 5 percent for 20 years. Investment credit was allowed on all new equipment purchases.

Capital gains or losses required a detailed accounting of the undepreciated value of purchased cows that died and the difference between "book" value of depreciable cows and their market value when culled. It was assumed that all cows had equal probabilities of dying or being culled whether home raised or purchased; therefore, only the average "book" value of purchased cows, the proportion of the herd consisting of purchased cows, the per cow cull market price, culling rate and death rate was required each year to determine livestock capital gains or losses. Capital gains or losses were also allowed in the sale of depreciated equipment during cases of herd reduction. The federal income tax schedule used included the current surtax, and state income tax was assumed to be 5 percent of the federal tax. Social security was computed at 6.15 percent with the upper level of subject income being $7,800. Personal exemptions of $2,400 for a family of four and a standard 10 percent deduction not to exceed $1,000 was assumed for income tax computations. For the detailed functions used in tax computations see Appendix B.

Long-term debt payment was based on a 20-year amortized repayment schedule. Even though the annual payments were identical on a particular long-term loan, the amount applied to the loan principle increased over time as interest payments decreased.

The criteria for family living were analyzed during the simulation after all other withdrawals were accounted for. If the lower limit for family living was not met more cows were culled from the lower end of the herd production scale to increase the gross income amount available for family living. If the lender debt limit was exceeded, cows were sold for intermediate loan repayment. If the upper limit of family living was exceeded the excess was diverted to intermediate loan repayment, herd expansion, and personal savings in that order. All excess was channeled toward debt repayment until the owner's desired equity position was obtained, then excesses were directed toward herd expansion in one cow increments. For this study an upper limit of 160 cows was established because of the limit of reliable survey data; therefore, excess income above family living requirements was allowed to be placed in personal savings only after the 160 cow herd had been achieved. Family living and reinvestment functions appear in detail in Appendix B.

Inputs for Successive Years

Other than the array of stochastic elements, input data were supplied from an external source only for the first year. Thereafter, the inputs for each year were generated by the preceeding yearly simulation. All successive yearly input derivations are presented in Appendix B.

Yearly Simulation Report

Forty replications of dairy firm operations were simulated for each of 10 successive yearly periods. A total of 109 runs was completed, varying the interest rate, wage rate, class I milk base price, class I milk base amounts, family living criteria, and average milk production (Tables III, IV, and V). At the conclusion of each year of the 10-year simulation data on 41 variables were printed for further analysis (Figure 2). For each variable, reading from left to right in Figure 2, the values of the variables are printed for the replication with the highest year ending net worth, the average value of each variable over the 40 replications, the value of the variable for the replication with the lowest year ending net worth, and the standard deviation of each variable. The print out provided the extremes of each variable over the 40 replications and the expected values of each variable. Each page was headed by the year of the simulation, the assumed hourly wage, the intermediate term interest rate, the price per pound of class I base, percent of class I base, and average initial milk production.

TABLE III

SIMULATION RUNS AT THE 9,000 POUND LEVEL OF PRODUCTION

Consumption Function	Per Cent Class I Marketings	Long Term Interest Rate / Hourly Wage Rate / Base Price Per Pound	6% / 1.50 / $10.00	6% / 1.75 / $10.00	6% / 2.00 / $10.00	6% / 1.75 / $15.00	7% / 1.50 / $10.00	7% / 1.75 / $10.00	7% / 2.00 / $10.00	8% / 1.75 / $15.00	8% / 1.50 / $10.00	8% / 1.75 / $10.00	8% / 2.00 / $10.00
Equity-Labor	50					X							
Income	50					X							
Rigid	70							X		X			
Equity-Labor	70											X	
Income	70											X	
Rigid	83		X	X*	X		X*	X*	X*		X	X*	X
Equity-Labor	83		X	X*	X		X	X*	X		X	X	X
Income	83		X	X*	X		X	X*	X		X	X	X

* Simulation runs analyzed in this study.

TABLE IV

SIMULATION RUNS AT THE 11,000 POUND LEVEL OF PRODUCTION

Consumption Function	Per Cent Class I Marketings															
		Long Term Interest Rate	6%	6%	6%	6%	6%	7%	7%	7%	7%	7%	8%	8%	8%	8%
		Hourly Wage Rate	1.75	1.50	1.75	2.00	1.75	1.75	1.50	1.75	2.00	1.75	1.50	1.75	2.00	1.75
		Base Price Per Pound	$ 0.00	10.00	10.00	10.00	15.00	0.00	10.00	10.00	10.00	15.00	10.00	10.00	10.00	15.00
Rigid	50		X		X			X		X*						
Equity-Labor	50						X									
Income	50						X									
Rigid	70				X					X*				X		
Equity-Labor	70													X		
Income	70													X		
Rigid	83			X	X*	X	X	X*	X*	X*	X*	X*	X	X*	X	X
Equity-Labor	83			X	X	X			X	X*	X		X	X	X	
Income	83			X	X	X			X	X*	X		X	X	X	

* Simulation runs analyzed in this study.

TABLE V

SIMULATION RUNS AT THE 13,000 POUND LEVEL OF PRODUCTION

Consumption Function	Per Cent Class I Marketings	Long Term Interest Rate	6%	6%	6%	6%	7%	7%	7%	8%	8%	8%	8%	8%
		Hourly Wage Rate	1.50	1.75	2.00	1.75	1.50	1.75	2.00	1.50	1.75	2.00	1.75	2.00
		Base Price Per Pound	$10.00	10.00	10.00	15.00	10.00	10.00	10.00	10.00	10.00	10.00	15.00	15.00
Rigid	50							X*						X
Equity-Labor	50					X								
Income	50					X								
Rigid	70													X
Equity-Labor	70										X			
Income	70												X	
Rigid	83		X	X*	X		X	X*	X*	X	X*	X		
Equity-Labor	83		X	X	X		X	X*	X	X	X	X		
Income	83		X	X	X		X	X*	X	X	X	X		

*Simulation runs analyzed in this study.

The output is divided into four parts: INCOME STATEMENT; NET WORTH STATEMENT; LIVESTOCK INVENTORY GROWTH, PRODUCTION, AND LABOR INFORMATION; and, AVERAGE RELATIONSHIPS. Several of the values need further explanation while others are self explanatory.

The values presented in Part I entitled "INCOME STATEMENT" are explained more fully as follows: "gross income" is the total cash receipts plus inventory increases; "gross expense" includes all operating expenses plus depreciation of capital assets; "net income" is "gross income" minus "gross expense"; "net cash income after taxes" is a cash flow concept which includes total cash receipts minus cash expenses and federal and state income taxes and social security taxes; "family living" is the amount used for consumption within the constraints of the model depending upon the specific consumption function employed; and "net for reinvestment or savings" is "net cash income after taxes" minus "family living" and includes money available for repayment of long-term and intermediate-term loans, capital for business expansion, and savings.

Most of the values presented in Part II are self explanatory except that it should be noted that "savings" remained at a zero value until some of the replications had reached 160 cows beyond which further expansion was not allowed. All values in the NET WORTH STATEMENT section were computed at the close of the year denoted in the page heading.

Some values included in Part III require further elaboration. "Cows in the herd during this year" refers to the number of cows upon which the current year income statement was computed. "Cows purchased" refers to those cows that were brought into the herd at the end of the

```
             YEAR -- WAGE -.-- INTERMEDIATE TERM INTEREST O/O --.-
       CLASS I BASE PRICE --.-- CLASS I BASE O/O -- AVERAGE PRODUCTION -----

                                                   HIGH     AVERAGE     LOW     S. DEV.

                                     PART I INCOME STATEMENT

GROSS INCOME
GROSS EXPENSE
NET INCOME
NET CASH INCOME AFTER TAXES
FAMILY LIVING
NET FOR REINVESTMENT OR SAVINGS

                                   PART II NET WORTH STATEMENT

                                             ASSETS
LIVESTOCK VALUE
BASE VALUE
EQUIPMENT VALUE
BUILDING AND FENCE VALUE
REALESTATE VALUE
SAVINGS
TOTAL ASSETS
                                      LIABILITIES
LONGTERM LOANS
INTERMEDIATE TERM LOANS
TOTAL LIABILITIES
NET WORTH AT CLOSE OF YEAR

     PART III LIVESTOCK INVENTORY GROWTH, PRODUCTION, AND LABOR INFORMATION

COWS IN HERD DURING THIS YEAR
COWS PURCHASED
COWS IN HERD AT END OF YEAR
YEARLINGS IN HERD DURING THIS YEAR
YEARLINGS IN HERD AT END OF YEAR
CALVES IN HERD DURING THIS YEAR
CALVES IN HERD AT END OF YEAR
PRODUCTION PER COW
CWT. MILK MARKETED
HOURS OF HIRED LABOR
TOTAL HOURS OF LABOR REQUIRED

                                  PART IV AVERAGE RELATIONSHIPS

GROSS INCOME PER COW
EXPENSES PER COW
NET INCOME PER COW
INVESTMENT PER COW
INVESTMENT PER CWT. MILK PRODUCED
INVESTMENT PER HOUR OF LABOR
RETURN TO CAPITAL
RETURN TO OWNER EQUITY
NET WORTH RATIO
RETURN PER HOUR OF LABOR
GROSS RETURN PER CWT. MILK MARKETED
EXPENSE PER CWT. MILK MARKETED
NET RETURNS PER CWT. MILK MARKETED
```

Figure 2. Yearly Simulation Report

year. "Cows in the herd at the end of year" is the number of cows to be in the herd at the beginning of the succeeding year. The information on yearlings and calves concerns beginning and ending current year inventories. "Production per cow" refers to the average milk production per cow during the current year. "Cwt. milk marketed" indicates the number of hundred weights of milk that were sold, allowing for milk used for calf feed but not for household use. "Hours of hired labor" plus family labor may exceed the "total hours of labor required" because of the non-divisability of hired labor increments assumed in this study.

Part IV includes several relationships that are useful in planning a dairy production enterprise. The first four values are per cow average income, expense, and investment for the current year. "Return to capital" refers to a net return to total investment and is computed as net income plus interest paid minus a wage bill for family labor at the indicated wage rate divided by the total assets; while "return to owner equity", again a net return concept, is computed as net income minus a wage bill for family labor at the indicated wage rate divided by net worth. The "net worth ratio", net worth divided by total assets, was never allowed to drop below 40 percent. "Return per hour of labor" is the net income plus the hired labor bill minus interest from a personal savings account all divided by hours of family plus hired labor. The last three values are hundred weights of milk marketed averages associated with "gross income", "gross expense", and "net income" values.

The output sheet in Figure 2 provides an annual estimate of the future of a specific dairy production unit plan. The information provided along with ranges and standard deviations could be very helpful to both borrowers and lenders of capital.

Firm Growth Prediction

Least-squares regressions were computed on the simulated growth results to arrive at growth prediction formulas. The net worth for each of the 10 years was analyzed. The prediction formulas and the effects of specific variables on growth will be discussed in later chapters.

Summary

This chapter has explained the environment within which the dairy firm growth simulator has operated. The specific models employed in obtaining pre-simulation data and the simulation model itself have been discussed. The computer routine is long and detailed for any simulation of reality, but an abbreviated flow chart will aid the reader in following the steps involved in this particular simulation model. Figure 3 presents the condensed computer routine flow chart of the dairy firm growth simulation.

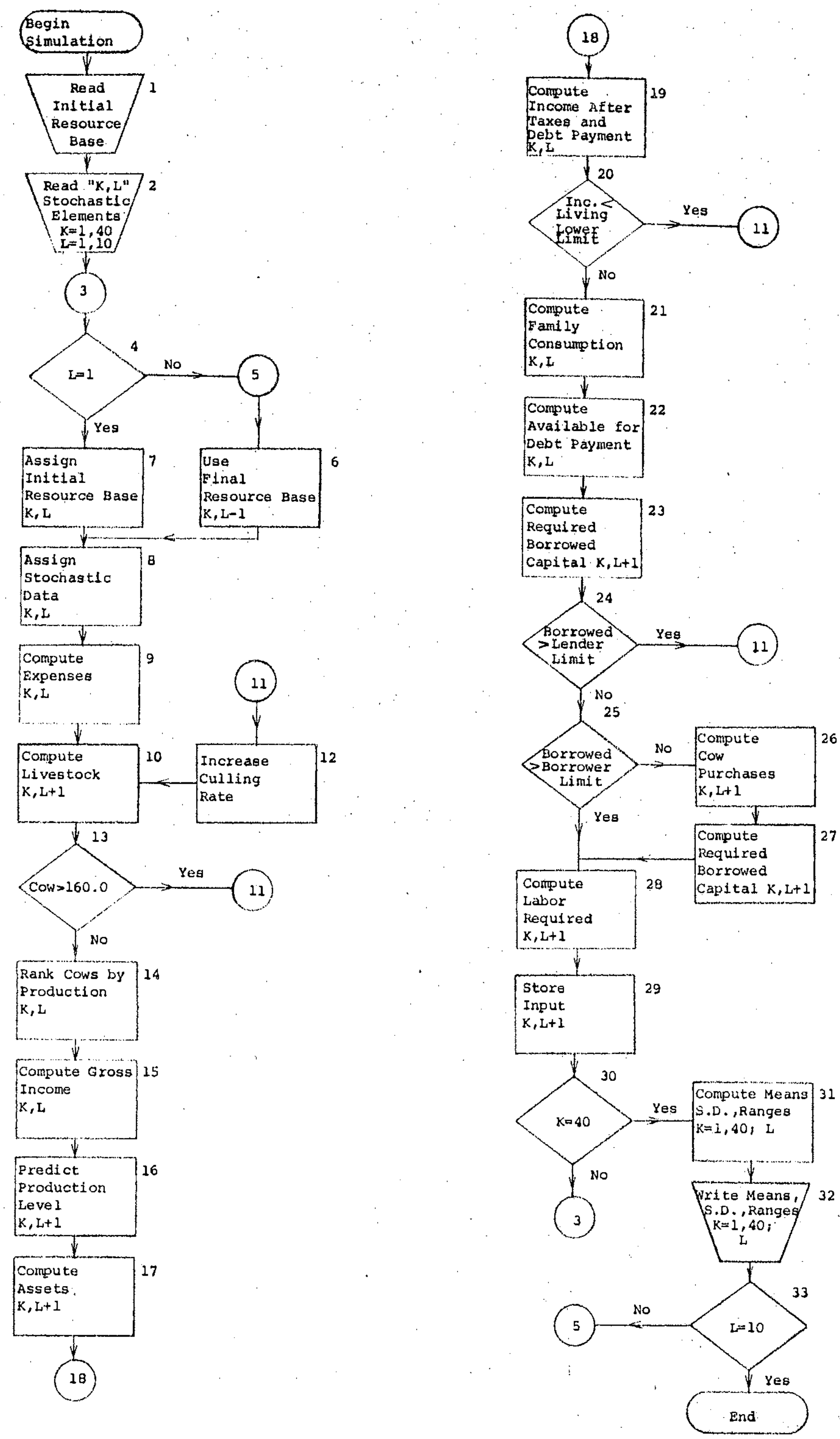

Figure 3. A Generalized Flow Chart of the Dairy Firm Growth Simulator (K = Replication, L = Year)

CHAPTER III

COSTS AND RETURNS ON OKLAHOMA GRADE A DAIRY FARMS

This chapter provides the data concerning capital investment, returns, and costs of producing grade A milk in Oklahoma for use in the firm simulation discussed in the previous chapter. Since average milk production and herd size affect investment, returns, and costs, an analysis of an average production unit size would have been meaningless. Costs for herd sizes of 40, 62, 87, and 130 cows each with average milk production of 9,000, 11,000, and 13,000 pounds of 3.5 percent milk were budgeted. Functions were derived from the budgets for the projection of investment, returns, and costs for herds included. The survey of Oklahoma grade A dairy production units was the basis for the budgets.

Initial Investment for Budgeted Firms

One of the greatest barriers to entry into grade A milk production is the high initial cost. Dairying is highly specialized and subject to strict health codes; hence there is little opportunity to postpone until the future the necessary initial investments. With the recent advent of Class I milk marketing bases, the amount of initial capital to commence business has become even greater.

The budgeted dairy farms indicated that fixed investment ranged from $7.11 per hundred pounds of milk for 40-cow herds averaging 9,000 pounds per cow to $2.86 per hundred pounds of milk for 130-cow herds averaging 13,000 pounds (Table VI). Table VI indicates that, within a specific production level, the average fixed investment per cow is reduced by approximately $300 from the 40 to the 130-cow herds. The large reduction in investment per cow indicates the presence of size economics in milk production.

The investment costs of variable resources (livestock and milk bases) based on market values are indicated in Table VII. This table also shows the initial investment costs per cow and per hundred pounds of milk by production level.

Class I base prices have not been firmly established in Oklahoma, but based on representative base sales, a value of $10 per pound has been assumed. Each pound of class I base entitles the owner to market 365 pounds of milk annually at the class I price; excess above base must be sold at a surplus milk price which is considerably lower than the class I price. By referring to Tables VI and VII it can be observed that as herd size, production per cow, and percentage of class I milk marketings increase, the proportion of variable resource investment costs to total investment increases. For example, only 45.6 percent of the total investment for a herd of 40 cows producing 9,000 pounds with 50 percent class I marketings is variable investment ($21,460 variable and $25,607 fixed), while for a herd of 130 cows averaging 13,000 pounds of milk with 83 percent class I marketings variable investment accounts for 67.7 percent of the total investment ($101,282 variable and $48,325 fixed).

TABLE VI

INVESTMENT COSTS OF TYPICAL FIXED RESOURCES ON OKLAHOMA GRADE A DAIRY FARMS BY HERD SIZE AND PRODUCTION, 1968

Investment Item	40-Cow Herd Average Production (Pounds)			62-Cow Herd Average Production (Pounds)			87-Cow Herd Average Production (Pounds)			130-Cow Herd Average Production (Pounds)		
	9,000	11,000	13,000	9,000	11,000	13,000	9,000	11,000	13,000	9,000	11,000	13,000
	dollars											
Land[1]	1,560	1,560	1,560	2,340	2,340	2,340	2,600	2,600	2,600	2,860	2,860	2,860
Improvements[2]	11,099	11,238	11,375	14,375	14,935	15,148	17,924	18,225	18,525	24,567	25,017	25,465
Dairy Equipment	5,798	6,379	6,379	6,840	7,306	7,557	7,352	8,320	8,521	9,133	11,100	12,370
Other Equipment	7,150	7,150	7,150	7,250	7,250	7,250	7,450	7,450	7,450	7,630	7,630	7,630
Total Fixed Investment	25,607	26,327	26,464	31,150	31,831	32,295	35,326	36,595	37,096	44,490	46,607	48,325
Fixed Investment Per Cow	640.18	658.18	661.60	502.42	513.40	520.89	406.05	420.63	426.39	339.92	358.52	371.73
Fixed Investment Per Cwt Milk[3]	7.11	5.89	5.09	5.58	4.67	4.01	4.51	3.82	3.28	3.78	3.26	2.86

1. Land charges include only that physically needed for buildings and lots.
2. Improvements include buildings, fences, water systems and feed storage.
3. Investment per Cwt. of 3.5% milk.

TABLE VII

INVESTMENT COSTS OF TYPICAL VARIABLE RESOURCES BY PRODUCTION LEVEL, OKLAHOMA GRADE A DAIRY FARMS, 1968

Type of Investment	Annual Milk Production Per Cow (Pounds) 9,000	11,000	13,000
	- - - - - - -	dollars	- - - - - - - - - - -
Livestock Only[1]			
Per Cow	415.81	451.77	487.74
Per Cwt. milk	4.62	4.11	3.75
Base Only[2]			
50% class I milk marketings			
Per Cow	120.70	148.10	175.50
Per Cwt. milk	1.34	1.35	1.35
70% class I milk marketings			
Per Cow	169.00	207.35	245.70
Per Cwt. milk	1.88	1.89	1.89
83% class I milk marketings			
Per Cow	200.38	245.85	291.35
Per Cwt. milk	2.23	2.24	2.24

[1]Livestock includes cows plus .2 yearling heifer and .2 replacement heifer calf.

[2]Value of base computed at $10 per pound.

Returns From Grade A Milk Production

Receipts from dairy farms are derived from two major sources - milk and animals or dairy-beef. The average annual sales of surplus calves and cull dairy cows from the survey amounted to $56.28 per cow. The amounts of receipts from the sale of beef and milk per hundred pounds of milk produced are shown in Table VIII.

TABLE VIII

RECEIPTS PER HUNDRED POUNDS OF MILK PRODUCED BY PRODUCTION LEVEL, SUBJECT TO VARIOUS CLASS I BASE MILK MARKETING PERCENTAGES, OKLAHOMA GRADE A DAIRY FARMS, 1968

Production Per Cow	Beef Sales	Milk Sales at Various Percentages of Class I Base		
		50%	70%	83%
	-dollars-			
9,000	.625	5.042	5.552	5.894
11,000	.512	5.062	5.573	5.907
13,000	.433	5.076	5.588	5.923

Sales of 18 percent of the cows as culls at $181.50 a head and a surplus of 0.6613 calves per cow at $35.70 per head account for the income from beef sales. The number of surplus calves sold was determined by assuming a 94 percent calving rate, based on DHIA records which indicated an average calving interval of 388 days, an 8.1 percent calf death loss, and the retainment of 0.2 calves per cow for replacement purposes.

It will be noted in Table VIII that receipts per hundred pounds of milk produced is not the same for each production level within a specific class I base marketing situation. It was assumed that 188 pounds of milk from each cow was retained on the farm for calf feed; therefore, only 97.91, 98.29, and 98.55 percent of the milk produced by cows averaging 9,000, 11,000, and 13,000 pounds of milk respectively was marketed. The class I and surplus milk prices used in this study were $6.46 and $3.83 per hundred pounds respectively. These prices were net to the producer after a 35-cent per hundred weight hauling, advertising, and marketing fee had been deducted.

Costs of Grade A Milk Production

Results from the farm and equipment supplier surveys provided a basis for determining the costs of depreciation, taxes, insurance, and repairs and maintenance. The life of buildings, fences, feed storage, and other improvements was considered to be 20 years, while equipment life was assumed to be 10 years. No salvage value was assumed for either buildings or equipment. No cow depreciation expense was included other than in an indirect manner as costs associated with the raising of replacements were included in operating expenses. The combined taxes and insurance costs were assumed to be 0.75 percent of the initial cost (1.5 percent of average value).

Repairs and maintenance were computed at 2.5 percent and 3.0 percent of the original value for buildings and equipment respectively. Interest of 7 percent was charged on the average building and equipment investment. The portion of miscellaneous overhead expenses that was associated with the dairy farm operation, but did not vary with herd size was included in fixed costs. Labor costs included a charge for both hired and family supplied labor. The wage rate used in the cost analysis was $1.75 per hour. Variable cost included interest and taxes on livestock and class I milk bases. Also included in variable costs were overhead costs that varied with cow numbers and livestock feed costs.

A summary of fixed and variable costs per hundred pounds of milk produced for the budgeted dairy production firms can be found in Table IX. The added variable costs due to the ownership of class I milk base are indicated toward the end of the table. It should be noted that the costs presented here include a payment to the dairyman of $1.75 per hour for labor supplied by him.

Derivation of Computational Formulas

In order for the firm growth simulator to effectively represent the operation of a dairy production firm, computational formulas were developed. The computational formulas were derived by least-squares regression from the empirical survey data and the constructed dairy budgets. These formulas include physical and economic relationships, investment costs, production costs, and returns. The equations used in the simulator are shown in Table X.

TABLE IX

COSTS PER HUNDREDWEIGHT OF MILK PRODUCED ON OKLAHOMA GRADE A DAIRY FARMS BY HERD SIZE AND PRODUCTION LEVEL, 1968

	40-Cow Herd Average Production (Pounds)			62-Cow Herd Average Production (Pounds)			87-Cow Herd Average Production (Pounds)			130-Cow Herd Average Production (Pounds)		
Fixed Cost Item	9,000	11,000	13,000	9,000	11,000	13,000	9,000	11,000	13,000	9,000	11,000	13,000
	---------- dollars per Cwt. of milk ----------											
Taxes & Insurance	.053	.045	.038	.042	.035	.030	.034	.029	.025	.028	.024	.021
Miscellaneous	.089	.073	.062	.057	.047	.040	.041	.033	.028	.027	.022	.019
Repairs	.186	.156	.133	.142	.119	.102	.114	.079	.083	.095	.083	.073
Depreciation	.517	.435	.370	.384	.323	.278	.303	.260	.223	.248	.218	.194
Interest	.263	.222	.189	.210	.175	.150	.170	.143	.123	.141	.121	.106
Total Fixed Cost	1.108	.931	.791	.835	.699	.600	.662	.563	.482	.540	.469	.413
Labor Cost	1.510	1.236	1.046	1.119	.916	.775	.915	.749	.633	.747	.611	.517
Variable Cost Item												
Feed	2.595	2.308	2.109	2.595	2.308	2.109	2.595	2.308	2.109	2.595	2.308	2.109
Miscellaneous	.445	.372	.315	.455	.372	.315	.455	.372	.315	.455	.372	.315
Taxes	.035	.031	.028	.035	.031	.028	.035	.031	.028	.035	.031	.028
Interest	.323	.287	.263	.323	.287	.263	.323	.287	.263	.323	.287	.263
Total Variable Cost	3.408	2.999	2.717	3.408	2.999	2.717	3.408	2.999	2.717	3.408	2.999	2.717
Total Cost	6.026	5.166	4.552	5.362	4.614	4.090	4.985	4.311	3.830	4.695	4.079	3.645

TABLE IX (Continued)

Added Cost of 50% Base	40-Cow Herd Average Production (Pounds)			62-Cow Herd Average Production (Pounds)			87-Cow Herd Average Production (Pounds)			130-Cow Herd Average Production (Pounds)		
	9,000	11,000	13,000	9,000	11,000	13,000	9,000	11,000	13,000	9,000	11,000	13,000
	dollars per Cwt. of milk											
Taxes	.010	.010	.010	.010	.010	.010	.010	.010	.010	.010	.010	.010
Interest	.094	.094	.094	.094	.094	.094	.094	.094	.094	.094	.094	.094
Total	.104	.104	.104	.104	.104	.104	.104	.104	.104	.104	.104	.104
Added Cost of 70% Base												
Taxes	.014	.014	.014	.014	.014	.014	.014	.014	.014	.014	.014	.014
Interest	.131	.132	.132	.131	.132	.132	.131	.132	.132	.131	.132	.132
Total	.145	.146	.146	.145	.146	.146	.145	.146	.146	.145	.146	.146
Added Cost of 83% Base												
Taxes	.017	.017	.017	.017	.017	.017	.017	.017	.017	.017	.017	.017
Interest	.156	.156	.157	.156	.156	.157	.156	.156	.157	.156	.156	.157
Total	.173	.173	.174	.173	.173	.174	.173	.173	.174	.173	.173	.174

TABLE X

INVESTMENT, COST, AND RETURN EQUATIONS EMPLOYED IN THE DAIRY FIRM GROWTH SIMULATOR

Simulation Equation		
Investment		
RLSTI	(dollars)	= 994.73665 + 18.74742C
EQPI	(dollars)	= 10490.03735 + 11.97403C + 0.0062597(B) (C)
BLDI	(dollars)	= 3565.37271 + 109.98355C + 0.0017399(B) (C)
YGBLD	(dollars)	= 18.60402 + 34.7404Y
CFBLD	(dollars)	= 32.3834 + 44.4711D
COWV	(dollars)	= 240.22266C + 0.01215(B) (C)
YLGV	(dollars)	= 45.94519Y + 0.01971 (B) (Y)
CLFV	(dollars)	= 22.7877D + 0.00945 (D) (Y)
BV	(dollars)	= (BAS) (PB)
Cost		
XMISC	(dollars)	= 320.34439 + 38.23115C + 4.30025D + 9.39683Y
WORK	(hours)	= 2013.7339 + 17.6039C
YGWRK	(hours)	= 114.89485 + 5.10126Y
CFWRK	(hours)	= 138.41055 + 11.36206D
FDC	(dollars)	= 2.27 (ALF) (C) + 0.000116(B) (ALF) (C) + 16.4(C) (GMP) + 0.0027 (B) (GMP) (C) + 14.0C
FDY	(dollars)	= 11.0 (GMP) (Y) + 1.2 (ALF) (Y) + 16.0Y
FDD	(dollars)	= 7.0 (GMP) (D) + 1.5 (ALF) (D)
RINT	(dollars)	= (DCAE) (RI) + (DRLST) (RL)
TAX	(dollars)	= 0.0075TI
DEP	(dollars)	= 0.05 (BLDI + CFBLD + YGBLD) + 0.1EQPI
REP	(dollars)	= 0.025 (BLDI + CFBLD + YGBLD) + 0.03 EQPI
WLAB	(dollars)	= (HL) (WG)
Return		
SVX	(dollars)	= (SAVG) (RSV)
SDX	(dollars)	= (CLFP) (C) (0.64 - 0.94DK)
SCX	(dollars)	= (COWP)(C) (CUL)
SMX	(dollars)	= 365.0 (BAS) (P) + (C (B - 188.0) - 365.0BAS) (SP)

Dependent variables are as follows:

RLSTI is the land investment for buildings and lots;

EQPI is the equipment investment;

BLDI is the building and fence investment for the milking herd;

YGBLD is the building and fence investment for the yearling replacement animals;

CFBLD is the building and fence investment for the replacement heifer calves;

COWV is the value of the milking herd;

YLGV and CLFV are the values of replacement yearlings and heifer calves respectively; and

BV is the value of class I milk base.

XMISC is the miscellaneous cost including supplies, records, veterinary expense, fuel and electricity;

WORK is the number of hours of labor required to care for the milking herd;

YGWRK and CFWRK are the number of hours of labor required to care for replacement yearlings and heifer calves respectively;

FDC is the feed cost for the milking herd;

FDY and FDD are the feed cost for the replacement yearlings and calves respectively;

RINT is the interest on borrowed capital;

TAX is the charge for insurance and taxes;

DEP is the building and equipment annual depreciation charge;

REP is the repairs and maintenance charge for buildings and equipment;

WLAB is the fixed labor expenses;

SVX is the income received from personal savings;

SDX is the returns from surplus calf sales;

SCX is the returns from cull cow sales; and

SMX is the returns from milk sales.

Independent variables are as follows:

C is the number of cows in the herd;

B is the average annual pounds of milk produced per cow;

Y is the number of replacement yearlings;

D is the number of replacement heifer calves;

BAS is the number of pounds of daily class I base owned; and

PB is the value per pound of class I milk base.

ALF is the price per ton of alfalfa hay;

GMP is the price per hundred pounds of grain mix;

DCAE and DRLST are the amounts of intermediate-term and long-term borrowed capital respectively;

RI and RL are the intermediate-term and long-term interest rates respectively;

TI is the total capital investment;

HL is the number of hours of hired labor;

WG is the hourly wage rate;

SAVG is the amount of personal savings;

RSV is the savings interest rate;

CLFP is the market price per surplus calf;

DK is the percent calf death loss;

COWP is the market price per cull cow;

CUL is the percent of cows culled;

P is the class I milk price per pound; and

SP is the price per pound of surplus milk.

The computational equations with the exception of those concerning the value of class I base, hired labor costs, and returns to the firm were derived via least-squares regression techniques from survey and budget data. The "t" and "R^2" values are presented in Appendix C.

The investment cost functions shown in Table X were used in determining the initial first-year input data, and also employed within the simulator to generate subsequent yearly inputs. The cost and return functions were employed in the simulation of yearly farm business activity.

Economies of Herd Size and Average Production

Economies of increased milk output that arise from increased herd size and average production can be clearly observed in Table IX and in Figures 4, 5, and 6. The three figures show the rapid decrease in average costs up to 60 cows where the average cost curve begins to level, but continues to decrease to the 160-cow size which was the limit of this study. Because no unique milk price exists with a class I base marketing plan, it was necessary to assume various percentages of total milk marketings subject to the class I base price. The class I base percentages of 50, 70, and 83 percent are depicted in Figures 4, 5, and 6, respectively. It is not conceivable that a producer would sell grade A milk if he owned no base; rather he would engage

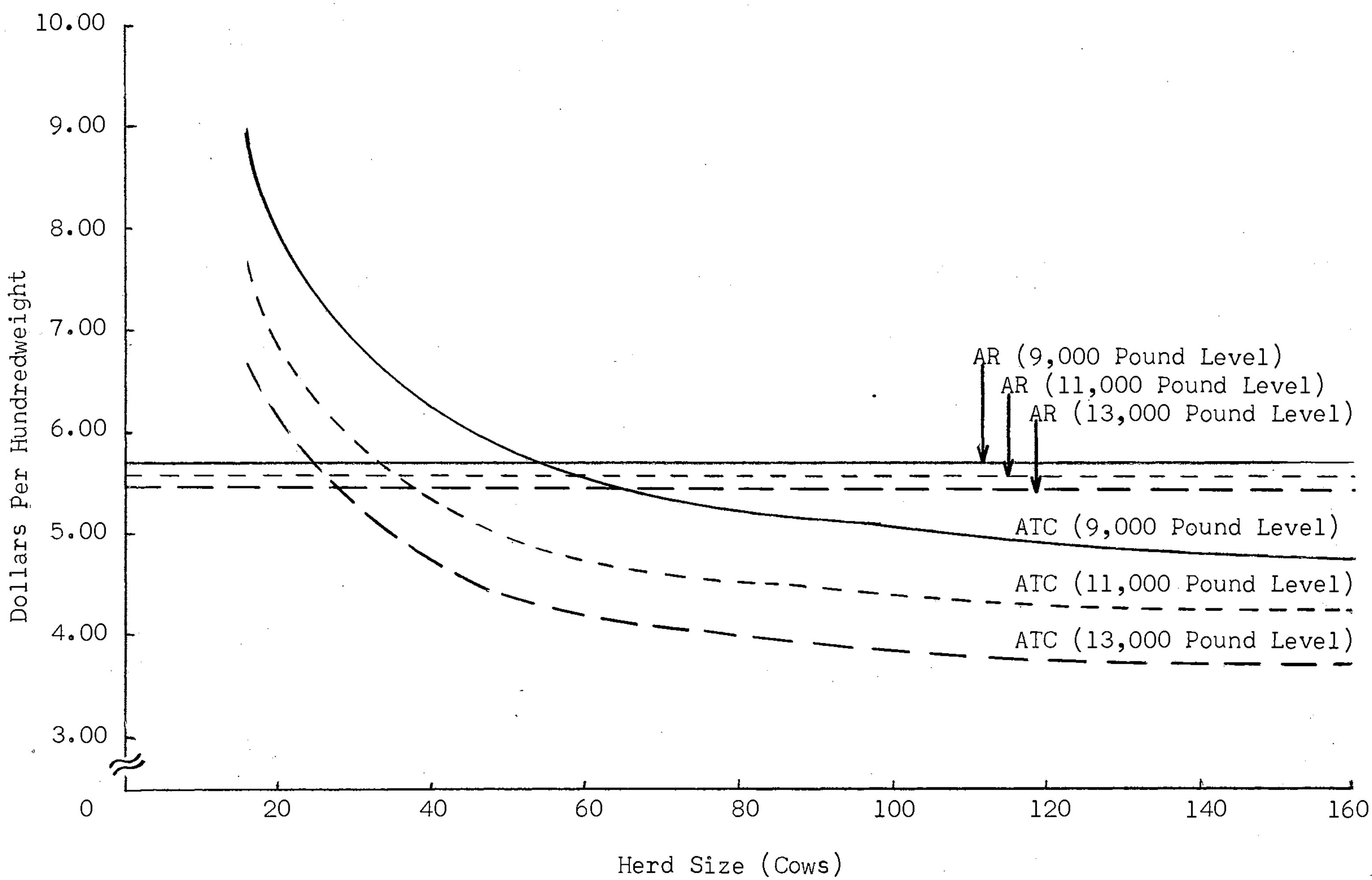

Figure 4. Average Total Cost and Average Revenue Per Hundredweight of Milk At Three Different Levels of Production When 50 Percent of the Milk Is Marketed at the Class I Price

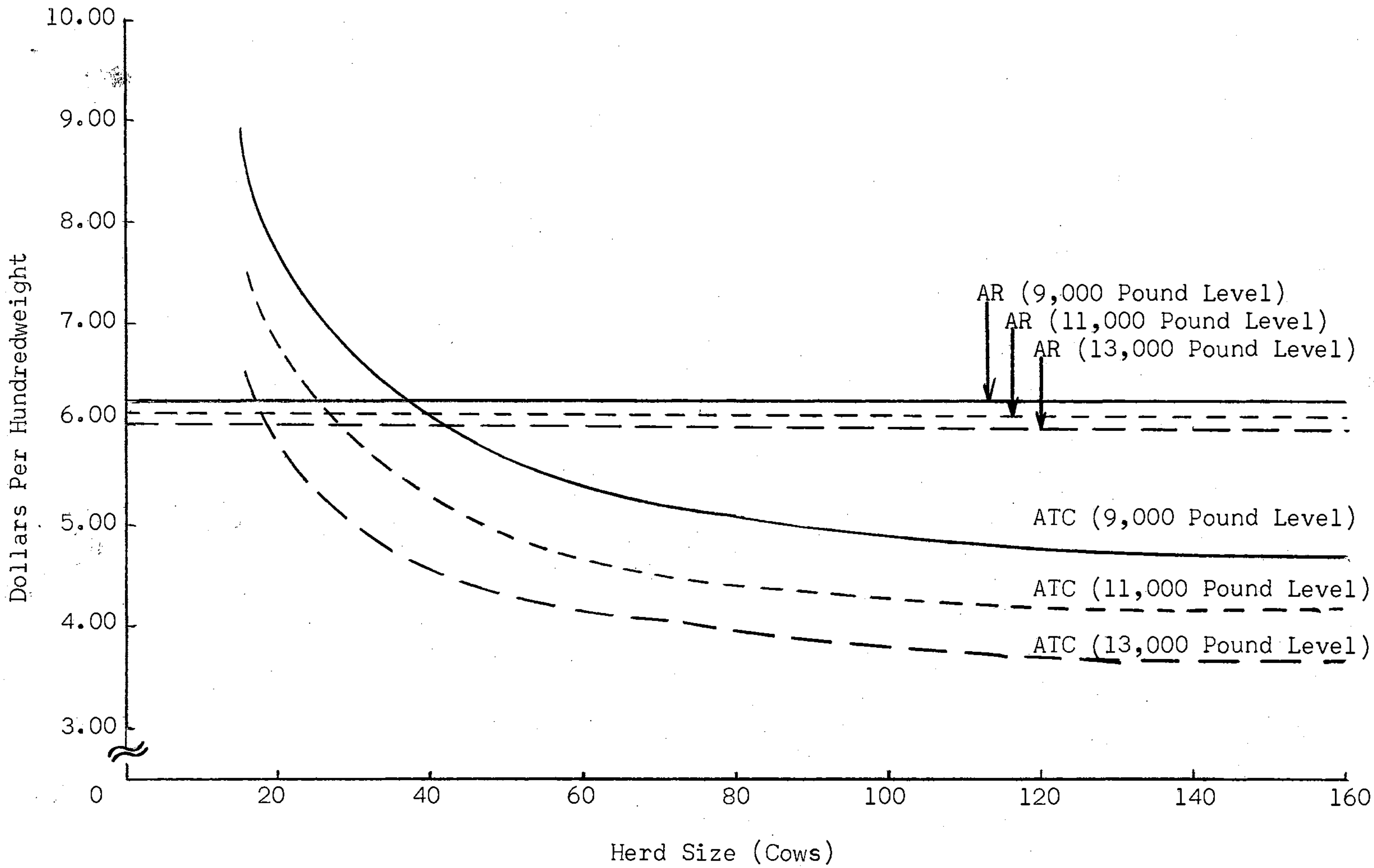

Figure 5. Average Total Cost and Average Revenue Per Hundredweight of Milk At Three Different Levels of Production When 70 Percent of the Milk Is Marketed at the Class I Price

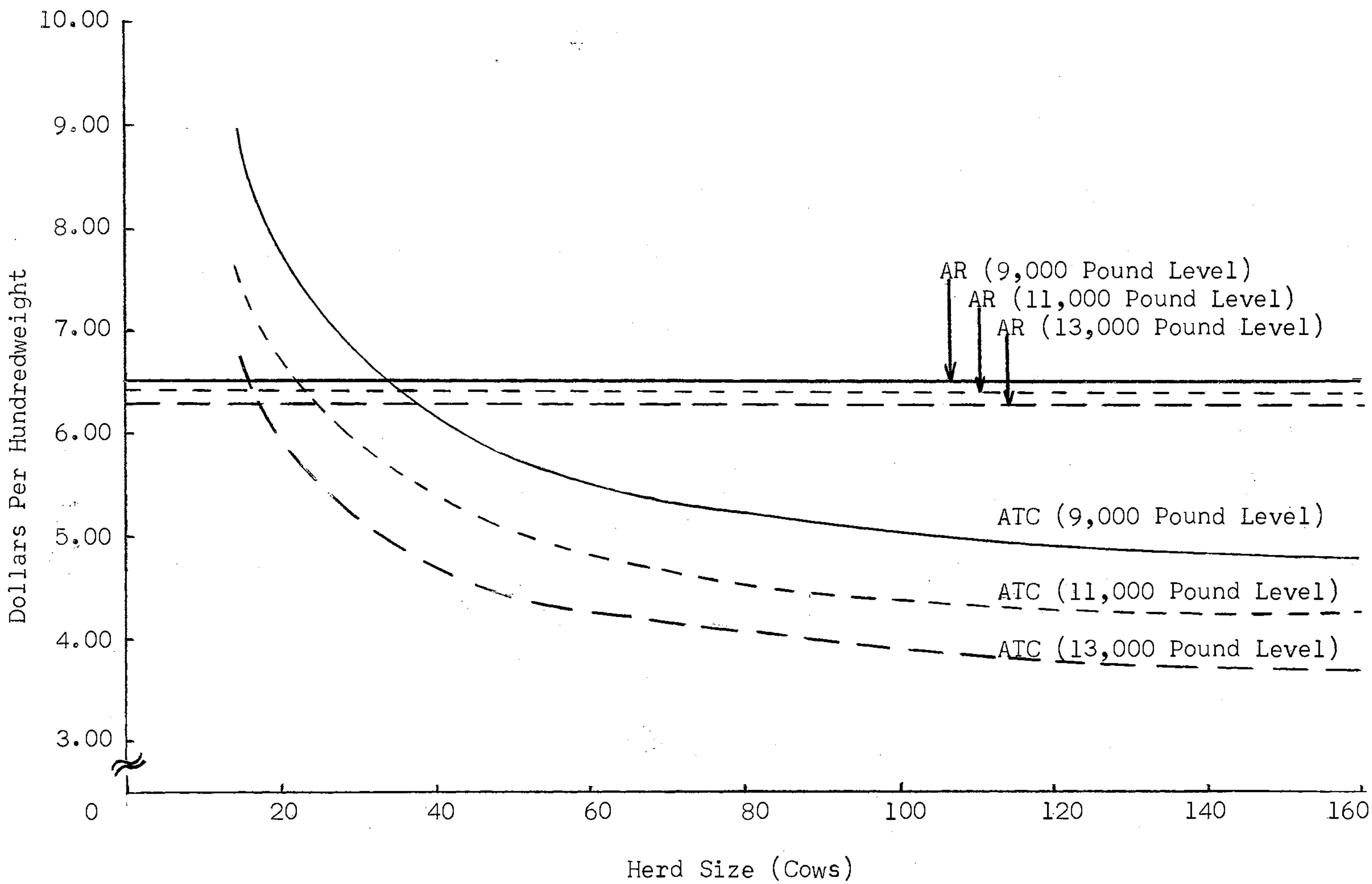

Figure 6. Average Total Cost and Average Revenue Per Hundredweight of Milk at Three Different Levels of Production When 83 Percent of the Milk Is Marketed at the Class I Price

in the production of ungraded or manufactured milk which would usually be priced at a level above the surplus milk price. Also it is unlikely that more than 83 percent of grade A milk would be processed as Class I (fluid) milk because processors desire a 20 percent surplus, to cover nonprocessing holidays and weekends. Even with this surplus requirement some individual producers could possess a class I base greater than 83 percent of their marketings, but the number would be small.

For the purposes of analysis the intermediate term interest rate was assumed at 8 percent, the wage rate at $1.75 per hour, and the value of class I base at $10 per pound in Figures 4, 5, and 6.

Figure 4 indicates the average total production costs and average returns per hundredweight of milk at 9,000, 11,000, and 13,000 pounds average production per cow for herd sizes of 20 to 160 cows. It was assumed that 50 percent of the marketed milk was subject to class I price. The average return per hundredweight of milk from beef and milk sales was $5,667, $5,574, and $5,509 for average 3.5 percent milk production levels of 9,000, 11,000, and 13,000 pounds respectively. The break-even herd size, allowing for a labor return to the owner of $1.75 per hour, was 53 cows at 9,000 pounds, 33 cows at 11,000 pounds, and 24 cows at 13,000 pounds.

It was assumed that 70 percent of the marketable milk was subject to the class I price in Figure 5. The average return per hundredweight of 3.5 percent milk was $6.177, $6.085, and $6.021 for production levels of 9,000, 11,000, and 13,000 pounds respectively. The break-even number of cows was 39 at 9,000 pounds, 26 cows at 11,000 pounds, and 19 cows at 13,000 pounds.

The amount of marketable milk assumed to be sold at the class I price was 83 percent in Figure 6. The average return per hundredweight of milk was $6.509, $6.419, and $6.356 for the three respective milk production levels. Thirty-four cows producing 9,000 pounds were required to reach the break-even point; while the break-even point was 23 cows and 17 cows at the 11,000 and 13,000 pound production levels.

The value per pound of class I base was assumed to be $10 in the cost of production study. It can be observed from the spread between average costs and returns in Figures 4, 5, and 6 that the opportunity exists for class I bases, cows and/or other production resources to attain higher prices than that now prevailing. Further discussion of class I base market and marginal values will be deferred to a later chapter in this study.

Summary

The initial investment costs, production costs, and returns for various herd sizes and production levels have been reviewed in this chapter. The computational functions derived for the simulation operations from empirical data and farm budgets were explained. The economies of herd size indicated a decline of average costs per hundred pounds of milk throughout the range of herd sizes studied. The economies associated with production per cow indicated that approximately twice as many cows producing 9,000 pounds of milk as cows producing 13,000 pounds of milk were required to provide a return sufficient to cover all expenses plus a labor income of $1.75 per hour to the herd owner.

CHAPTER IV

EFFECTS OF INPUT PRICES ON GROWTH

The effect of key input price variables on firm growth is discussed in this chapter. The variables are the price effects of capital, labor and class I milk base inputs. Simulation runs were conducted in which effects of varying a particular variable were observed, but all stochastic events occurred in the same sequence from one complete run to another. The effects of class I base price changes will be reviewed in a later chapter when the effects of milk prices are discussed. The effects of interest and wage rate key variables are presented in this chapter with reference to firms commencing operation at the three specified technology levels of 9,000, 11,000, and 13,000 pounds of milk per cow. The results of firm growth at each of the three levels of technology are unique when key variables are analyzed; therefore, an analysis for each of the technological levels is presented in the following chapters.

The Effects of Variable Interest Rates on Firm Growth

The growth of the dairy production firm was observed under intermediate term interest rates of 7, 8, and 9 percent. Long term interest rates paired with the above intermediate term interest rates were 6, 7, and 8 percent. Similarly 5, 6, and 7 percent respectively were used for personal saving rates as shown in Table XI.

Simulated firm growth results employing the three levels of interest rates were evaluated. The primary results and implications were:

1. Interest rates had little effect on growth of firms starting at the low level of technology, 9,000 pounds of milk per cow. The firm underwent some internal restructuring as a result of increased interest expenses and the reorganization of assets caused increased technological adaptation that nullified interest rate effects.
2. Interest rate effects on the growth of firms starting at higher levels of technology were observable.

TABLE XI

INTEREST RATE PAIRINGS EMPLOYED IN THE SIMULATION

Savings Interest Rate	Long Term Interest Rate	Intermediate Term Interest Rate
5 %	6 %	7 %
6 %	7 %	8 %
7 %	8 %	9 %

To analyze the effects of various interest rates, it was necessary to employ the <u>ceteris paribus</u> concept to other variables. The effects of interest rates on growth for each level of technology were observed by assuming the wage rate fixed at $1.75 per hour, the percentage of class I marketings at 83 percent, the price per pound of daily class I base at $10.00, and family living based on the rigid consumption function (a minimum of $4,500, a maximum of $7,500, and minimum three-year average of $6,000). Figure 7 compares the 10-year net worth under the three initial levels of production.

Effects of Interest Rates on Firm Growth at the 9,000 Pound Level of Technology

The 9,000 pounds of milk per cow level of production is not a high enough level of technology to provide the necessary family living income assumed under the rigid consumption function. Many grade A production firms do, however, commence operation at this level either because of the unavailability of higher quality cows or inexperience on the part of the manager.

The net worth at the conclusion of 10 years of operation showed very little variation between the three different interest rates when the initial production level was 9,000 pounds of milk per cow. The reason for the similarity of net worth values under the three different interest rates is largely associated with the minimum family consumption restriction and the mechanics through which the minimum is maintained. When the normal operations of the firm did not produce enough net income after all withdrawals to provide the minimum average income of $6,000, cows were sold from the low end of the production scale. This action increased the average production at a faster rate than would have occured if minimum levels of family consumption had been reached each year without the sale of assets. In essence, the greater the pressures on gross income in early years of operation, the larger the culling rate, and the greater the increase in average production.

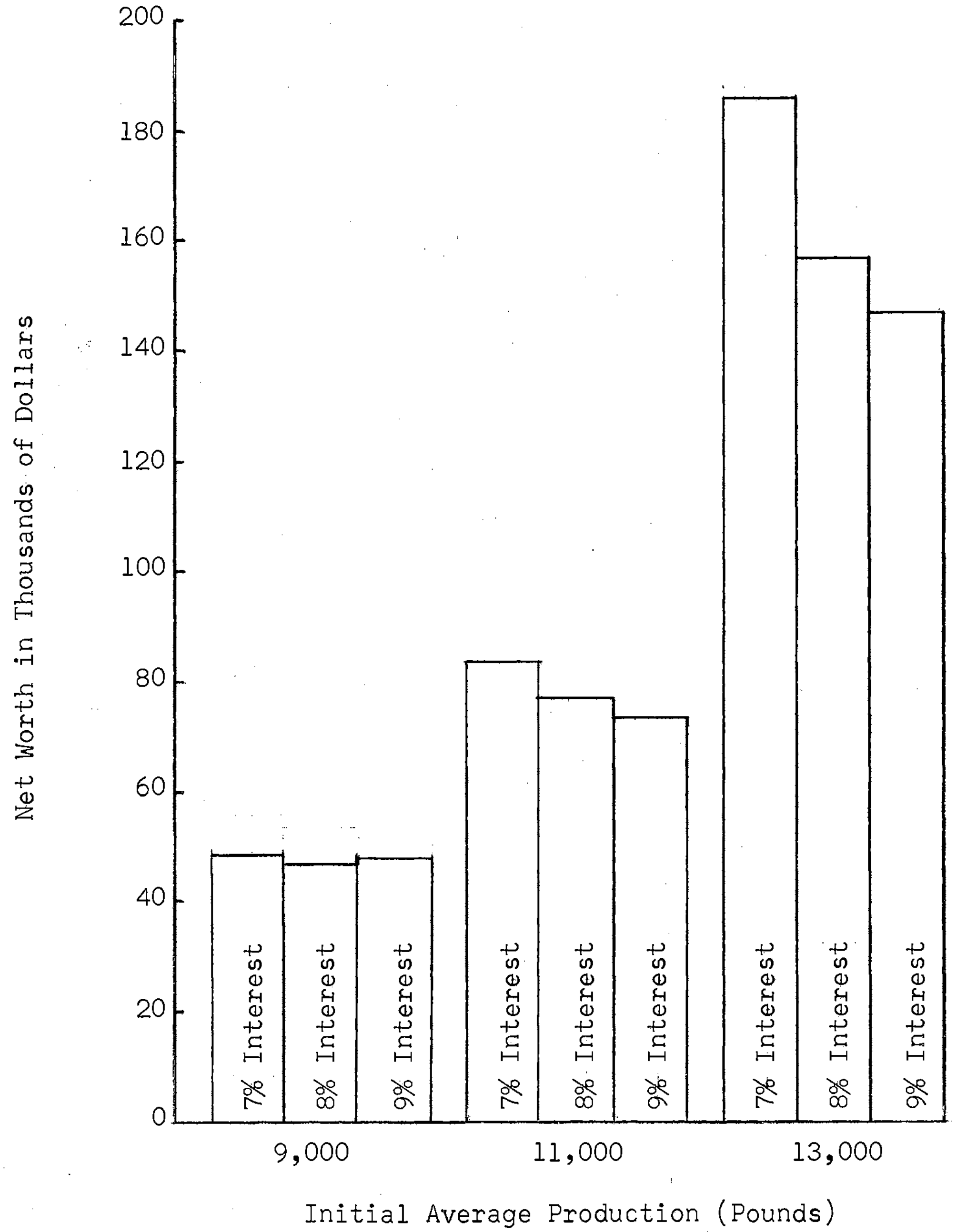

Figure 7. Simulated Tenth-Year Net Worth Values for Grade A Dairy Production Firms Under Three Different Intermediate Term Interest Rates

The simulator allowed family living to be no lower than $4,500 in any single year. Under the rigid consumption function the first three years had to average $6,000, which required the selling of cows during the third year to comply with the average family living restriction.

Since this study is positivistic and concerned with practices currently employed by dairy firms, a production culling rate of five percent of the herd as revealed by the survey was assumed. Preliminary simulation runs indicated that the five percent culling rate was not optimum and that greater culling rates would increase firm growth because of movement to high production levels.

The liquidation of assets was allowed in simulated situations where family living requirements were not met by the normal operation of the firm. Livestock are most easily liquidated. Since it was assumed that individual cow milk production was known, the poorest cows would be marketed to increase the cash flow, and thus increase the average cow milk production and efficiency of production. Figures 8 and 9 indicate the decrease in cow numbers during the third year and the corresponding increase in average production for the fourth year.

As indicated in Figure 7 the average net worth for the 40 replications at the end of 10 years was $47,433 with an intermediate term interest rate of 7 percent. Also of interest is the range of net worth values. The 10-year net worth values of 75 percent of the 40 replications were between $56,902 and $38,480. The average 10-year net worth with an 8 percent interest rate was $46,945; while 75 percent of the net worth values were between $62,083 and $34,050. At 9 percent interest, the average tenth year net worth value was $47,200; and three-fourths of values were between $59,457 and $32,112.

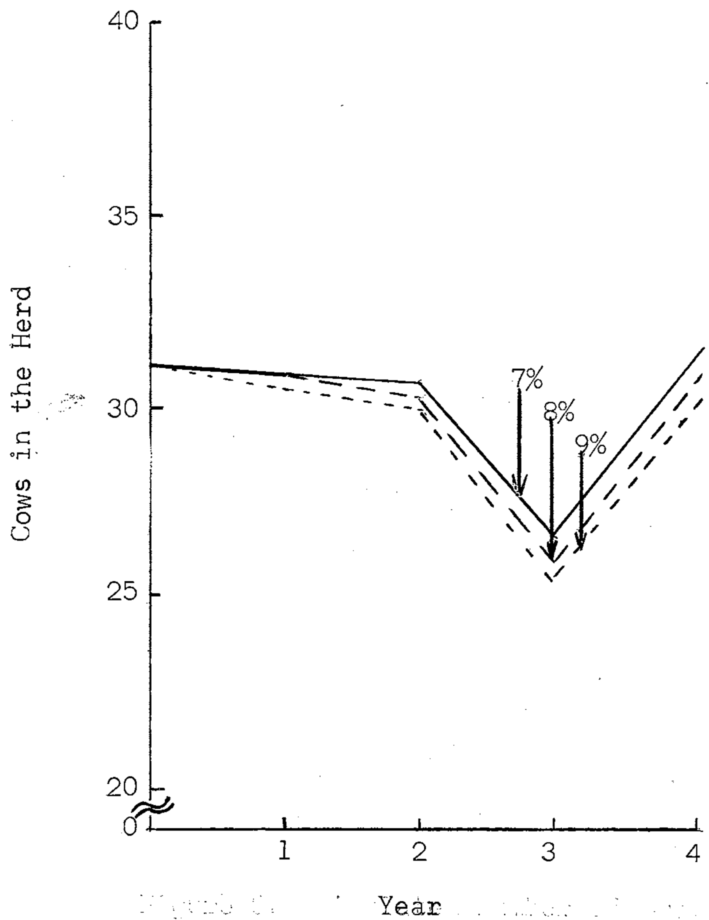

Figure 8. Simulated Number of Cows at End of Year Under Three Different Interest Rates

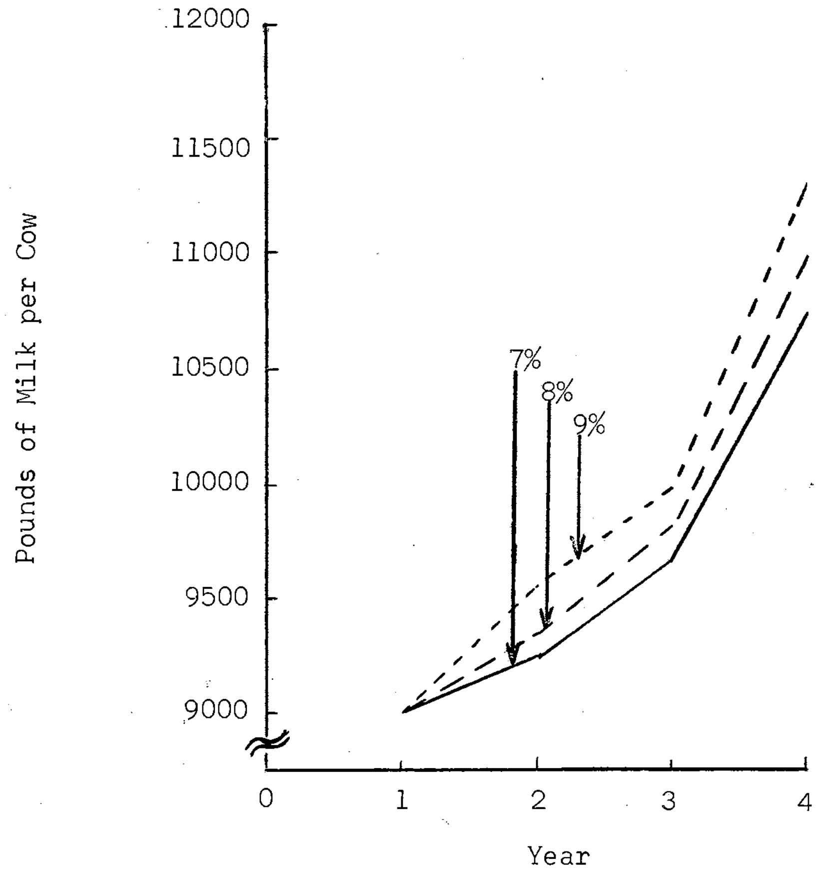

Figure 9. Simulated Annual Production Under Three Different Interest Rates

The discounted present value of the income streams for family living were very similar under each interest rate condition. Discounted 3 percent semi-annually, the present values were $51,594, $51,146, and $51,228 respectively for 7, 8, and 9 percent interest rates.

Effects of Interest Rates on Firm Growth at the 11,000 Pound Level of Technology

The average firm surveyed for this study was operating at the 11,000 pounds of milk per cow level of technology. This level of production is attainable for the beginning grade A dairy production firm as supplies of this quality of cattle are available through dispersal sales and surplus from higher quality herds.

The restrictions that caused the sale of cows for additional revenue to maintain minimum family living levels, when firms commenced operation at a 9,000 pound milk average, did not cause the increased culling of cows, when firms began operation at the 11,000 pound milk level of technology. Even though preliminary simulation runs indicated that higher culling rates would have increased herd production and firm growth; it was questionable if the supply of high quality cows (11,000 pounds or greater) was sufficient to meet the demand that would have been created by stricter culling and purchased replacements. Firms operating at the 11,000 pound level of technology provided family living incomes above the $6,000 average restriction level; consequently the effects of interest rates can be clearly observed in Figure 7.

The average net worth at the end of 10 years was $81,562 when the intermediate term interest rate was 7 percent, and 75 percent of the 10-year net worth values of the 40 replications were between $57,694 and $106,075. At an 8 percent interest rate the values were $76,803, $57,144, and $103,981 respectively. Figure 10 indicates the minimum, average, and maximum growth patterns of the 40 replications over a 10-year period for the three different interest rate conditions. The replications with the maximum and minimum net worth gains are also graphically illustrated.

The present value of the family living income stream was affected very little by the effective rates of interest. The present values of family living income were $56,392, $55,935 and $55,584 for the rates of 7, 8, and 9 percent respectively. Since this analysis is made under the assumption of a rigid consumption function, large variations in family living income were not expected.

Effects of Interest Rates on Firm Growth at the 13,000 Pound Level of Technology

Not many firms would commence operation at an annual average production per cow level of 13,000 pounds of milk, but the possibility exists. Usually to attain this degree of technology, many years of herd improvement through breeding and management are necessary. Simulation runs were, however, conducted for a firm with such a level of technology and the growth was very rapid. Figure 7 indicates that the variation in growth of net worth due to interest rates was greater than with the other two levels of technology considered.

The very high net worth value under the assumed intermediate term interest rate of 7 percent was due, in part, to the fact that seven-eighths of the replications attained the herd size limit of 160 cows by the tenth year. Once this limit was attained the firm was not

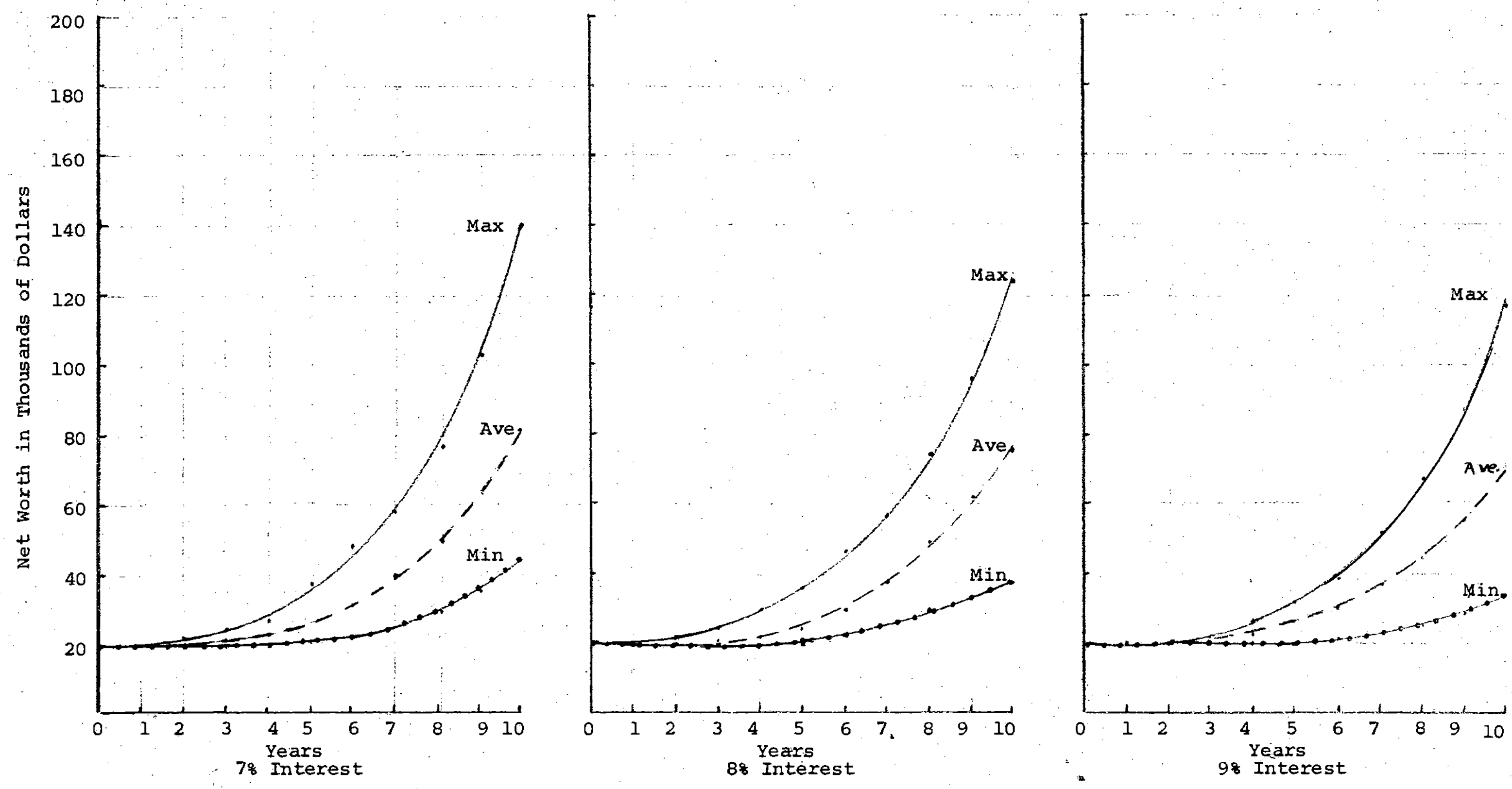

Figure 10. Average, Maximum, and Minimum Net Worth Growth Over Forty Replications at Various Intermediate Term Interest Rates (11,000 Pound Level of Production)

allowed to expand, and all excess revenue was directed toward debt payment which lead to a higher net worth ratio. The average of the 10-year net worth values over the 40 replications at the interest rate of 7 percent was $184,724. Three-fourths of the 40 replicated tenth-year net worth values were within the range of $152,355 to $219,490.

When the interest rate was increased to 8 percent, net worth growth was slowed somewhat to an average of $156,469. Eighteen of the 40 replications reached the herd size limit. The upper and lower limits encompassing 75 percent of the replicated net worth values were $204,026 and $115,732 respectively.

At an interest rate of 9 percent the average 10-year net worth value was $146,115. Three-fourths of the 40 replications were included in the interval of $119,200 to $181,600.

When the intermediate term interest rates were at either 7 or 8 percent the amount available for family living was less than the upper limit of $7,500 only in the first year. The $7,500 limit was not reached in either of the first two years when the interest rate was 9 percent. The discounted present values of the family living income streams were $57,205, $56,756, and $56,556 for the three interest rate conditions respectively. The income streams were discounted at 3 percent semi-annually.

The Effects of Variable Wage Rates on Firm Growth

The dairy production firm net worth growth patterns were observed when the hired labor hourly wage rate was varied over three specific values of $1.50, $1.75, and $2.00. Hired labor was not divisible into units of less than 600 hours. It was assumed that 2,950 hours were supplied by the farm family. Firms requiring no more than 2,950 hours would not be directly affected by wage rates except where family consumption was a function of the wage rate. No firms required hired labor during the first year of operation because initial cow numbers were such that all labor could be supplied by the family. Only firms that were required to decrease assets to meet family living requirements operated with no hired labor after the second year. The greatest number of hours of hired labor was 3,000 hours, which occurred when a firm had reached the herd size limit of 160 cows assumed in this study.

Simulated firm growth results employing the three levels of wage rates were evaluated. The main results and implications were:

1. Wage rates little effected the growth of firms commencing operation at the lowest level of technology. In this analysis, as with the interest rates, the firms adjusted to the greater expense through internal reorganization which elevated the firm to a higher level of technology.
2. Increasing the wage rate from $1.50 to $1.75 per hour affected the two higher levels of technology only slightly, while the $2.00 wage rate resulted in a marked decline in tenth-year net worth values. The results indicate that the range of wage rates employed did not necessitate internal firm reorganization to meet family living minimum levels, but that the $2.00 wage rate affected herd expansion activities over the 10-year period.

For the analysis of wage rate effects, other key variables were fixed as follows: intermediate term interest rate at 8 percent, percentage of class I marketings at 83 percent, price of class I base at

$10 per pound, and family living withdrawals based on the rigid consumption function. The results of the effects of wage rates on tenth-year net worth values are presented in Figure 11.

Effects of Wage Rates on Firm Growth at the 9,000 Pound Level of Technology

There was little variation in the net worth of firms after 10 years of operation when the initial level of production was 9,000 pounds of milk per cow. The same forces were responsible for this similarity as for the absence of net worth variation when interest rates varied. The firm beginning operation at the 9,000 pound level could not provide enough income for family living to maintain an annual average of $6,000 without the sale of production assets (cows). The increased herd culling raised the herd average production in a manner similar to that observed when interest rates varied. The effect of wage rates on additional culling was not as great as that of changes in interest rates. The reasons for this were two-fold: (1) there was no hired labor the first year of operation, and (2) there was no hired labor when the herd was decreased in order to meet family living requirements.

The average net worth at the close of the tenth year was $47,661 when the wage rate was $1.50. Three-fourths of the 40 replicated tenth-year net worth values ranged between $34,541 and $59,286. At a At a wage rate of $1.75 the range of 75 percent of the tenth-year net worth values was from $34,050 to $62,083, and the average was $46,945. The average net worth was $46,757 at the end of the tenth year of operation when the wage rate was $2.00, and three-fourths of the replicated ten-year net worth values ranged from $32,875 to $57,193.

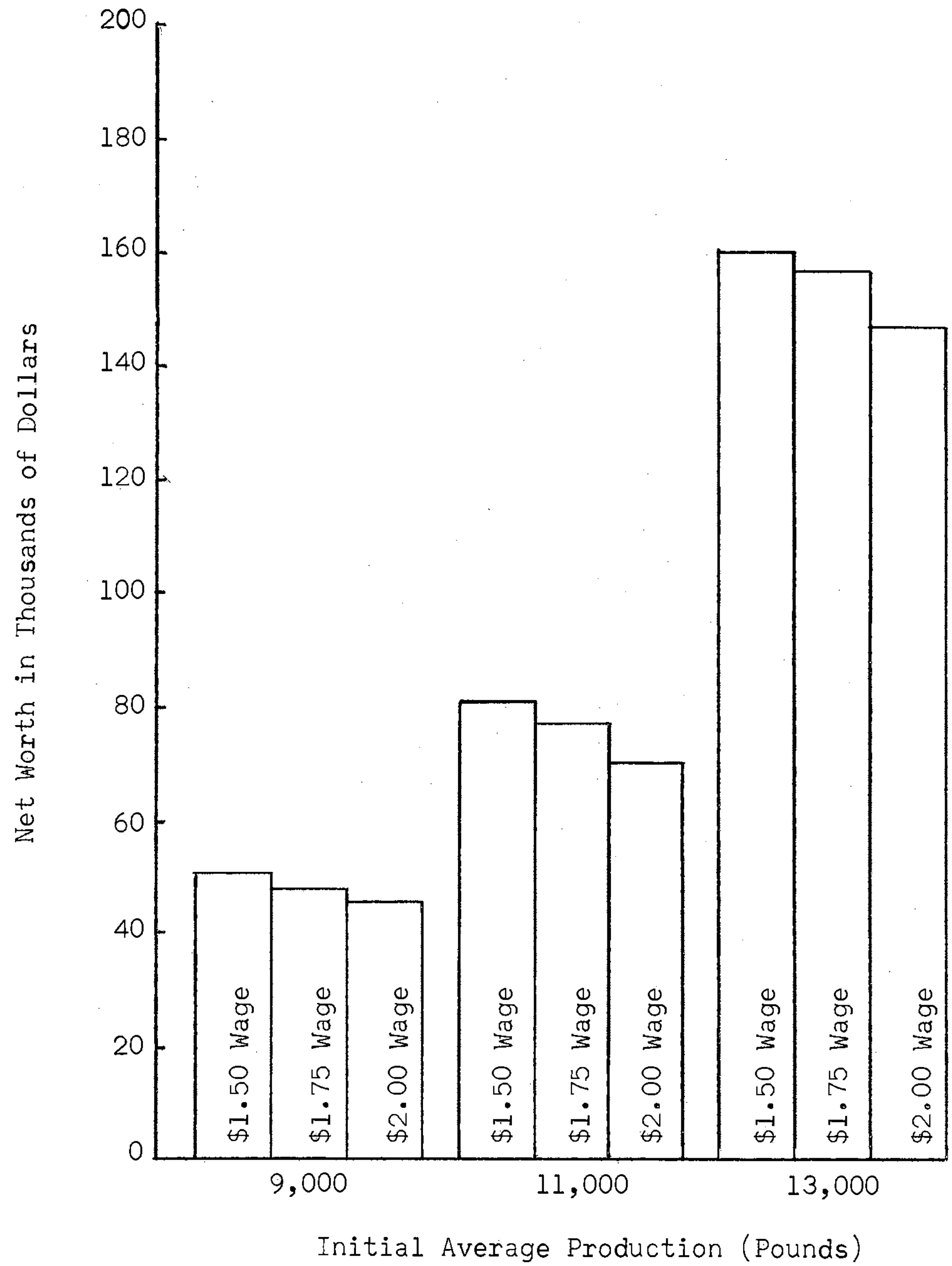

Figure 11. Simulated Tenth-Year Net Worth Values for Grade A Dairy Production Firms Under Three Different Hourly Wage Rates

The discounted family living incomes for the 10-year period of the simulation varied little over the range of wage rates. The discounted values did decrease, however, as wage rates increased. Only during the final two years did the firm provide enough income for family living to reach the upper limit of $7,500 when the wage rate was $2.00 per hour. The discounted family living income was $50,524 for the 10 years. The upper limit for family living was attained the final three years with a wage rate of $1.75, and the discounted present value of family living was $51,146. With the lowest wage rate the present value of family living was $51,402, and the upper limit was attained during the final four years.

Effects of Wage Rates on Firm Growth at the 11,000 Pound Level of Technology

The effects of wage rates on the growth of net worth over time can be observed in Figure 11 for an initial production level of 11,000 pounds. The wage rate had little effect on growth at this level of technology particularly when the rate increased from $1.50 to $1.75. The effects of increasing wage rates were largely absorbed in a reduced income for family living in the early years of operation. Observation of family living withdrawals indicated that in no instance was the firm forced to sell additional cows to maintain the specified family living level, but there are some significant differences in family living incomes when wage rates vary as exemplified in Figure 12. The absorption of added expenses due to increased wage rates by family consumption in the early years of operation contributed to a softening effect of wage rates on firm growth. The discounted present values of the 10-year family income streams were $56,190, $55,935, and $55,705 respectively at the $1.50, $1.75, and $2.00 wage rates.

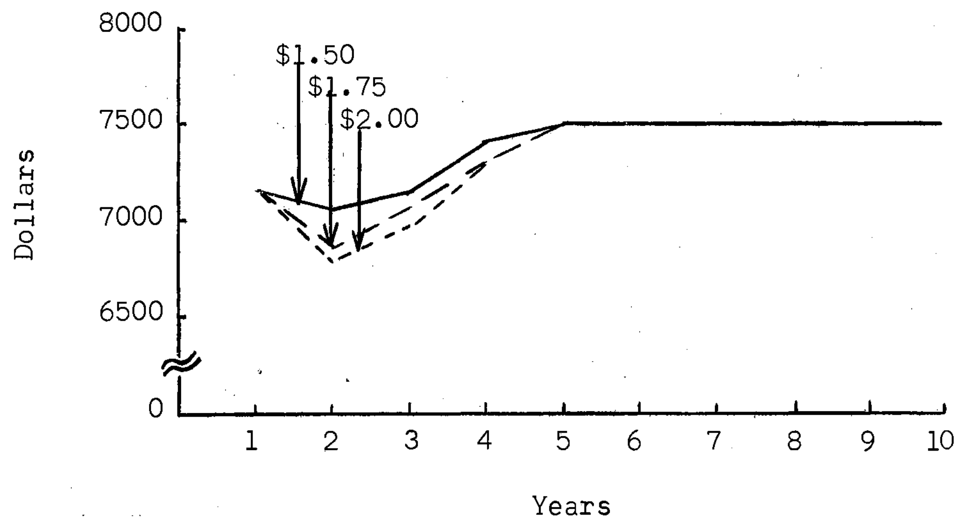

Figure 12. Simulated Family Living Income as Affected by Three Different Wage Rates

Three-fourths of the tenth-year net worth values at the wage rate of $1.50 were between $97,431 and $57,623, while the average was $78,496. When the wage rate was $1.75, the three respective net worth values were $103,981, $76,803, and $57,144. At a wage rate of $2.00 per hour, 75 percent of the 40 replications of net worth values at the close of the tenth year were between $82,397 and $53,168. The mean value was $70,080. The net worth growth patterns over time at the three specified wage rates are illustrated in Figure 13 for firms commencing operation at the 11,000 pound level of technology. Depicted in this figure are the growth paths of the slowest, average and fastest growing replications.

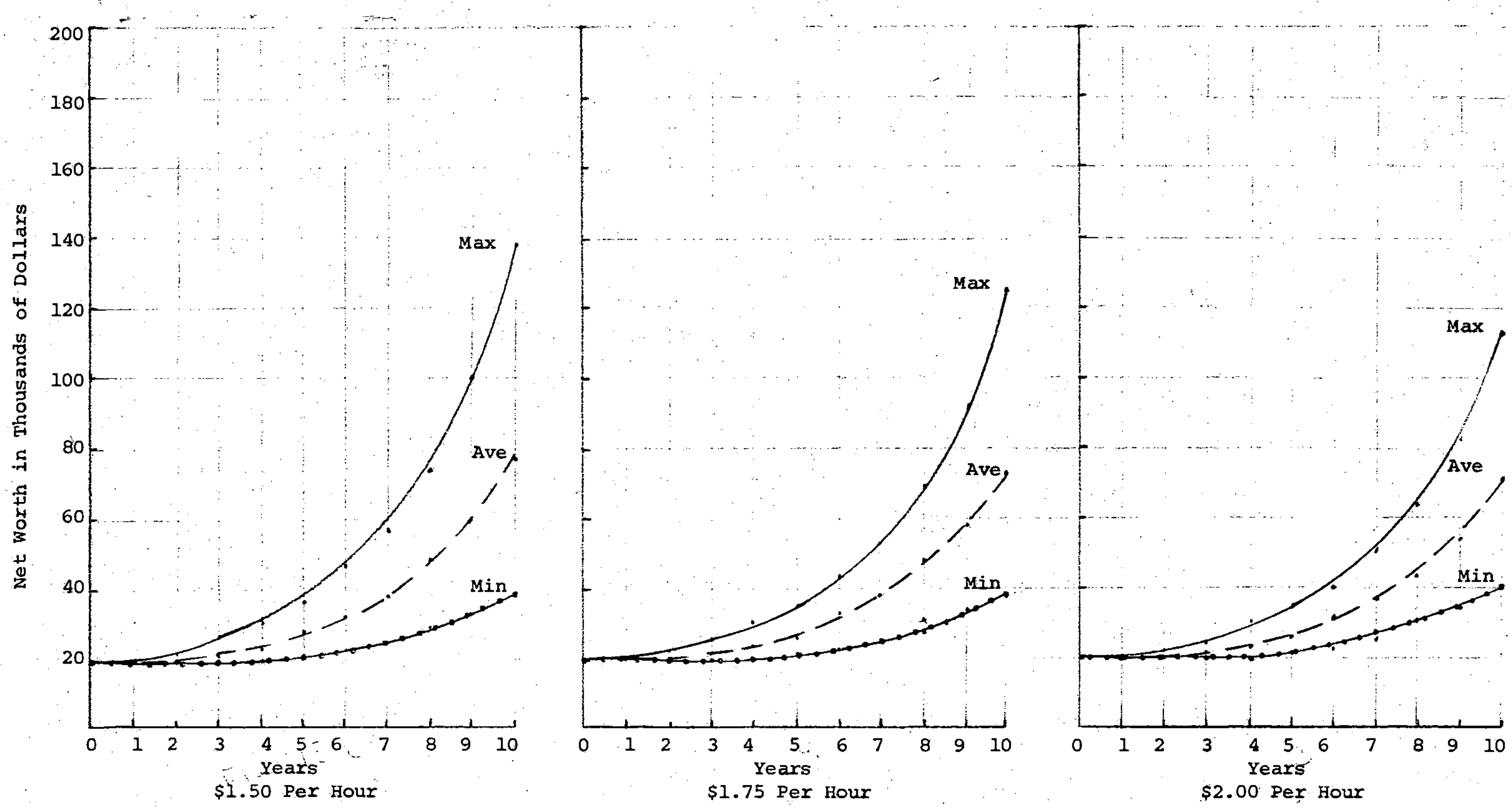

Figure 13. Average, Maximum, and Minimum Net Worth Growth Over Forty Replications at Various Hourly Wage Rates (11,000 Pound Level of Production)

Effects of Wage Rates on Firm Growth at the 13,000 Pound Level of Technology

At the two lower wage rates one-half of the replications had attained the upper limit of herd size by the end of the tenth year. Eighteen of the 40 replications had attained this herd size limit when the wage rate was $2.00. Upon reaching this limit, herd expansion ceased and all excess income was directed toward debt repayment.

The average tenth year net worth was $158,274 at the $1.50 wage rate, while the upper and lower ranges including 75 percent of the replicated net worth values were $201,037 and $119,613. At a wage rate of $1.75 the comparable highest, average and lowest net worth values at the close of the tenth year were $204,026, $156,469, and $115,732. The average net worth value was $48,490 at the $2.00 wage. The respective net worth values at the $2.00 wage were $174,826, $148,490, and $114,806.

As the firms were capable of generating sufficient net income to meet the upper limit of family living in all years except the first under the three wage rates, there was no variation in the discounted present values of the family living income streams. It should be noted that in the first year of operation, no labor was hired; therefore, wage rates did not affect family living income that year.

Summary

Capital and labor input price levels had little effect on firms commencing operation at the lowest level of technology. The nullification of input price effects on firm growth was the result of family living restrictions and the methods undertaken by the firm to meet these restrictions. By selling cows from the lower end of the production scale efficiencies were gained through a higher milk production average. The increased level of technology allowed the firm to survive, provide a sufficient family income, and grow.

At higher initial levels of technology the effects of input prices were evident, but the effects of interest rates on firm growth were more pronounced than were the effects of wage rates. There were primarily two reasons for the absence of large variations in the effects of wage rates: (1) the wage bill was less than the interest bill for all firms which allowed for the absorption of expense differences, due to wage differentials, by the family living income; (2) the "lumpiness" of labor inputs produced some analytical problems because small changes in cow numbers could result in large changes in hired labor costs.

As might be expected within each simulated run of a specific set of conditions, the range of net worth values over the 40 replications increased over time. Frequency distributions of tenth year net worth values can be found in Appendix D for all the conditions discussed in this chapter.

CHAPTER V

EFFECTS OF CLASS I MILK MARKETINGS AND CLASS I BASE PRICES ON GROWTH

The price of grade A milk is determined by a class I price and a surplus milk price. Class I milk is processed primarily into fluid milk products such as skim milk, 2 percent milk, whole milk and cream; surplus milk is utilized in the manufacture of products such as butter, skim milk powder, cheese and ice cream. The class I price is principally composed of a base price (average price of milk used for manufactured products in Minnesota and Wisconsin) plus a class I price differential which is approximately equivalent to a transfer cost from the Minnesota-Wisconsin production area to a given market. Both the base price and the surplus price are basically the support price for manufactured milk. For this study an Oklahoma class I price of $6.46 per hundred pounds and a surplus price of $3.83 per hundred pounds were assumed. These prices were net to the producer after transportation, advertising and marketing costs were deducted.

The average or blend price a producer receives for his marketed milk is dependent upon the proportions sold as class I and surplus. The majority of Oklahoma grade A milk is sold under a class I milk base plan. Under this marketing plan, the amount of milk marketed at the class I price is determined by the amount of class I base owned by the production firm and the percentage of the base milk used for class I in the market as a whole. For each pound of class I base owned by the firm, it can market one pound of class I milk per day, assuming 100 percent of base milk is used in class I utilization. In this study it is assumed that each pound of class I base entitles the holder to market 365 pounds of milk at the class I price per year. Milk produced in excess of class I base holdings is sold at the surplus price. Theoretically a grade A production firm could possess either no class I base or sufficient class I base to include all milk marketings. It is unlikely that a firm would or could operate for a very long period of time with no class I base. Other alternative markets such as cheese plants and condensaries usually afford the producer a higher net price than for surplus grade milk.

Class I bases can be purchased by new firms from existing or exiting producers. As the demand for milk expands or supply decreases; firms engaged in grade A milk production are also able to earn additional class I base. For the beginning dairyman, the class I milk base should be considered a resource necessary for grade A milk production, a resource which, like the cow, must be purchased.

In this study 50, 70, and 83 percent class I milk marketing situations were considered. To ensure a dependable supply of milk to retailers, processing plants must have some surplus, preferably 20 percent, to provide for non-processing holidays and irregular deliveries due to weather and seasonal trends. Therefore, even though percentages of class I marketings greater than 83 percent would be possible for individual producers, farms could average no more than 83 percent to supply 120 percent of class I needs. The prices of class I base analyzed were zero, $10 and $15 per pound of daily base. Since the inception of a class I base marketing plan in Oklahoma, few class I bases had been traded prior to the study. Prices in 1968 averaged about $10 per pound in the few cases of base sales.

The Effects of Variable Percentages of Class I Marketings on Firm Growth

Firm growth simulations were not conducted for all of the class I marketing percentages for the 9,000 and 13,000 pound levels of technology, but were for the 11,000 pound level of production. Where applicable the effect of percentage of class I marketings is discussed for each of the three levels of technology. The net worth growth patterns are traced for the 11,000 pound level of production which was characteristic of the firms surveyed for this study. The analysis was conducted with an intermediate term interest rate of 8 percent, hourly wage rate of $1.75, price of class I base of $10 per pound, and family living based on the rigid consumption function. Figure 14 indicates comparative tenth-year net worth values at various class I marketing percentages and technological levels.

The primary results and implications of simulated firm growth under various class I marketing percentages were:

1. Firms commencing operation at the 9,000 pound level of production were forced out of business when allowed to market only 50 percent of their milk as class I. At least 64 percent of the milk would have to have been marketed as class I for the firm to have survived with no growth.
2. The percent of class I milk marketings greatly affected firm growth at the 11,000 and 13,000 pound levels of technology.

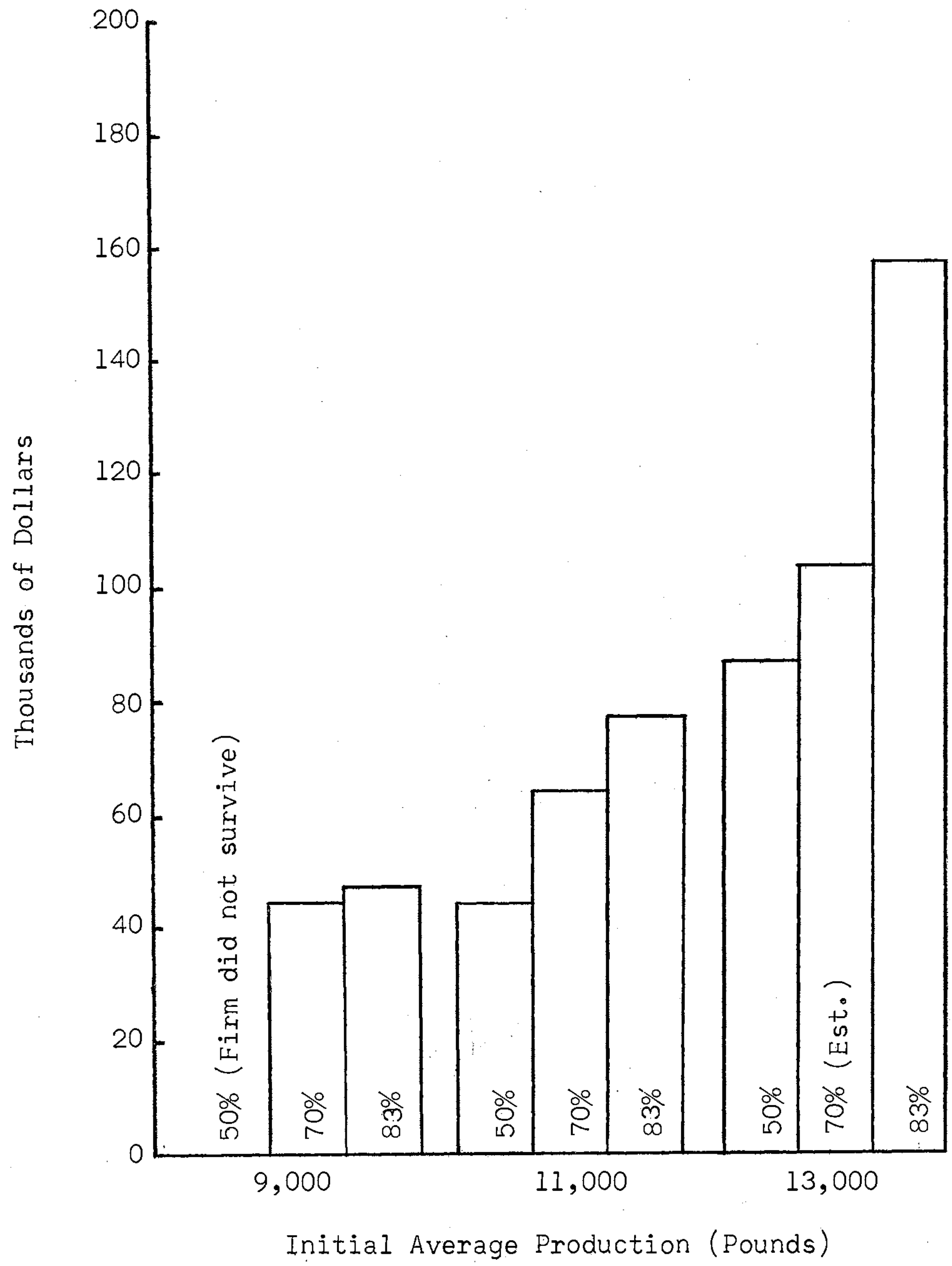

Figure 14. Simulated Net Worth at the Close of the Tenth Year for Grade A Dairy Production Firms Under Three Different Class I Marketing Percentages

For each one percent increase in class I marketings, net worth growth was increased about five percent at the 11,000 pound level; the increase in net growth was approximately 10 percent for each one percent increase in class I milk marketings at the 13,000 pound level.

Value for tenth-year net worth for the 13,000 pound level of technology and 70 percent class I milk marketings was estimated from other simulation results using the following least squares regression equation:

$$NW_{10} = -\ 407440.67 + \underset{(6.40056)}{7184.15\ LVST}$$

$$-\ \underset{(2.31385)}{2.59TI} - \underset{(2.87863)}{5369.41RI} - \underset{(0.14771)}{1329.5WG}$$

$$+\ \underset{(7.12573)}{18.37B} + \underset{(9.78354)}{1789.3XB} - \underset{(2.29807)}{1653.58PB};$$

where NW_{10} is the net worth at the end of the tenth year; LVST, the number of cows and replacements in the first year; TI, the value of assets at the start of year one; RI, the intermediate term interest rate; WG, the hourly wage rate; B, the initial average production of milk; XB, the percentage of class I milk marketings; and PB, the price per pound of class I base. The "t" values appear in parenthesis beneath the coefficients. The R^2 value for this regression equation was 0.9577.

<u>Effects of Class I Milk Marketings on Firm Growth at the 9,000 Pound Level of Technology</u>

Simulation runs were conducted only on 70 and 83 percent class I milk marketings. Attempts to simulate the firm growth at 50 percent class I marketings resulted in the firm dispersing the herd and exiting the industry in the fourth year in order to meet the 6,000 average annual family living income requirement. The firm would have been able to survive only if the average family living expense had been lowered to approximately $5,000.

Figure 14 indicates little variation between the 70 and 83 percent levels of class I marketings when the firm commenced operation at the 9,000 pound level of production. The firm was involved in an internal restructuring of assets which increased the production in the same manner as that observed in the previous chapter. Figure 15 indicates the deceased cow numbers in the herd when assets must be sold to meet family living requirements. The resultant increased average production per cow appears in Figure 16.

When 83 percent of the milk was marketed as class I the average tenth-year net worth value was $46,954. Three-fourths of the tenth-year net worth values of the 40 replications were between $62,083 and $34,050. By decreasing the per cent of class I marketings to 70 per-cent the average net worth at the end of the 10 years was $45,060; while the upper and lower values encompassing 75 percent of the replications were $57,927 and $30,538.

The 3 percent semi-annually discounted present value of the family living income stream was $51,146 when 83 percent of the milk was marketed as class I. The present value of the family living 10-year income stream was $50,276 when class I marketings were reduced to 70 percent.

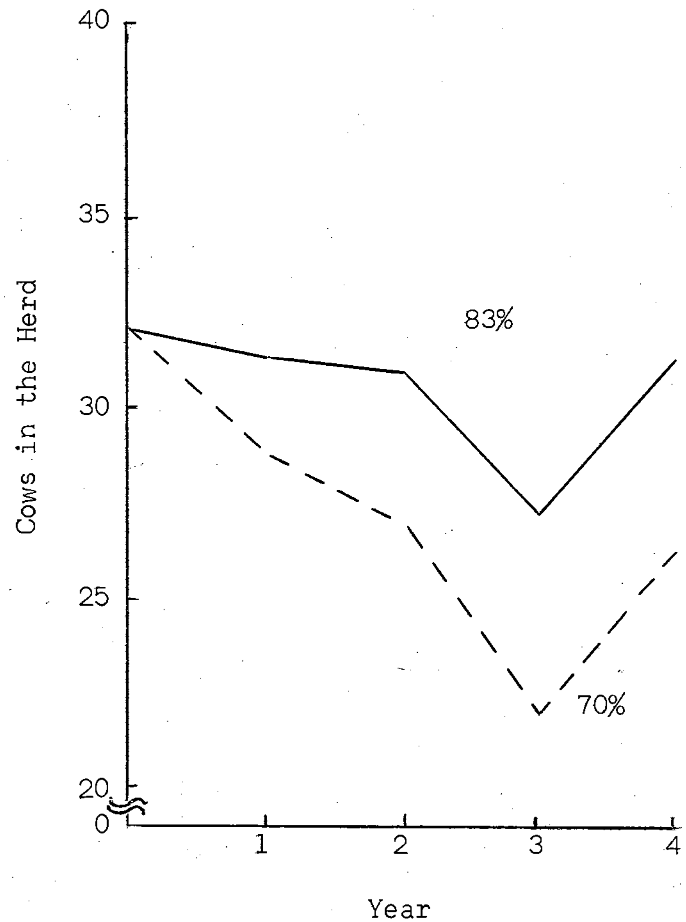

Figure 15. Simulated Number of Cows at End of Year Under Two Different Percentages of Class I Marketings

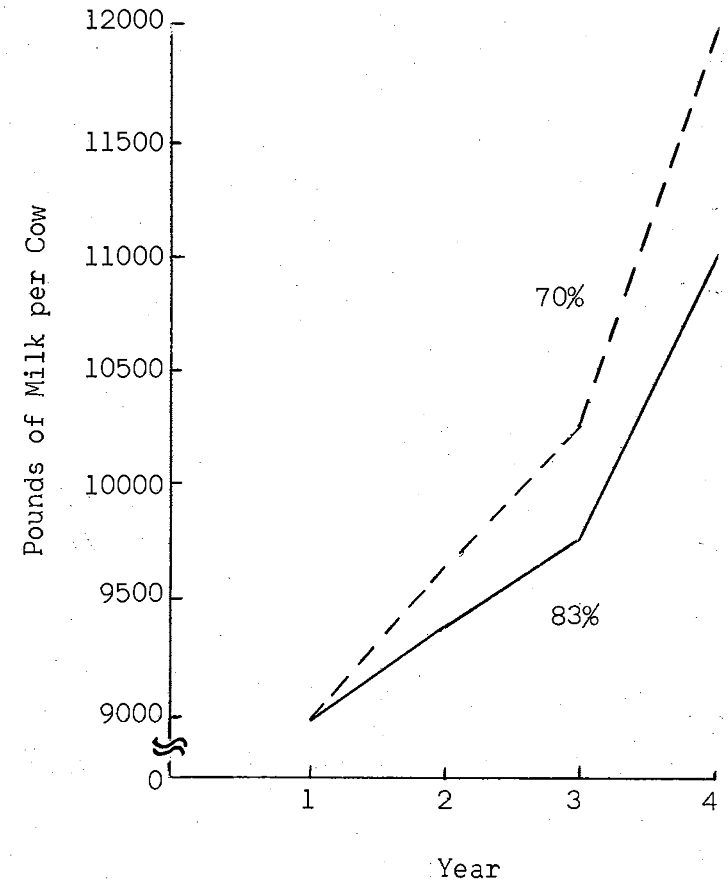

Figure 16. Simulated Average Annual Production Under Two Different Percentages of Class I Marketings

Effects of Class I Marketings on Firm Growth at the 11,000 Pound Level of Technology

Many firms may find themselves initially marketing only 50 percent of their milk for class I purposes. Also a decreasing milk demand could place producers in this marketing situation. Even at the resultant relatively low blend price for milk, the firms commencing operation at the 11,000 pound level of technology could survive and grow, but at a slow pace. Figure 14 reveals the differences of net worth at the end of the tenth year of operation under the three specified levels of class I marketings.

Specific year by year net worth growth can be observed in Figure 17. Depicted in this figure are the net worth growth patterns of the fastest, slowest, and average of the 40 replications in the simulation runs for each of the three class I marketing percentages.

The average net worth at the close of the tenth year was $76,803 when 83 percent of the milk was marketed under class I base. The upper and lower values encompassing three-fourths of the 40 replications were $103,981 and $57,144.

When 70 percent of the milk was marketed as class I the average net worth after 10 years of operation was $63,062. Seventy-five percent of the values for the 40 replications were between $76,516 and $49,673.

The reduction of milk marketings to 50 percent class I and 50 percent surplus reduced firm growth greatly. The upper range of tenth-year net worths of three-fourths of the 40 replications was $59,122, the mean value was $43,879; and the lower range was $28,599. It is of interest to note in Figure 17 that the slowest growing of the 40

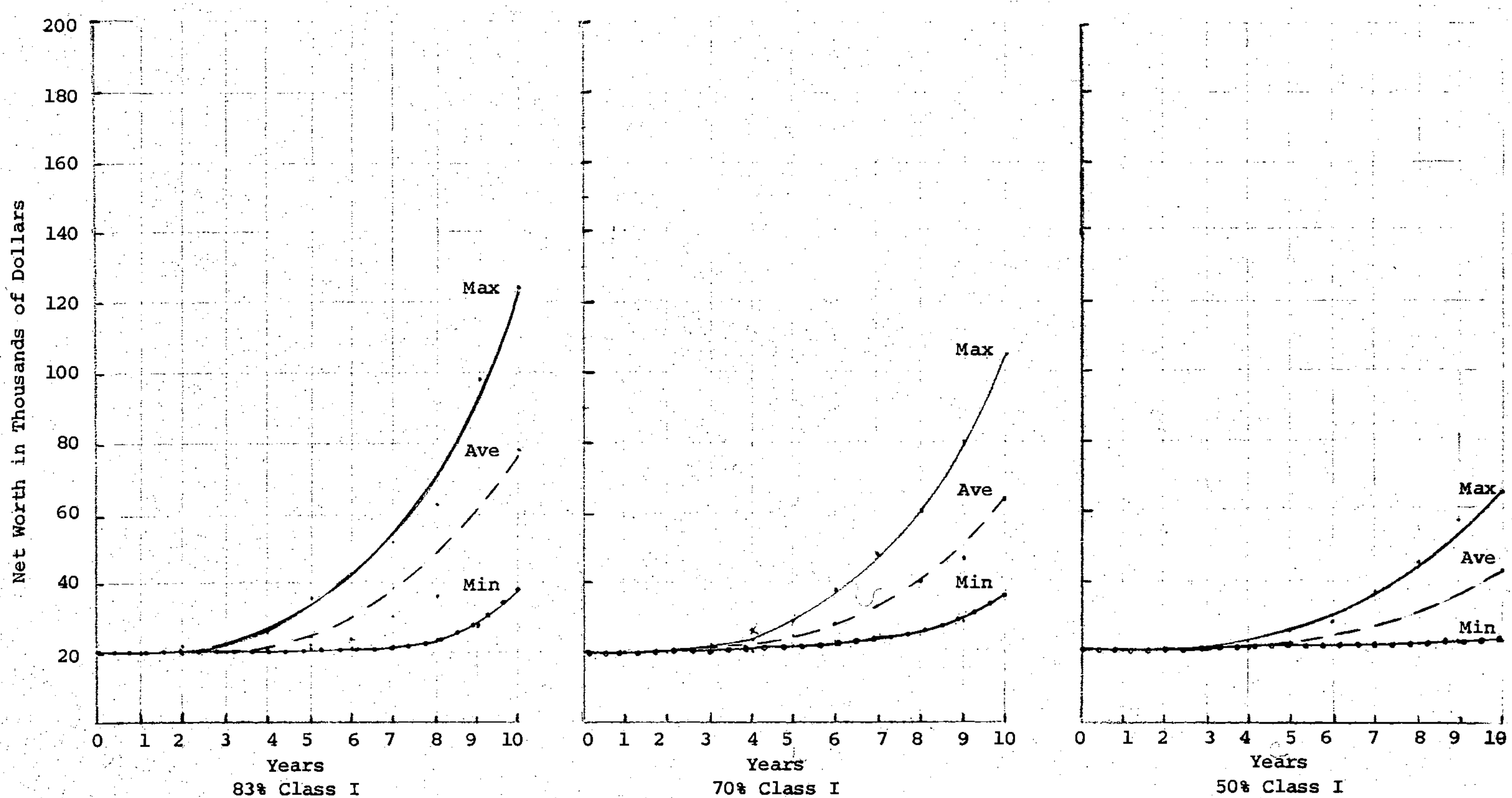

Figure 17. Average, Maximum, and Minimum Net Worth Growth Over Forty Replications at Various Class I Marketing Percentages (11,000 Pound Level of Production)

replications only increased net worth by $2,248 in ten years when marketing 50 percent class I milk. Throughout the ten years of operation, the slowest growing replication never attained a net worth position that would allow for the purchase of cows for herd expansion.

A large difference between 10-year discounted present values of family living income streams resulted from changes in percentages of class I milk marketings. When the family living income streams were discounted, the present values were as follows: $49,722 with 50 percent class I marketings; $52,934 with 70 percent class I marketings; and $55,935 with 83 percent class I marketings.

Effects of Class I Milk Marketings on Firm Growth at the 13,000 Pound Level of Technology

Firm growth simulations were not conducted for the 13,000 pound level of technology at 70 percent class I marketing, but the tenth year net worth value has been estimated in Figure 14. Firm growth for those firms commencing operation at 13,000 pounds of milk per cow was slowed considerably by decreasing the percentage of milk marketed as class I. Whereas almost one-half of the replications (18) attained the upper limit of 160 cows when 83 percent of the milk was sold at the class I price, none of the replications reached this limit in herd size when class I marketings were reduced to 50 percent.

With class I marketings at 83 percent, the average net worth at the end of ten years of operation was $156,496. The range including 75 percent of the 40 replication was from $115,732 to $204,026. The average tenth year net worth was $86,057 when 50 percent of the milk was sold as surplus. The upper and lower ranges of 75 percent of the 40 replications were $103,783 and $67,812.

Little variation in the discounted present value of family living resulted from changes in milk prices because the amount available for family living was below the maximum only for the first year and first three years for the 83 percent and 50 percent class I marketing conditions, respectively. The 10-year discounted family living present values were $56,756 with 83 percent class I marketings and $53,054 with 50 percent class I marketings.

Effects of Variable Class I Base Values of Firm Growth

The value of class I bases affected only slightly the cost of milk production, but it had a great effect on initial investment costs and future expansionary costs. A complete analysis of the effects of class I base prices was conducted only at the 11,000 pound level of technology. The analysis was conducted with an intermediate term interest rate of 8 percent, wage rate of $1.75 per hour, 83 percent class I milk marketings, and family living based on the rigid consumption function. Through the use of predictive least squares regression equations, estimated tenth-year firm net worth values were obtained for the lower and higher levels of technology. Figure 18 gives the comparison of tenth-year net worth values at different class I base values and at the three levels of technology.

The main result of the simulation of firm growth at various prices of class I base was that the price of the base had little direct effect on costs of milk production. The effect was indirect in that higher prices of class I base slowed growth by increasing investment costs. A slower growth prevented the firm from enjoying

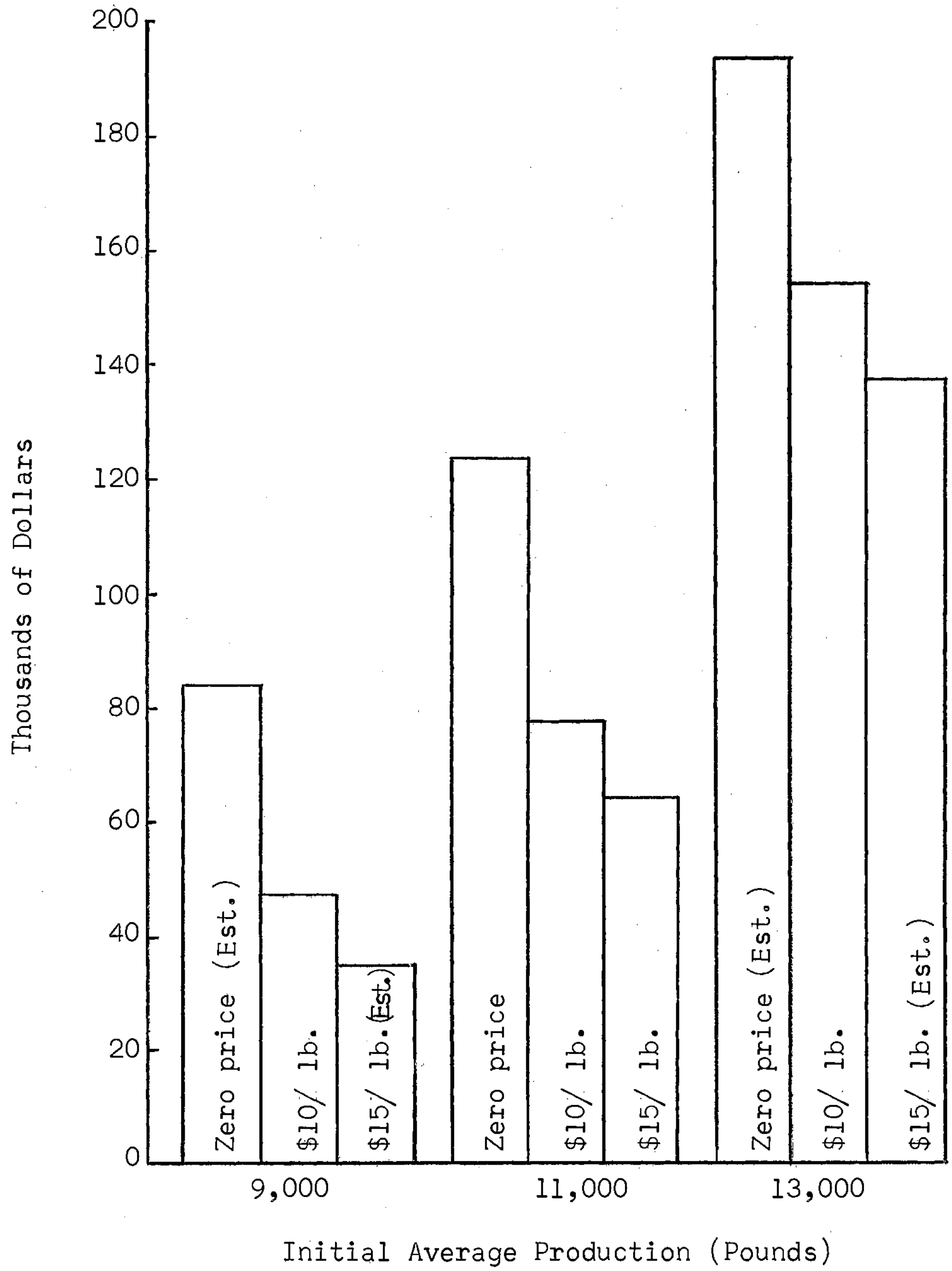

Figure 18. Simulated Tenth-Year Net Worth Values for Grade A Dairy Production Firms Under Three Different Class I Milk Base Values

economies of size that were otherwise possible at faster growth rates due to lower prices of class I bases.

Effects of Class I Base Values on Firm Growth at the 11,000 Pound Level of Technology

The net worth growth pattern of the firm commencing operation at the 11,000 pound level of production was greatly affected when a value (price) was placed upon the class I base. When no price was assumed per pound of class I base, the firm grew to a net worth of $123,138. The upper and lower ranges including 75 percent of the simulated replications were $173,044 and $77,578. The assumption of a $10.00 per pound price decreased growth to $76,803, with extremes among the centrally located three-fourths of the replications of $103,981 and $57,144. Increasing the price to $15.00 per pound decreased tenth-year net worth to $64,252, with 75 percent of the replications between $81,564 and $47,050. Average, maximum and minimum growth patterns are illustrated in Figures 19.

The primary differences between the growth rates associated with specific class I base prices were due to expansionary costs and not added costs of production. A review of the simulation results revealed unique differences in cow purchases for herd expansion. Table XII includes the average annual cow purchases for the 40 replications, under the three class I base price assumptions. The firm was able to expand by cow purchases earlier when the price of class I bases were lower. This was due partly to the lower expenses associated with milk production when base prices were lower but largely to the fact that it cost much less to purchase an additional cow if there was no cost to

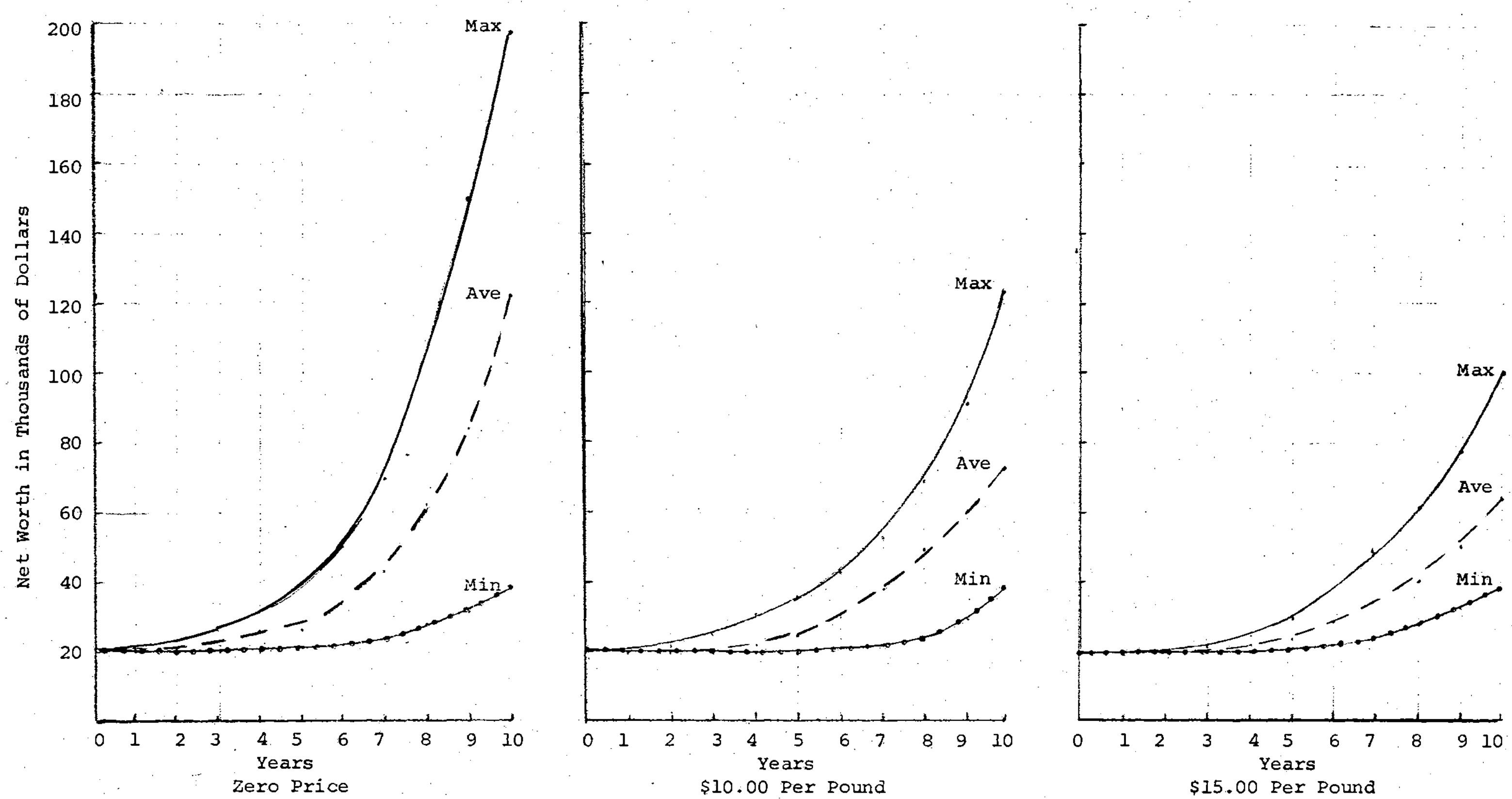

Figure 19. Average, Maximum, and Minimum Net Worth Growth Over Forty Replications at Various Prices Per Pound of Class I Base (11,000 Pound Level of Production)

the base that accompanied the cow. A one dollar increase in the price of a pound of class I base resulted in an increase of $0.0174 in the cost of producing 100 pounds of milk when a class I base equal to 83 percent of the milk marketings was owned. The increased investment cost per cow added to the herd was $24.59 for each increase of one dollar per pound of class I base, assuming a production per cow of 11,000 and a class I base equal to 83 percent of marketable milk. The increased investment cost due to one dollar increase in base price per additional cow was $20.04 for cows producing 9,000 pounds of milk and $29.13 for cows producing 13,000 pounds of milk. It can be readily observed that the price of class I bases would have no small effect on herd expansion or initial entrance into the dairy industry.

TABLE XII

AVERAGE YEARLY COW PURCHASES FOR FORTY SIMULATION REPLICATIONS WHEN CLASS I BASES WERE PRICED AT ZERO, $10, AND $15 PER POUND (11,000 POUND LEVEL OF PRODUCTION)

Base Price	Year of Simulation 1	2	3	4	5	6	7	8	9	10
	Average Cows Purchased									
$ 0	0.2	0.9	0.3	0.5	1.4	7.8	17.4	31.7	38.8	29.1*
$10	0.0	0.0	0.0	0.3	1.0	0.7	1.0	2.7	10.7	16.8
$15	0.0	0.0	0.0	0.0	0.1	1.0	2.4	4.2	5.6	5.4

*Fourteen of the replications had reached the 160 cow limit in size and did not purchase cows in the tenth year.

Since the price of class I base had little effect on the cost of producing milk, one would not expect much variation in family living income assuming the rigid consumption function. The discounted present value of the family income stream was $54,758 when the price of class I base was $15 per pound, $55,935 at the $10 price, and $56,700 when no price was assumed for the base.

The Value of Class I Base

The determination of the value of a pound of class I base involves many complex relationships. There is no specific value of a pound of base. The value of a pound of class I base for a specific firm is dependent upon such factors as the price differential between class I and surplus milk, growth rate goals of the firm, and size of the firm.

The problem of determining the value of class I base has been approached in the same way that one would determine the value of an annuity. The formula for the present value of an annuity is

$$V = \frac{R}{r} \quad (1 - \frac{1}{(1-r)n});$$

where R is the annual return, r is the interest and risk discount factor, and n is the number of years over which income will be forthcoming. if the income stream is known to continue with certainty into perpetuity, the formula reduces to $V = \frac{R}{r}$. When applying the annuity formula to base values, R becomes the added income due to the ownership of one pound of base. If an 8 percent interest rate, a 0.75 percent tax rate, and a 10-year income stream are assumed, a pound of class I base would be worth $6.49 per dollar of addition to the income stream due to ownership of the base

$$[6.49 = \frac{1.00}{0.0875} \left(1 - \frac{1}{(1.0875)^{10}}\right)].$$

If the difference between the class I and surplus milk prices were $2.00 per hundred pounds, one pound of daily base would generate (3.65 cwt.) (2.00) = $7.30 in additional income. The class I base would have a value of $47.38. If perpetuity were assumed, a pound of class I base would be worth $11.43 per dollar of addition to the income stream ($11.43 = \frac{1}{0.0875}$). Base values computed by the annuity method appear in Appendix E.

The above procedure errs in that it ignores problems of firm survival and firm growth. The technique of simulation offers another approach to the problem of class I base value determination. Admittedly this method is specific for the class I and surplus milk prices of $6.46 and $3.83 per hundred pounds and the class I milk sales percentages of 50, 70, and 83 percent. This approach does, however, consider firm survival and firm growth. Through least-squares regression procedures, firm growth for the 11,000 pound level of technology was explained by the following equation:

$$NW_{10} = 110720.8792 - \underset{(2.31385)}{2.59TI} - \underset{(2.87863)}{5369.41RI} - \underset{(0.14771)}{1329.50WG}$$

$$+ \underset{(9.78354)}{1789.3XB} - \underset{(2.29807)}{1653.58PB}:$$

where NW_{10} is the net worth at the close of the tenth year, TI is the beginning total asset value, RI is the intermediate term interest rate, WG is the wage rate, XB is the percent of marketed milk subject to class I price, and PB is the price per pound of class I base. The "R^2" value for the regression was 0.9577, and the "t" values appear in parenthesis below each coefficient. A class I base value equation that will provide for specific firm growth rates can be derived from the above equation. Under the assumptions employed in this study concerning initial herd size and the additional assumptions of an 8 percent interest rate and a $1.75 hourly wage rate, the following equation for determining class I base value can be obtained:

$$P = (1789.3XB - 32111.8477 - NW_{10})/(24.55061XB + 1653.58)$$

where P equals the average value per pound of class I base.

Marginal values of class I base were derived from the average values obtained from the above formula. The marginal values of an additional pound of class I base increase as more base is obtained. The increasing marginal value occurs because of the compounding effects the increased income derived from greater class I milk sales has on future firm growth and income producing ability. Table XIII provides the marginal and average values of class I milk bases at various percentages of class I marketings and with various 10-year growth objectives. The marginal values indicate the maximum price that a firm can pay for a pound of class I base while moving from one percentage class I marketing situation to another. The average values represent the maximum average investment per pound of base at a specified percentage class I marketing situation. It is assumed that the class I base retains its value at the end of the 10-year period and these values are included in the final net worth value.

It was found that a firm at the 11,000 pound level of technology could expect no growth unless it marketed at least 30 percent of its milk as class I. This percentage of class I marketings would yield a net price of $4.62 per hundred pounds of milk. A firm in this position for any length of time would probably progress more rapidly by selling milk on markets other than grade A; however, the scope of this study does not indicate the feasibility of this alternative.

TABLE XIII

MARGINAL AND AVERAGE VALUES OF A POUND OF CLASS I BASE AT VARIOUS CLASS I MARKETING PERCENTAGES AND FIRM GROWTH GOALS FOR FIRMS COMMENCING OPERATION AT THE 11,000 POUND LEVEL OF PRODUCTION

Percentage of Class I Marketings	Per Cent Increase in Net Worth Over a Ten-Year Period							
	No Growth		100% Growth		150% Growth		200% Growth	
	A.V. 1/	M.V. 2/	A.V. 1/	M.V. 2/	A.V. 1/	M.V. 2/	A.V. 1/	M.V. 2/
[illegible] 40	7.38	7.38	3/	3/	3/	3/	3/	3/
41-50	12.96	35.28	6.02	6.02	2.78	2.78	3/	3/
51-60	17.18	38.28	10.72	34.22	7.49	31.04	2.86	2.86
61-70	21.18	45.18	15.19	42.01	12.20	40.46	7.56	35.76
71-80	25.19	53.26	19.67	51.02	16.90	49.80	12.27	45.24
81-90	29.35	62.63	24.31	61.43	21.79	60.91	17.51	59.43

1/ A.V. is average value.
2/ M.V. is marginal value.
3/ Indicated percentage growth is not possible at the assumed production level and percentage of class I marketings.

Summary

The percentage of class I milk marketings greatly affected the growth of firms at the levels of technology considered in this study. The firm commencing operation at the 9,000 pound level of production could not survive and maintain the required family living income level when 50 percent of the milk was marketed at the surplus price. In order for this firm to survive, but not grow, the required percentage of class I marketings was 64 percent. The firm commencing operation at the 9,000 pound level of technology was not affected appreciably by changes in per cent class I marketings from 70 to 83 percent. This was caused by firm reorganization due to the same family living pressures discussed in Chapter IV. Firms at the 11,000 pound level of technology responded with approximately a 5 percent increase in tenth-year net worth growth for each 1 percent increase in class I milk marketings. The growth response was approximately 10 percent for each 1 percent increase in class I marketings at the 13,000 pound level of technology.

The price of a pound of class I base affected the investment cost of firm expansion, but only slightly affected the cost of producing a hundred pounds of milk at a given output. Under the assumption that appropriate size class I bases to conform to the specified percentage of class I marketings must accompany new cows entering the herd, a one dollar increase in the price of a pound of class I base increased the investment cost per cow $20.04, $24.59, and $29.13 for cows producing 9,000, 11,000, and 13,000 pounds of milk respectively.

Values per pound of class I base were determined from the simulation results. Growth rate objectives and per cent of class I marketings were important in the determination of class I base values. The marginal values of class I bases increase as per cent of class I marketings increase because of the compounding effects increased income has on future firm growth and income producing capabilities.

CHAPTER VI

EFFECTS OF FAMILY CONSUMPTION ON GROWTH

The amounts of family living withdrawals from firm net income and the stages of firm growth in which the withdrawals are made greatly affect the pattern of net worth growth over time. The effects of three specific family consumption functions on firm growth are discussed in this chapter.

The three consumption functions have been previously designated as rigid, equity-labor return, and income. The rigid consumption function required that annual family living average at least $6,000 over any consecutive three-year period and that in any single year consumption could not be greater than $7,500 or less than $4,500.

The equity-labor return consumption function was based on a return to owned equity at a rate of 1 percent less than the long term interest rate plus a return on family labor at the assumed wage rate. Consumption could be no greater than the return to owner equity and family labor plus $1,500; also it could be no less than the return to owner equity and family labor minus $1,500 or $4,500 which ever was the greater.

The income consumption function was of the form -- $C = 28.775768 I^{0.59}$ -- where C is family consumption and I is net income after taxes and long term debt repayment. Family living was computed from this function but never allowed to fall below $4,500 per year.

Simulated firm growth results employing the three different family consumption functions revealed the following primary results and implications.

1. As indicated in Figure 20, the income consumption function provided the greatest firm growth for the 9,000 and 11,000 pound level of technology firm; while the rigid consumption function provided the greatest firm growth at the 13,000 pound level of technology. The equity-labor return consumption function resulted in the slowest firm growths at all three levels of technology.
2. The consumption function that resulted in a relatively slow growth rate provided a high discounted family living income stream with two exceptions. At the 11,000 pound level of technology the income consumption function provided more growth and a larger family living income stream than did the rigid consumption function. At the 13,000 pound level of technology the income consumption function resulted in more growth and a larger family living income stream than did the equity-labor return consumption function.

For the analysis of consumption function effects on firm growth, other key variables were fixed as follows: intermediate term interest rate at 8 percent, percentage Class I marketings at 83 percent, price per pound of Class I base at $10, and hourly wage rates at $1.75.

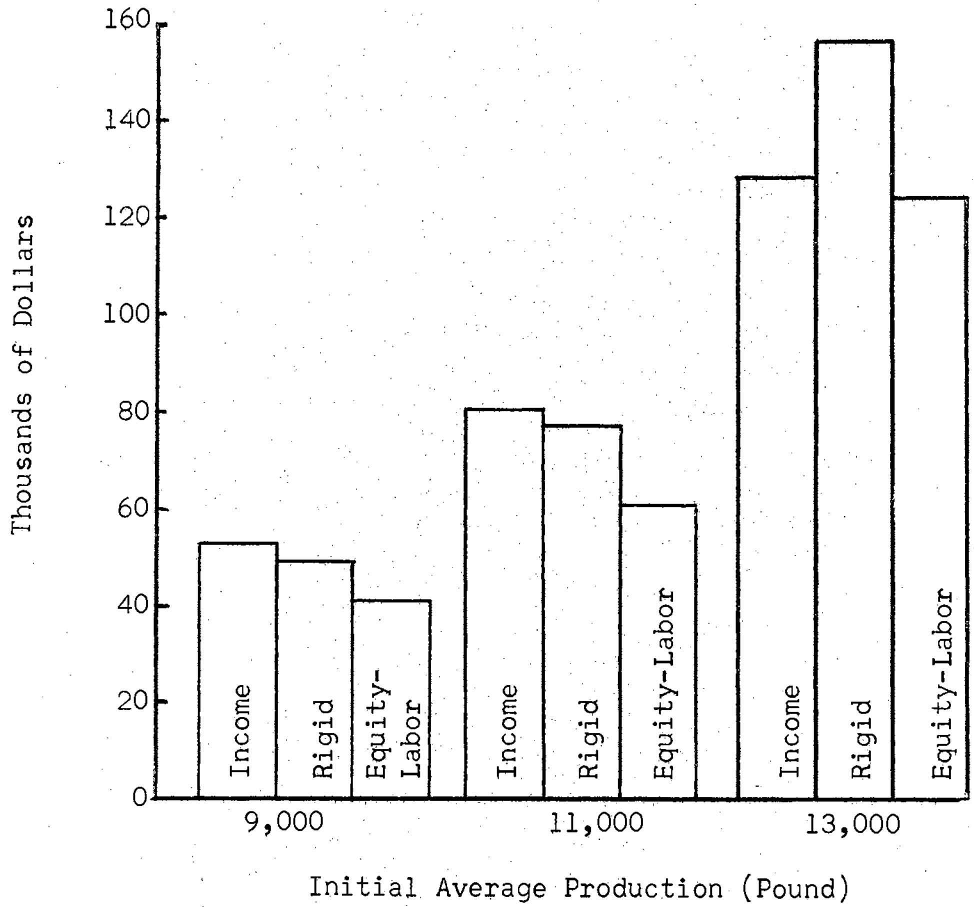

Figure 20. Simulated Tenth-Year Net Worth Values for Grade A Dairy Production Firms Under Three Different Types of Family Consumption Functions

Effects of Family Consumption on Firm Growth at the 9000 Pound Level of Technology

When comparing firm growth under various family consumption functions it is important to compare the growth pattern and the consumption pattern cuncurrently. Figures 21a and 21b present such a comparison for firms commencing operation at the 9,000 pound level of production.

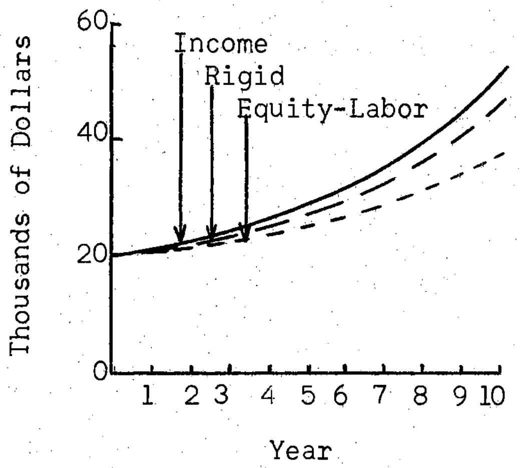

Figure 21a. Simulated Net Worth Growth Patterns Under Three Different Consumption Functions (9,000 lb.)

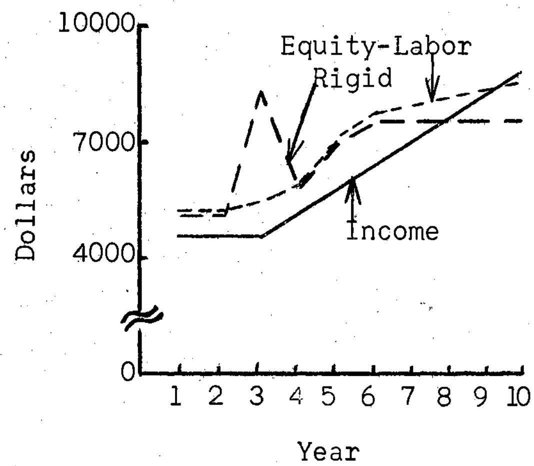

Figure 21b. Simulated Annual Consumption Under Three Different Consumption Functions (9,000 lb.)

The firm was able to grow fastest when consumption was based on income because it was not required to sell as many cows to meet family living requirements as with the other two types of consumption functions. Figure 22 indicates the cow numbers in each of the first four years of operation under the three different consumption methods. When consumption was based on income, curtailed family living in early years allowed for herd expansion early in the life of the firm. This allowed the firm to gain economies of size early which enhanced the growth of a resource base. Also by not having to reduce cow numbers to meet high living income requirements, the original resource base was maintained.

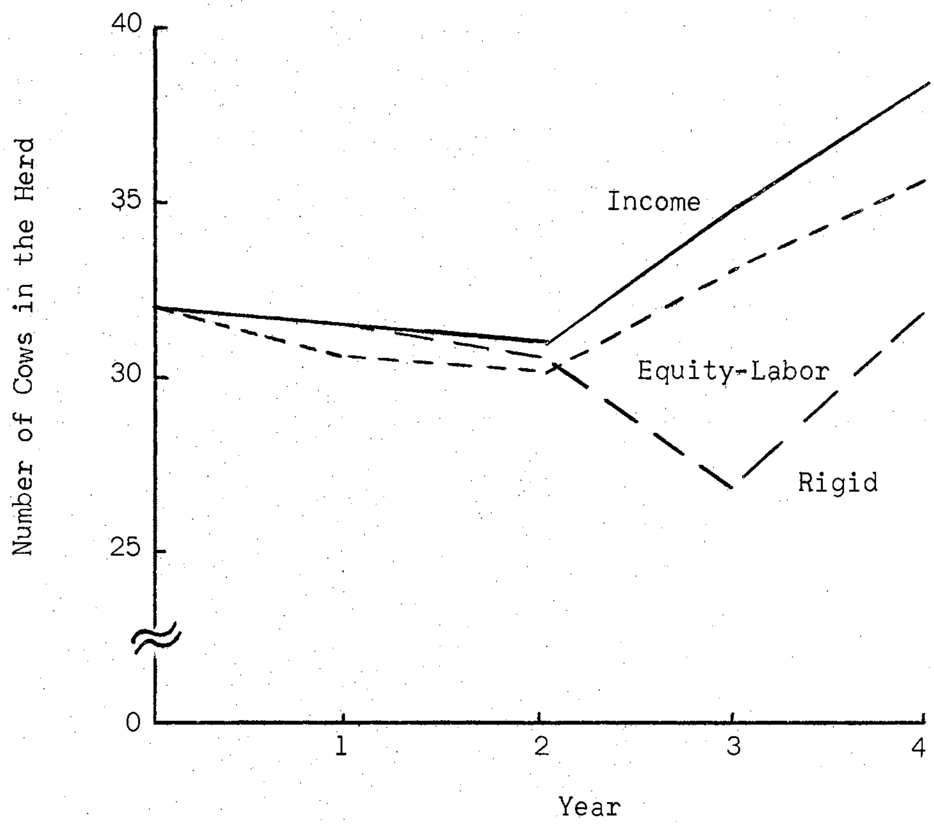

Figure 22. Simulated Number of Cows in the Herd at the Close of the Year as a Result of Increased Culling to Meet Family Living Requirements Under Three Different Types of Consumption Functions

When the rigid consumption function was employed, the resource base was reduced greatly in the third year to meet the $6,000 average annual income requirement. Even though the number of cows was greatly reduced, some advantages were gained by the firm in high production levels. The herd average production in the fourth year was 10,962 pounds of milk when the rigid consumption function was used, 10,233 pounds when consumption was based on a return to equity and labor, and 10,170 pounds when consumption was based on net income. Beyond the fourth year, family living requirements did not necessitate the sale of cows beyond normal culling. The high production level and the upper consumption limit of $7,500 allowed the firm under the rigid consumption function to grow faster than under the return to equity-labor consumption function.

The average net worth at the close of the tenth year was $51,880 when family living was based on the income consumption function. Three-fourths of the 40 replications were between $59,828 and $44,838. When family living was based on the rigid consumption function, 75 percent of the replications were between $34,050 and $62,083; the average was $46,954. When the firm operated under the return to equity and labor family consumption pattern the average tenth-year net worth was $38,880, and 75 percent of the replications were encompassed in the range of $28,558 to $49,663.

The 3 percent semi-annually discounted present values of the family living income streams varied greatly. The total discounted present value for the 10-year period was $45,266 with the income consumption function. The discounted present value of the family income stream when the simulation run employed the rigid consumption function was $51,146. The ten year firm operation simulation with the return to equity and labor consumption function revealed a discounted present value of $51,572 for family living.

Effects of Family Consumption on Firm Growth at the 11,000 Pound Level of Technology

Growth commenced early in the life of the firm when family living was based on the income consumption function. As can be observed in Figures 23a and 23b, the rate of growth from the fourth year on was not as great as when other consumption functions were employed, but growth started much earlier. When the equity-labor return and rigid consumption functions were used, the firm remained relatively dormant for the first four years. Commencing with the fifth year the firm under the rigid consumption function grew at a faster rate than that under the equity-labor return consumption function. The reason for the difference in growth patterns can be observed in Figure 23b. Starting in the fifth year, larger amounts were withdrawn from the firm income stream with the equity-labor return consumption function than with the rigid consumption function.

The average net worth at the end of ten years of operation under the income consumption function was $80,737. The range that encompassed 75 percent of the replications was $64,061 to $97,303. When consumption was based on a return to equity and family labor, the average tenth-year net worth was $58,981, while 75 percent of the replications were between $41,995 and $74,305. The simulation of firm growth under the rigid consumption function yielded an average net worth value at the end of ten years of $76,803, and the range of $57,144 to $103,981 included three-fourths of the replications.

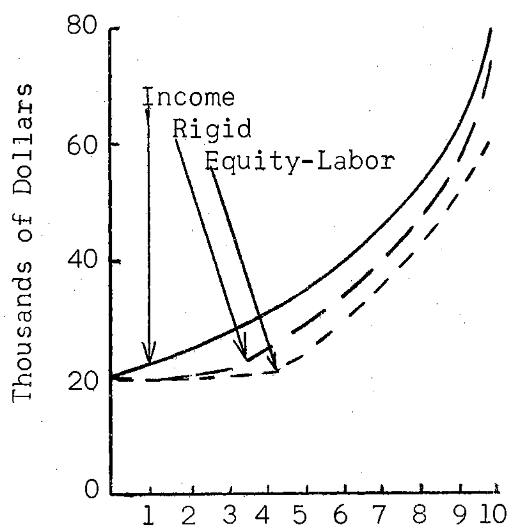

Figure 23a. Simulated Net Worth Growth Patterns Under Three Different Consumption Functions (11,000 lb.)

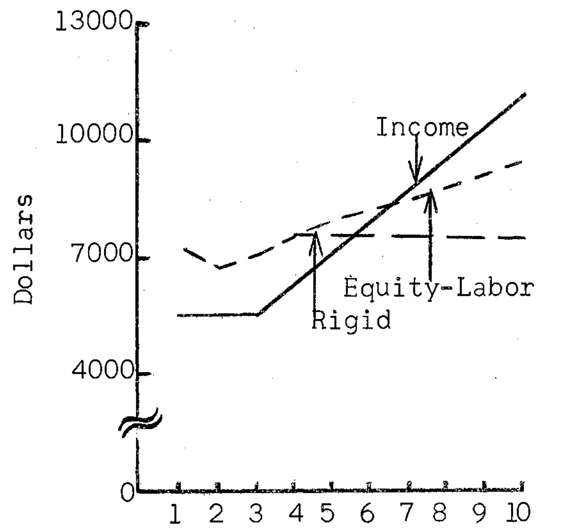

Figure 23b. Simulated Annual Family Consumption Under Three Different Consumption Functions (11,000 lb.)

The equity-labor return consumption function provided the greatest discounted present value of the family living income stream of $60,417. The present values of the family living income streams for rigid and income consumption functions were $55,935 and $56,256 respectively.

Effects of Family Consumption on Firm Growth at the 13,000 Pound Level of Technology

The rigid consumption function resulted in the greatest 10-year growth for the firm beginning operation at the 13,000 pound level of production. The firm at this level of technology encountered no problems in meeting the minimum family living requirements stipulated by the rigid consumption functions. The upper limit of consumption was achieved in every year except the first as revealed in Figure 24b. The average net worth at the end of ten years was $156,469 when the rigid consumption function was employed. Seventy-five percent of the replicated net worth values were between $115,732 and $204,026.

Figure 24a reveals that firm growth was initially greatest for the income consumption function, but this growth pattern was surpassed in the seventh year by that of the simulated firm operating under the rigid consumption function. Lower family living income withdrawals in the early years of operation allowed for early firm expansion, but as family income withdrawals increased (Figure 24b) growth rates decreased. The average firm net worth after ten years of operation was $125,831 when family living was based on net income. Three-fourths of the tenth-year net worth values were between an upper range of $145,039 and a lower range of $109,468.

When family living was subject to owner equity and labor returns, firm growth was the slowest, but as indicated in Figure 24a the tenth-year net worth value was little different from the value for the firm operating under the income consumption function. Large early family living withdrawals impeded firm growth in the early years of operation. In the fifth year (Figure 24b) such income withdrawals became less

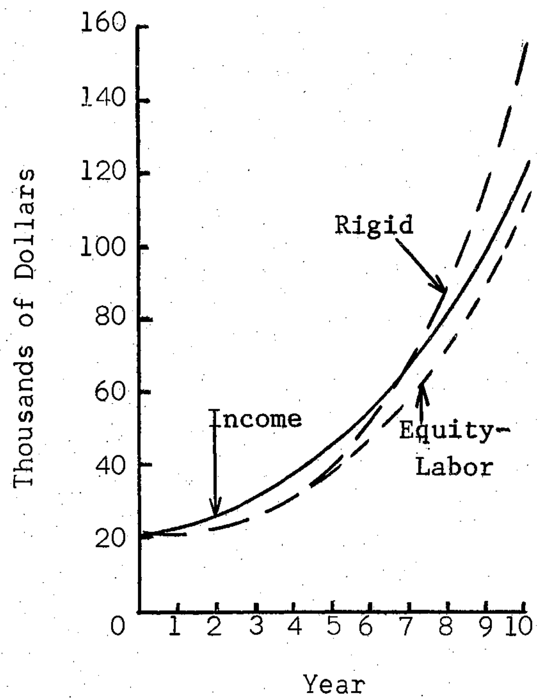

Figure 24a. Simulated Net Worth Growth Patterns Under Three Different Consumption Functions (13,000 lb.)

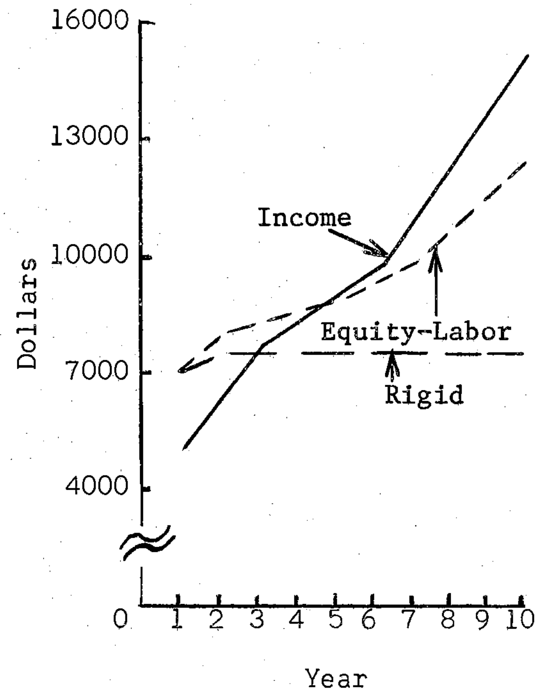

Figure 24b. Simulated Annual Family Consumption Under Three Different Consumption Functions (13,000 lb.)

than for the income consumption function situation, and firm growth began to accelerate. The average tenth-year net worth value was $124,344 when the return to equity and family labor consumption function was used. The range of net worth values that encompassed 75 percent of the replications was from $93,873 to $152,195.

The discounted present value of the family living income stream was least when the rigid consumption function condition was simulated. The present value of the ten year income stream was $56,756. The present values were very similar for the income and return to equity and labor consumption function situations. The family income stream present values were $69,394 and $68,569 for the income consumption function and the return to equity and labor consumption function, respectively.

The Conflict of Family Living and Firm Growth Goals

Current family consumption clearly affects future firm growth as exemplified by the preceding discussion. Depending on the level of technology, large family living withdrawals early in the firm growth pattern can seriously jeopardize the existance of a firm. Within the realm of consumption functions discussed in this study, early firm growth can best be achieved by basing family consumption on the net income produced by the firm. Other methods of family consumption determination that are not directly associated with the income producing ability of the firm such as a specific range (rigid) and return on owner supplied resources can subject the firm's net income to detrimental withdrawals. The amount of capital available for firm expansion is directly associated with family living withdrawals.

One would be naive to suspect that a farm family would operate on the same consumption function throughout the life of their firm. Family consumption is affected by age, family size, personal goals, and firm goals. A family may have a specific goal for the firm that will necessitate family consumption sacrifices until the goal is attained. After the firm goal is reached, family consumption strategy probably will change to allow greater consumption withdrawals. Because of the close interrelationship of family and firm with the owner-managed dairy production firm, the firm owner needs to apply specific management strategies not only to the firm but also to family consumption.

Summary

The amount and timing of family income withdrawals from firm net income can greatly affect firm growth. The deferment of family living expenses until the firm could support such withdrawals resulted in the fastest growth rate for the two lower levels of technology. Family needs and desires might not allow such a deferment, however. When family living was based on firm net income, the firm at the 9,000 pound level of technology was able to provide only the minimum family living level of $4,500 for the first three years. Over the ten year period family living averaged just slightly more than $6,000.

At the 11,000 pound level of technology the consumption function based on firm net income provided sufficient family living to average $6,000 over the first five years, and averaged over $7,600 for the ten year period. This pattern of family consumption differs from the rigid consumption function primarily in lower family income provisions in the first four years of operation.

It is unlikely that a firm at the 13,000 pound level of technology would limit family consumption to a maximum of $7,500, particularly after the first four or five years. All of the consumption functions employed in the study provided an average income over any three year period in excess of $6,000. The average annual incomes over the ten year simulated time span were $9,537, $7,438, and $9,223 for the income, rigid, and return to equity and labor consumption functions respectively.

The type of family consumption function adopted by the firm would depend on the level of technology, family needs and desires, and net worth growth objectives. The firm would probably use a variety of family living consumption functions throughout its life. A farm family consumption function is approximate at best, and is dependent upon circumstances of the moment.

CHAPTER VII

SUMMARY AND CONCLUSIONS

The central purpose of this study was to determine the potential nature and magnitude of the net worth growth patterns of Oklahoma grade A dairy production firms under various input resource prices, milk prices, production levels and family consumption functions. The specific objectives were to determine the effects of interest rates, wage rates, class I milk base prices, percentages of class I milk marketings, and family consumption on firm growth. These effects were analyzed at three different levels of firm technology. It was also the objective of this study to develop a simulation procedure by which the growth pattern of a specific firm could be estimated.

The study was restricted to commercial grade A dairy production firms in the northern two-thirds of Oklahoma. Only the dairy enterprise was considered in the study, and it was assumed that all feed inputs were purchased by the firm. Operational costs other than those allowed to vary for analytical purposes in the study were derived from surveys of grade A milk producers, building contractors, and equipment suppliers. Feed costs were derived from historical feed price data. Product prices were based on 1968 milk prices and historical dairy-beef price data. Livestock death, culling and calving rates were obtained from milk producer records.

The model employed for the analysis of key variable effects on firm net worth growth was one of stochastic simulation. The firm commenced operation with a net worth value of $20,000 and a liabilities to assets ratio no greater than 0.6. Simulation runs, each consisting of 40 replications, were conducted to determine firm net worth growth patterns over a 10-year period for (1) three levels of technology, (2) three sets of interest rates, (3) three wage rates, (4) three percentages of class I milk marketings, and (5) three family consumption functions. Other variables were held constant while analyzing a specific variable.

Summary of Effects of Interest Rates

Firm net worth growth patterns as affected by many of the key variables in this study were unique to the level of technology. Such was the case with respect to interest rates. The primary findings and implications of the effects of varying interest rates were:

1. The firms beginning operation at the 9,000 pound level of technology were affected very little by interest rates. This was because higher expenses incurred by higher interest rates forced the firm to sell cows from the lower end of the production scale to meet family living requirements, thereby increasing the level of technology and nullifying the effects of higher interest rates. The tenth-year net worth values were (a) $47,433 for an intermediate term interest rate of 7 percent, (b) $46,945 for an interest rate of 8 percent, and (c) $47,200 for an interest rate of 9 percent.

2. When the firm started operation at the 11,000 pound level of technology, growth was somewhat affected by interest rates. The tenth-year net worth values were (a) $81,562 for an intermediate term interest rate of 7 percent, (b) $76,803 for an interest rate of 8 percent, and (c) $71,518 for an interest rate of 9 percent.
3. The tenth-year net worth values for the firm commencing operation at the 13,000 pound level of technology were (a) $184,724 for an intermediate term interest rate of 7 percent, (b) $156,469 for an interest rate of 8 percent, and (c) $146,115 for an interest rate of 9 percent. The reason for the relatively higher net worth values at the 7 percent level of interest was that 35 of the 40 replications grew in cow numbers to the maximum herd size (160 cows) allowed in this study. After attaining this size all excess income was directed toward debt payment instead of herd expansion; therefore, net worth increased rapidly in the tenth year.

Summary of Effects of Wage Rates

The hiring of farm labor was restricted to units of no less than 600 man hours. It was assumed that the farm family supplied 2,950 hours per year. The firms commenced operation with a unit requiring no more labor than the family could supply. If the firm did not grow or decreased in cow numbers, wage rates had no effect on its growth. The major findings and implications of the effects of wage rates on firm growth were:

1. Wage rates affected firm growth very little at the lowest level of technology for the same reasons that the interest rate effect was small. The tenth-year net worth values were (a) $47,661 for an hourly wage rate of $1.50, (b) $46,957 for a wage rate of $1.75, and (c) $46,757 for a wage rate of $2.00.
2. An increase in wage rates from $1.50 to $1.75 per hour only slightly affected the growth of firms at the two higher levels of technology, but the $2.00 per hour rate reduced tenth-year net worth values considerably. The increase in production costs due to an increase of hourly wage rates from $1.50 to $1.75 was absorbed by decreased family living income. A further increase of hourly wage rates to $2.00 was too great to be absorbed by family living; therefore, it curtailed expansion activities and growth. The tenth-year net worth values for the firm at the 11,000 pound level of technology were (a) $78,496 for a wage rate of $1.50, (b) $76,803 for a wage rate of $1.75, and (c) $70,080 for a wage rate of $2.00. For the 13,000 pound level of technology firm the net worth values at the close of the tenth year were (a) $158,274 for the $1.50 wage rate, (b) $156,469 for the $1.75 wage rate, and (c) $148,490 for the $2.00 wage rate.

Summary of Effects of Class I Base Prices

The price per pound of class I milk bases had little affect on the cost of producing milk, but greatly affected the investment cost of additional cows. It was assumed in this study that when cows entered the herd whether from home raised replacements or purchases, that class I base must be purchased to cover the additional milk marketings. The main findings and implications were:

1. With a class I base sufficient to market 83 percent of the milk at the class I price, every one dollar increase in class I base price increased the investment cost per cow by $20.04, $24.59, and $29.13 for cows producing 9,000, 11,000, and 13,000 pounds of milk respectively.
2. The growth of firms at all levels of technology was affected by base price changes. The tenth-year net worth values were approximately twice as great at a zero price as at a $15 price. The net worth values for firms at the 9,000 pound level of technology were (a) $84,057 for a base price of zero, (b) $46,954 for a $10 per pound base price, and (c) $35,601 for a $15 per pound base price. The tenth-year net worth values were $123,138, $76,803, and $64,252 at the 11,000 pound level of technology at the zero, $10 and $15 base prices respectively. Firms at the 13,000 pound level of technology grew to net worth values of $193,954, $156,468, and $140,861 in the 10-year period at base prices of zero, $10 and $15 respectively.

Summary of Effects of Percentages of Class I Marketings

A class I base price of $6.46 and a surplus price of $3.83 per hundred pounds of milk were assumed for this study. A blend of these two prices resulted in the price received by the dairy firm for milk. The amount of class I base owned by the firm determined the blend price received for milk. Analyses were conducted at three levels of class I milk marketings-50 percent, 70 percent, and 83 percent. The major findings and implications were:

1. The firm commencing operation at the 9,000 pound level of technology could not survive by marketing only 50 percent of its milk at the class I price. The firm exited the industry during the fourth year of operation. A firm starting at this level of production required at least 64 percent class I milk marketings to survive. The tenth-year net worth values were $45,060 for 70 percent class I milk marketings and $45,954 for 83 percent class I marketings.
2. As production levels increased, the resultant firm rate of growth from higher percentages of class I milk marketings increased. This can be observed by comparing the 10-year growth of firms under the three different percentages of class I marketings. At the 11,000 pound level of technology, tenth-year net worth values were (a) $43,879 for 50 percent class I marketings, (b) $64,063 for 70 percent class I marketings, and (c) $76,803 for 83 percent class I marketings. At the 13,000 pound level of technology the net worth values at the end of the tenth year were (a) $86,057 for 50 percent class I marketings, (b) $103,376 for 70 percent class I marketings, and (c) $156,469 for 83 percent class I marketings. Because the rate of growth increased as the percentage class I marketings increased, the marginal values of class I bases increased as more class I base was acquired.

Summary of Effects of Consumption Functions

The effects on firm growth of three different types of family consumption functions were analyzed. The methods of determining family consumption were a rigid type consumption function maintaining family consumption between $4,500 and $7,500, a consumption function based on net income, and a consumption function reflecting return to the owner's equity and labor. The main findings and implications of the effects of family consumption were:

1. The growth of firms at the two lower levels of technology was quite similar between the rigid and the income consumption functions. Growth was slowed considerably when consumption was based on a return to equity and labor. The return to equity and labor consumption function required large family living withdrawals from the firm net income stream during the early years of operation. The tenth-year net worth value for the firm beginning operation at the 9,000 pound level of technology was (a) $51,880 when consumption was based on net income, (b) $46,957 for the rigid consumption function, and (c) $38,880 when consumption was based on a return to owned equity and labor. At the 11,000 pound level of technology tenth-year net worth values were (a) $80,737 when consumption was based on net income, (b) $76,803 for the rigid consumption function, and (c) $58,981 when consumption was based on return to owned equity and labor.

2. When the firm started operation at the 13,000 pound level of technology growth was fastest for the rigid consumption function. The family living withdrawals were similar for the three consumption functions in the early years of operation. After the second year family consumption was greater for the income and return to equity and labor consumption functions than for the rigid consumption function. The tenth-year net worth values were (a) $125,831 when consumption was based on net income, (b) $156,469 for the rigid consumption function, and (c) $124,344 when income was based on a return to owner equity and labor.

Implications for Dairy Production Firms

Herd milk production levels affect firm growth more than any of the other factors considered in this study. Given specific capital and labor restrictions, a firm starting operation at a 13,000 pound level of production can grow about three and one-half times faster in a 10-year period than a firm starting at a 9,000 pound level of production. Firms commencing operation at the 11,000 pound level of production can grow about twice as much in 10 years as a firm starting at the 9,000 pound level.

Wage and interest costs have little affect on firm growth. Firms at the 11,000 pound level of technology increased their net worth by 250 percent in 10 years when wage rates were $2.00 per hour. Interest rates affected growth more than wage rates, but increases in interest rates did not appear to deter growth appreciably.

The percentage of milk marketed as class I had a decided effect on firm growth. Firms starting at the 9,000 pound level of technology should not expect to survive unless at least 64 percent of the milk is marketed as class I. The acquisition of sufficient class I base should be a major objective of the firm to insure survival and growth. Since class I base requires little cost once obtained and no extra labor, firm expansion may be better achieved by base purchases rather than cow purchases.

Firms grow fastest (except at 13,000 pound level) when family consumption is based on net income. Deferment of large withdrawals for family consumption until later years in the firm life can enhance firm growth. Family consumption and firm growth are two objectives of the firm which may often be in conflict.

The results of this study revealed that new firms generally experience a period of dormancy, as far as net worth growth is concerned, during the first five years of operation. Dairy producers should not become discouraged unless the firm begins to decrease in net worth in the early years.

Application of the Firm Growth Model

The firm growth model, that was developed in this study, can be applied to specific grade A dairy production firms. The firm would supply information such as herd size and average production level, appropriate interest and wage rates, percentage of class I marketings, class I base values, and family living criteria. The firm would also report its long-term and intermediate term assets along with accompanying liabilities. A minimum net worth ratio under which the firm desires to operate would be indicated. The report form for specific firm variables is shown in Appendix F.

A specific firm growth simulation would be helpful in determining the feasibility of alternative dairy enterprise reorganization plans, and in the comparison of dairy and other farm enterprises. An estimate of future firm growth could provide insight into the capability of the firm to provide family security, desired growth, and credit security.

Need for Further Study

This study involved a micro analysis of the grade A milk producing firm. It did not consider the supply of specific qualities of livestock, the supply of dairy labor, nor any change in the demand for milk. Further study is needed to analyze the dairy industry by geographic or market areas in a macro framework to determine firm interaction as the industry reacts to shifts in the supply of resources and the demand for milk. Additional studies would be beneficial concerning firm expansion by methods other than herd size increases such as the acquisition of additional class I base.

A SELECTED BIBLIOGRAPHY

[1] Blakley, Leo V. and John R. Price. Prices Paid by Oklahoma Farmers, 1937-1961. Oklahoma Agricultural Experiment Station, PSP-447, Stillwater, 1963.

[2] Brake, John M. "Firm Growth Models Often Neglect Important Cash Withdrawals." American Journal of Agricultural Economics, Vol. 50 (1968), pp. 769-772.

[3] Edwards, Clark and H. W. Grubb. Dairy Farm Organization in Central and Northeast Oklahoma. Oklahoma Agricultural Experiment Station, B-573, Stillwater, 1961.

[4] Glikstein, Aaron et al. Simulation Procedures for Production Control in an Indiana Cheese Plant. Purdue University Agricultural Experiment Station, Research Bulletin No. 757, Lafayette, 1962.

[5] Halter, A. N. and G. W. Dean. "Use of Simulation in Evaluating Management Policies Under Uncertainty: Application to a Large Scale Ranch." Journal of Farm Economics, Vol. 47 (1965) pp. 557-573.

[6] Hutton, Robert F. A Simulation Technique for Making Management Decisions in Dairy Farming. Economic Research Service, USDA Agricultural Economics Report No. 87, Washington, 1966.

[7] Hutton, Robert F. and H. R. Hinman. A General Agricultural Firm Simulation. Pennsylvania Agricultural Experiment Station, A. E. and R. S. No. 72, University Park, 1968.

[8] McDaniel, Ben. "Production Increases Possible Through Use of USDA-DHIA Sire Summaries." Values of Dairy Cows and Sires for Production Traits. National Extension Seminar, Madison, Wisconsin, April, 1968.

[9] Orcutt, Guy H. "Simulation of Economic Systems." American Economic Review, Vol. 50 (1960), No. 5, pp. 893-907.

[10] Ramsey, John M. "Heterogeneity of Variance at Different Genetic Levels of Milk Production." Unpublished Ph.D. Thesis, Iowa State University, Ames, 1966.

/11/ Raup, Philip M. "Farm Family Capital Accumulation and Investment Processes." Capital and Credit Needs in a Changing Agriculture (E. L. Baum, Howard C. Diesslin, and Earl O. Heady, ed.), Ames, Iowa, 1961.

/12/ Richardson, Curtis W. Feeding Dairy Replacement Heifers. Oklahoma Cooperative Extension Service, F. S. No. 4004, Stillwater, 1966.

/13/ Shubik, Martin. "Simulation of the Industry and the Firm." American Economic Review, Vol. 50 (1960) No. 5, pp. 908-919.

/14/ Suttor, Richard E. and Richard J. Crom. "Computer Models and Simulation." Journal of Farm Economics, Vol. 46 (1964), pp. 1341-1350.

/15/ Tyner, Fred H. and Luther G. Tweeten. "Simulation as a Method of Appraising Farm Programs." American Journal of Agricultural Economics, Vol. 50 (1968), pp. 66-81.

/16/ United States Department of Agriculture, Economic Research Service, Cost and Return on Commercial Farms, 1930-1957. Washington, 1961.

/17/ __________. Dairy Situation. Washington, September, 1966.

/18/ __________. Dairy Situation. Washington, November, 1966.

/19/ __________. Dairy Situation. Washington, March, 1969.

/20/ United States Department of Commerce, Bureau of the Census. United States Census of Agriculture, 1950. Vol. 1, Part 25, Washington, 1950.

/21/ __________. United States Census of Agriculture, 1954. Vol. 2, Washington, 1954.

/22/ __________. United States Census of Agriculture, 1964. Vol. 1, Part 36, Washington, 1964.

/23/ __________. United States Census of Agriculture, 1964. Vol. 2, Washington, 1964.

/24/ Zusman, Pinhas and Amatz Amida. "Simulation: A Tool for Farm Planning Under Conditions of Weather Uncertainty." Journal of Farm Economics. Vol. 47 (1965), pp. 574-594.

APPENDIX A

APPENDIX A

Appendix A includes a description of the population from which a stratified random sample was drawn for this study; also included is a discussion of the sampling procedure. Information concerning the degree of enterprise specialization, characteristics of the firm owners, the goals and objectives of the firms, and a brief description of the resource markets are presented in this section.

Sampling Procedure

A total sample size of approximately 80 farms was desired for the study. As all farm managers were to be interviewed personally, a larger number would have increased data collection costs considerably. Considering the small size of the sample a system of stratification was desirable. The grade A dairy farms in each district were divided into two categories - those participating in the production and cost record keeping system (DHIA) and those not. It was believed that validity could be gained in the collected data by drawing the majority of the sample from the farms enrolled in the DHIA program.

Since the agricultural census data does not delineate herd size beyond 50 cows, it was necessary to estimate herd sizes greater than 50 cows from Oklahoma Crop and Livestock Reporting records. The number of herds enrolled in the record program for each herd size and district was obtained from the Oklahoma State University Dairy Extension office. The herd size categories used in this study were identical to those employed by the Oklahoma Crop and Livestock Reporting Board, i.e. 30 - 49 cows, 50 - 74 cows, 75 - 99 cows, and 100 or more cows. The herd distribution by size, district, and participation in the Dairy Herd Improvement program is indicated in Table XIV.

TABLE XIV

GRADE A DAIRY HERD DISTRIBUTION BY SIZE, CROP AND LIVESTOCK REPORTING DISTRICT AND DAIRY HERD IMPROVEMENT PARTICIPATION - 1967

Herd Size	Districts 1 and 4		District 2		District 3		District 5	
	*N	P	N	P	N	P	N	P
30-49	145	14	41	17	207	16	271	24
50-74	71	19	16	11	89	12	128	31
75-99	12	10	1	6	17	8	31	9
≥100	8	12	5	1	21	2	29	7

*N = Non participation and P = Participation in the DHIA programs.

Source: 1964 Census of Agriculture and Oklahoma Crop and Livestock Reporting Service 1964 Dairy Survey.

To obtain the desired sample size with approximately 2/3 DHIA participating dairymen and 20 samples of each herd size the stratified random sampling technique depicted in Table XV was used.

TABLE XV

PERCENTAGE OF POPULATION SAMPLED BY HERD SIZE AMONG DHIA PARTICIPATING AND NONPARTICIPATING OKLAHOMA GRADE A DAIRY HERDS

Herd Size Cows	Percent Sample	
	Nonparticipating	Participating
30–49	1.0	20.0
50–74	2.5	20.0
75–99	10.0	40.0
≥100	10.0	60.0

This sampling procedure yielded 83 samples to be drawn at random. It was desirous that none of the cells illustrated in Table XIV be omitted, but because of herd size and number changes and errors in the estimation of herd sizes, one cell was not sampled. From the estimation procedures discussed earlier it was ascertained that this cell population numbered only one dairy farm. Due to herd size changes and three unusable surveys all herd sizes were not represented by exactly 20 farms. The desired samples from each cell and the obtained samples are reviewed in Table XVI.

There were a total of 27 non-DHIA farms and 53 DHIA farms in the survey. There exists the possibility that the high proportion of DHIA farms might have biased the study toward the more progressive dairy operation, but only if one first accepts the premise that DHIA enrolled dairymen are more progressive. The primary reason for the large proportion of DHIA farms in the survey was as previously stated to add validity to the data collected because of the access to monthly feed costs, breeding and calving records, and milk production records.

TABLE XVI

DESIRED AND OBTAINED SURVEYS BY SAMPLE CELLS

Herd Size	Districts 1 and 4				District 2				District 3				District 5			
	N[1/]		P		N		P		N		P		N		P	
	D[2/]	O	D	O	D	O	D	O	D	O	D	O	D	O	D	O
30-49	1	1	3	2	1	1	3	2	2	1	3	2	3	3	5	4
50-74	2	2	4	3	1	2	2	2	2	4	2	2	3	3	6	5
75-99	1	1	4	4	1	0	2	3	2	1	3	4	3	2	4	5
≥100	1	1	7	7	1	1	1	1	2	2	1	2	3	2	4	5

1/ N = Nonparticipation and P = participation in DHIA program.
2/ D = Desired sample and O = obtained sample.

Results of Survey

The majority of the surveyed farms were specialized dairy farms with accompanying small operations in other enterprises. On the average only 14.1 percent of the net farm income was derived from sources other than dairy. The percentage of net income reported from agricultural sources other than dairy were 14.4 percent, 14.1 percent, 8.1 percent, and 15.7 percent for farms of 30-49, 50-74, 75-99, and greater than 99 cows respectively. Thirty-three farms (41.25 percent) reported no other enterprise except dairying and feed production.

Most of the dairymen were fully employed on the farm with only 3.1 percent of the family net income being earned off the farm. The percentage of off-farm earnings ranged from 60 percent to none. The farms of more than 99 cows reported no off-farm income, while the farms of 30-49 cows, 50-74 cows, and 75-99 cows averaged 9.1 percent, 4.3 percent, and 0.3 percent off-farm net income respectively.

The ownership of the sampled farms revealed a particular pattern. All of the farms in the smaller size group were one-owner farms. Thirteen percent of the 50-74 cow farms, 30.0 percent of the 75-99 cow farms, and 38.1 percent of the farms with more than 99 cows were partnerships. Many dairymen not presently involved in a partnership were interested in forming one in the near future. They viewed the partnership as a method of gaining labor flexibility and specialization on the farm.

Characteristics of the Dairymen

The average age of the surveyed dairyman was 42.6 years. The average number of years in dairying was approximately 15 years, and the dairymen anticipated that they would remain in dairying for about 15 years more. Table XVII relates the age, experience, years remaining, and educational level by herd size groupings. The managers of the largest herds indicated the least number of years of experience. Several of these dairymen had taken over the operation from their fathers.

TABLE XVII

AGE, TENURE, AND EDUCATION LEVEL OF SURVEYED DAIRYMEN

Herd Size	Age When Starting	No. Years in Dairy	Present Age	Years Left	Education
30-49	29.3	16.4	45.7	12.6	11.6
50-74	27.2	14.0	41.2	15.1	12.1
75-99	25.6	17.1	42.7	15.6	11.1
≥100	28.2	13.3	41.5	17.7	12.3
Ave.	27.7	14.9	42.6	15.1	12.1

Of the dairymen interviewed, 61.7 percent indicated that they would enter retirement when they discontinued dairying; 30.0 percent said that they would remain in dairying; while 8.3 percent planned to enter a nonfarm business upon discontinuance of dairy farming.

Several questions were asked the dairymen concerning their likes and dislikes in dairying and farming in general. Seven answer choices to the question, "What do you like about dairying?" were presented to the interviewers. The answers ranked as follows: regular income, like dairy cows, complete family labor utilization, lower income risk than other farming enterprises, capital more readily available for dairy than with other types of farming, even monthly labor demand distribution, and "other" which included independence, pride of ownership of registered cattle, and a record of accomplishment in herd improvement. The answers to the question "What do you dislike about dairying?" were ranked as follows: too confining, scarcity of experienced labor, capital requirements high, difficult to vary herd size with feed supply, and "other" which included a lack of producer bargaining power. The surveyed dairymen were also asked the two following questions with accompanying ranking scales:

How do you like farming?

0-1	2-3-4	5-6-7	8-9
dislike it very much	rather be doing something else	better than most occupations	best of all occupations

How do you like dairying?

0-1	2-3-4	5-6-7	8-9
dislike it very much	rather be doing something else	better than most types of farming	best of all types of farming

In the aggregate they ranked their appraisal of farming at 7.7 while that of dairying was 7.5.

Income Levels

An attempt was made to determine the net income for family living from the dairy enterprise after taxes and long-term debt repayment. The herds of 30-49 cows averaged $4,895, herds of 50-74 cows averaged $5,681, herds of 75-99 averaged $8,094, and herds of more than 99 cows averaged $8,164 of annual per family living income. As has been noted previously 30.0 percent of the herds greater than 99 cows were more than one family units which explains the similarity of the family net incomes for the two largest herd size groupings and the absence of a proportionate increase which might have been expected over smaller herd size incomes.

Goals and Objectives

In answer to goals in family living income the average amounts were $7,581, $7,860, $8,172, and $8,285 respectively for the four herd size groups. The apparent contentment of the two larger size groups was further exemplified by the small expected change in herd size. The smallest herd size group averaged 36.7 cows but had a 10-year goal of 58.6 cows. The second size group had 62.7 cows on the average and anticipated more than a 60 percent growth to 103.0 cows during the next decade. The herds of 75-99 cows averaged 85.0 cows but expected a small 10-year growth to 99.7 cows. The largest herd size group anticipated very little growth in herd size from 129.2 cows to 134.5 cows. The largest herd size group was characterized by over half (52.4 percent) indicating a decrease in herd size or going out of business during the next decade; however, of those decreasing their herd size, 62 percent anticipated that they would still have milking herds of 100 or more cows. Those that indicated plans for herd expansion predicted size increases in their herd to 200, 300, and even 400 cows in the future. Of the four dairymen who projected these large herd sizes two were father-son partnerships, one was a two-brother operation, and one was a single owner firm. Table XVIII indicates the present and the anticipated future 10-year herd size distribution of the surveyed dairy farms as well as the number that anticipate exiting the dairy business during the coming decade. Of the 17 dairymen anticipating leaving the dairy business six planned to retire, 10 were going to continue farming but in a different enterprise and one planned to pursue an occupation off the farm.

TABLE XVIII

NUMBER OF FARMS IN EACH SIZE CATEGORY

	Herd Size				
	30-49	50-74	75-99	>99	Out of Business
Present Distribution	16	23	20	21	--
Future Distribution	8	11	6	38	17

A transition matrix of present and anticipated herd size distribution is shown in Table XIX. Of the small herds (<50 cows) 50 percent anticipated no increase or increase only to the next size group. The majority of those with herds of 50-74 cows were planning to remain at their present size or make a large increase to over 100 cows. The majority of the dairy farms in the two larger size groups anticipated having herds of 100 or more cows in 10 years time.

TABLE XIX

EXPECTED MOVEMENT TO HERD SIZE CATEGORIES IN 10 YEARS BY PERCENTAGES

Present Distribution	Anticipated Distribution				
	<50	50–74	75–99	>99	Out of Dairy
<50	.25	.25	.0625	.1250	.3125
50–74	.0870	.1739	.0870	.3913	.2608
75–99	.05	.10	.10	.55	.20
>99	.0476	.0476	.0476	.7619	.0953

Resource Market

Of greatest concern in the resource market was labor. The two major complaints were that dairying was too confining and that good labor was scarce. Analysis of the wages paid revealed much variation. The monthly wages for a married man ranged from less than $200 to over $600 plus milk, a house, and utilities. The average wage for married men was $333.40 plus house, utilities, and milk. The monthly wage for single men varied less than for married men, and averaged $157.50 plus board and room. Wages for hourly labor averaged $1.38 per hour and ranged from $1.00 to $2.50 per hour.

The managers of herds less than 100 cows did not feel that capital was difficult to borrow, and felt that lending agencies would allow them to borrow to an extent of indebtedness greater than they themselves desired. The owners of larger herds were not quite as conservative and felt that lending agencies were not lending enough on owner equity in the dairy. The percentage of liabilities to assets desired by dairymen and desired by lending agencies according to the dairy producers' estimations are shown in Table XX by herd size groupings. There was a desire by most dairymen surveyed to be free of all debt by the time they retired. The reluctance of dairymen to borrow large amounts of capital indicated that the dairy enterprise was financed internally to a great extent.

TABLE XX

PERCENTAGE OF LIABILITIES TO ASSETS CRITERIA OF BORROWERS AND LENDERS

	Herd Size				
	<50	50-74	75-99	>99	Average
Borrower	46.2%	51.3%	56.0%	65.7%	55.2%
Lender	55.0%	58.3%	58.5%	63.8%	59.1%

APPENDIX B

APPENDIX B

The frequency distribution of stochastic variables used in the study are included in this section. The frequency distributions for resource and product prices were obtained from historical data. The firm growth simulator included many functional relationships for income withdrawals and for the derivation of succeeding year simulation inputs. These functions are shown in Table XXIV. The fortran source listing for the simulator is presented in Table XXV.

Stochastic Variables

The prices of ingredients for the grain mix were selected randomly from a frequency distribution. Random selection was achieved by using a random number generating computer routine. The randomly selected feed prices were used in the computation of 400 least-cost rations which were used in each of the 10-year 40 replicated growth simulations. The grain mix ingredient prices can be found in Table XXI.

Table XXI also includes the frequency distribution of alfalfa hay prices, cull cow prices, and surplus calf prices used in the simulation. Four hundred unique values were randomly selected in the manner previously discussed for use in each of the 10-year simulations.

TABLE XXI

FREQUENCY DISTRIBUTIONS OF THE HISTORICAL PRICES (DOLLARS) OF GRAIN MIX INGREDIENTS, ALFALFA HAY, AND DAIRY-BEEF OBTAINED FROM OKLAHOMA PRICE DATA

Cotton Seed Meal	Soybean Oil Meal	Oats	Sorghum	Corn	Barley	Alfalfa Hay	Cull Cows	Surplus Calves
Price per cwt. (Freq.)	Price per cwt. (Freq.)	Price per cwt. (Freq.)	Price per cwt. (Freq.)	Price per cwt. (Freq.)	Price per cwt. (Freq.)	Price per ton (Freq.)	Price per head (Freq.)	Price per head (Freq.)
3.80 (.10)	4.20 (.10)	2.60 (.10)	2.10 (.10)	2.70 (.10)	2.25 (.15)	26.50 (.10)	154.00 (.10)	30.00 (.10)
3.90 (.10)	4.30 (.10)	2.70 (.10)	2.20 (.15)	2.80 (.20)	2.35 (.20)	27.50 (.10)	168.00 (.10)	34.00 (.10)
4.00 (.20)	4.40 (.20)	2.80 (.10)	2.30 (.15)	2.90 (.15)	2.45 (.30)	28.50 (.20)	172.00 (.15)	36.00 (.15)
4.10 (.20)	4.50 (.20)	2.90 (.20)	2.40 (.20)	3.00 (.10)	2.55 (.10)	29.50 (.20)	179.00 (.15)	33.00 (.15)
4.20 (.20)	4.60 (.20)	3.00 (.20)	2.50 (.20)	3.10 (.15)	2.65 (.10)	30.50 (.20)	182.00 (.15)	35.00 (.15)
4.30 (.10)	4.70 (.10)	3.10 (.20)	2.60 (.10)	3.20 (.10)	2.75 (.10)	31.50 (.10)	183.00 (.15)	38.00 (.15)

TABLE XXI (Continued)

Cotton Seed Meal	Soybean Oil Meal	Oats	Sorghum	Corn	Barley	Alfalfa Hay	Cull Cows	Surplus Calves
Price per cwt. (Freq.)	Price per cwt. (Freq.)	Price per cwt. (Freq.)	Price per cwt. (Freq.)	Price per cwt. (Freq.)	Price per cwt. (Freq.)	Price per ton (Freq.)	Price per head (Freq.)	Price per head (Freq.)
4.40 (.10)	4.80 (.10)	3.20 (.05)	2.70 (.10)	3.30 (.10	2.85 (.05)	32.50 (.10)	209.00 (.10)	40.00 (.10)
		3.30 (.05)		3.40 (.05)			210.00 (.10)	40.00 (.10)
				3.50 (.05)				

The frequency distributions of culling rates, and calf death rates are presented in Table XXII. The frequency distributions for these variables were obtained from survey data collected for this study.

Simulation Functions

Several functions were employed in the firm growth simulator to reflect withdrawals from the firm's income stream. The first withdrawals from the net income were long-term debt repayment and income and social security taxes. Simulator equations for these withdrawals are shown in Table XXIII.

It was next necessary to determine if sufficient net income after taxes and long-term debt repayment was available to meet the family living requirements. If a sufficient amount did exist, further income stream withdrawals including family living, intermediate term loan repayment, savings, and firm expansion were calculated. The operational equations for these withdrawals are also presented in Table XXIII.

Inputs were provided the simulator for the initial year of operation, but inputs for successive years were determined internally by the growth simulator. The functions for successive yearly inputs are shown in Table XXIV.

TABLE XXII

FREQUENCY OF CULLING AND DEATH RATE VARIABLES OBTAINED FROM FARM SURVEY DATA

Cow Culling Rate (Freq.)	Cow Death Rate (Freq.)	Yearling Death Rate (Freq.)	Calf Death Rate (Freq.)
5% (.05)	0% (.20)	0% (.65)	2% (.10)
7% (.10)	1% (.05)	1% (.10)	4% (.15)
9% (.10)	2% (.20)	2% (.10)	6% (.20)
11% (.15)	3% (.25)	3% (.05)	8% (.15)
13% (.20)	4% (.10)	4% (.05)	10% (.15)
15% (.15)	5% (.10)	5% (.05)	12% (.10)
17% (.10)	6% (.05)		14% (.10)
19% (.10)	7% (.05)		16% (.05)
21% (.05)			

TABLE XXIII

LONG-TERM DEBT REPAYMENT, INCOME AND SOCIAL SECURITY TAX, FAMILY LIVING, INTERMEDIATE TERM LOAN REPAYMENT, SAVINGS AND FIRM EXPANSION EQUATIONS USED IN THE FIRM GROWTH SIMULATION

Equation
RLSTR = PRLST + REALN(RL/(1.0 -(1.0/(1.0 + RL)^{20})))-RINTL
DPC = (PURC - 100.0)(PBC)0.2
TPURC = PBC + PBCO + PBCTW + PBCT + PBCF
AVPP = ((PURC)(PBC)+(PURO)+(PURTW)(PBCTW)+(PURT)(PBCT)+(PURF)(PBCF)) /TPURC
PPUR = TPURC/C
CDP = DPC + DMO + DMTW + DMT + DMF
AVDEP = CDP/TPURC
CGC = SCX + (PPUR)(C)(CUL+CK)(AVDEP - AVPP)
SEQX = XI - XIT
SCX = CGC + SEQX
SSINC = SALE - EX - CDP
PTXI = SSINC - SCX + 0.5 (SCY) - DED - EXP
TOTX = (FTX - 0.07(QI))1.05 + SSTAX
RT = SALE + SEQX - EX - TOTX - RLSTR
RORT = RT - CONS + SAVG
SAVGN = RORT - DCAE (given a value only if SAVGN is positive)
ACI = PLI/(252.19669 + 0.0184097 B + ((PB)(XB)/3650)(B-188.0)
ACL = PLL/(128.73097 + 0.0017399 B)
PBL = ACI or ACL (smallest value used)

The dependent variables in Table XXIII are as follows: RLSTR is the repayment on long-term loan principle each year; DPC is the depreciation on cows purchased at the end of the previous year; TPURC is the number of purchased cows for the previous five years; AVPP is the average purchase price for cows for the previous five years; PPUR is the percentage of cows in the herd that are depreciable; CDP is the amount of cow depreciation allowable for the current year; AVDEP is the average amount of depreciation claimed this year on the purchased cows in the herd; CGC is the capital gain or loss realized from the sale of cull cows during the current year; SEQX is the capital gain or loss realized from the sale of equipment during the current year; SCY is the total capital gains or loss realized during the current year; SALE is the gross income; EX is the total operating expenses; DED is the standard allowable deductions of 10 percent of taxable income. SSINC is the income subject to social security tax; PTXI is the income subject to federal income tax; QI is additional investment in equipment in the current year and allowable as investment credit; TOTX is the total federal and state income tax and social security withdrawals from net income; RT is the net cash income after taxes and long-term debt payment; RORT is the amount available for intermediate term debt repayment; SAVGN is the residual amount available for firm expansion or savings after intermediate term loans have been paid; ACI and ACL are intermediate and long-term asset expansion possible within debt restrictions in terms of cow numbers; and PBC is the number of cows purchased.

The independent variables used in Table XXIII are as follows: PRLST is any former yearly long-term loan repayment commitment;

REALN is any long-term loan received for the current year; PURC, PURO, PURTW, PURT and PURF are the purchase prices of cows purchased at the close of the previous one, two, three, four, and five years respectively; PBC, PBCO, PBCTW, PBCT, and PBCF are the numbers of cows purchased at the close of the previous one, two, three, four and five years; DMO, DMTW, DMT, DMF are the amount of cow depreciation allowed in the four previous years; XI is the value of assets except livestock at the beginning of the year; XIT is the value of assets other than livestock at the end of the year; CONS is family living expense; and XB is percent of class I milk base purchased with purchased cows.

TABLE XXIV

FIRM GROWTH SIMULATOR EQUATIONS FOR DETERMINING SUCCESSIVE YEAR INPUTS

Equation
$SP_t + 1 = SP_t$
$P_t+1 = P_t$
$PB_t+1 = PB_t$
$B_t+1 = 1.01B_t$ plus improvement due to culling low procedures
$C_t+1 = C_t + PBC_t+Y - SCOW - (C_t)(CK_t)$
$Y_t+1 = D_t - (D_t)(YK_t)$
$D_t+1 = 0.3C_t$
$RLSTI_t+1 = RLSTI_t + 18.74742\ (C_t+1 - C_t)$ (if $C_t+1 \quad C_t$, $RLSTI_t+1 = RLSTI_t$)
$EQPI_t+1 = EQPI_t + 11.97403(C_t+1-C_t) + 0.0062597((C_t+1(B_t+1)-(C_t)(B_t))$
$BLDI_t+1 = BLDI_t+109.98355\ (C_t+1 - C_t) + 0.0017399((C_t+1)(B_t+1) -(C_t)(B_t))$ (if $C_t+1 \quad C_t$, $BLDI_t+1 = BLDI_t$)
$YGBLD_t+1 = YGBLD_t + 34.7404\ (Y_t+1 - Y_t)$(if $Y_t+1 \quad Y_t$, $YGBLD_t+1 = YGBLD_t$)
$CFBLD_t+1 = CFBLD_t + 44.4711\ (D_t+1-D_t)$(if $D_t+1 \quad D_t$, $CFBLD_t+1 = CFBLD_t$)
$CV_t+1 = 240.22266C_t+1 + 0.01215(B_t+1)(C_t+1) - CDP_t + 22.7877D_t+1 + 0.00945B_t+1(D_t+1) + 45.94519(Y_t+1) + 0.01971\ B_t+1\ (Y_t+1)$
$BAS_t+1 = C_t+1\ (B_t+1 - 188.0)\ XB/365.0$
$BV_t+1 = (BAS_t+1)(PB_t+1)$
$TLI_t+1 = RLSTI_t+1 + BLDI_t+1 + YGBLD_t+1 + CFBLD_t+1$
$TII_t+1 = EQPI_t+1 + CV_t+1 + BV_t+1$

TABLE XXIV (Continued)

Equation
$TI_t+1 = TLI_t+1 + TII_t+1$
$QI_t+1 = EQPI_t+1 - EQPI_t$ ($QI_t+1 = 0.0$ if $EQPI_t+1 \quad EQPI_t$)
$WRKF_t+1 = WRKF_t$
$WORK_t+1 = WORK_t + 17.6039(C_t-1 - C_t)$
$YGWRK_t+1 = YGWRK_t + 5.10126(Y_t-1 - Y_t)$
$CFWRK_t+1 = CFWRK_t + 11.36206(Y_t-1 - Y_t)$
$HLB_t+1 = WORK_t+1 + YGWRK_t+1 = CFWRK_t+1 - WRKF_t+1) / HHLAB$ (HLB_t+1 is truncated to next highest integer)
$PRLST_t+1 = RLSTR_t$
$DRLST_t+1 = DRLST_t - RLSTR_t + TLI_t+1 = TLI_t$
$DCAE_t+1 = DCAE_t - RORT_t + TII_t+1 - TII_t$ (if $DCAE_t+1$ is negative $DCAE_t+1 = 0.0$)
$BORT_t+1 = DCAE_t+1 + DRLST_t+1$
$SAVG_t+1 = DCAE_t+1(-1.0)$(if $DCAE_t+1$ is positive $SAVG_t+1 = 0.0$)
$REALN_t+1 = TLI_t+1 - TLI_t$
$PURC_t+1 = 240.22266 + 0.01215B_t+1$
$PURO_t+1 = PURC_t$
$PURTW_t+1 = PURO_t$
$PURT_t+1 = PURTW_t$
$PURF_t+1 = PURT_t$
$PBCO_t+1 = PBC_t(1.0 - (CK_t + CUL_t)$
$PBCTW_t+1 = PBCO_t(1.0 - (CK_t + CUL_t))$
$PBCT_t+1 = PBCTW_t(1.0 -(CK_t+CUL_t))$
$PBCF_t+1 = PBCT_t(1.0 - (CK_t+CUL_t))$

TABLE XXIV (Continued)

Equation
$DMD_t+1 = DPC_t$
$DMTW_t+1 = DMO_t$
$DMT_t+1 = DMTW_t$
$DMF_t+1 = DMT_t$
$VIV_t+1 = VIV_t$
$VIV_t+1 = UIV_t$

Dependent variables in Table XXIV not previously defined are as follows: CV is the value of livestock; TLI is the value of long-term assets; TII is the value of intermediate term assets; TI is total assets; WRKF is the hours of family supplied labor; HLB is the number of increments of hired labor; PRLST is the amount of annual long-term debt payment; BORT is the total amount of borrowed capital; REALN is the addition to long-term debt through firm expansion in the t+1 time period; VIV is the lower family consumption limit; and UIV is the upper family consumption limit where applicable. Independent variables are YK as the yearling death date, CK as the cow death rate, and CUL as the percentage of the herd culled.

TABLE XXV

FORTRAN SOURCE LISTING FOR DAIRY FIRM GROWTH SIMULATOR

```
ISN        SOURCE STATEMENT

  0  $IBFTC DCKNAM
     C DAIRY GROWTH MODEL
  1    500 CONTINUE
     C       INITIAL SITUATION
  2          DIMENSION BORQ(40),BORN(40),WKQ(40),WKN(40),EQPIQ(40),EQPIN(40),
            1BLDIQ(40),BLDIN(40),RLSTIQ(40),RLSTIN(40),CVQ(40),CVN(40),
            2TLIQ(40),TLIN(40),TIIQ(40),TIIN(40),TIQ(40),TIN(40)
  3          DIMENSION XIVQ(40),XIVN(40),PBCQ(40),PBCN(40),PBCOQ(40),PBCON(40),
            1PBCTWQ(40),PBCTWN(40),PBCTQ(40),PBCTN(40),PBCFQ(40),PBCFN(40),
            2PUROQ(40),PURON(40),PURTWQ(40),PURTWN(40),PURTQ(40),PURTN(40),
            3PURFQ(40),PURFN(40),SPQ(40),SPN(40),BVQ(40),BVN(40)
  4          DIMENSION CQ(40),DQ(40),YQ(40),PQ(40),BQ(40),EQ(40),BASQ(40),
            1QIQ(40),FAMLOQ(40),FAMLTQ(40),    WRKFQ(40),SAVGQ(40),HHLABQ(40),
            2HLBQ(40),DCAEQ(40),DRLSIQ(40), VIVQ(40),UIVQ(40),
            3PURCQ(40),PRLSTQ(40),DMFQ(40), DMTQ(40),DMTWQ(40),DMOQ(40),
            4REALNQ(40),           WG(3),R(3),AX(80,40), AALF(40,10),
            5ACLFP (40,10),ACOWP(40,10),ACU(40,10),AYK(40,10),ACK(40,10),
            6ADK (40,10),AGMP(40,10)
  5          DIMENSION CN(40),DN(40),YN(40),PN(40),BN(40),EN(40),BASN(40),
            1QIN(40), FAMLON(40),FAMLTN(40),   WRKFN(40),SAVGN(40),HHLABN(40),
            2HLBN(40),DCAEN(40),DRLSTN(40), VIVN(40),UIVN(40),
            3PURCN(40),PRLSTN(40),DMFN(40), DMTN(40),DMTWN(40),DMON(40),
            4REALNN(40),           QX(175),YY(175),SD(80),
            5VMAX(80),VMIN(80),TOTAL(80),TMAX(80),TMIN(80)
  6          READ(5,100)HLB,PBC,PBCO,PBCTW,PBCT,PBCF,PURC,PURO, PURTW,PURT,
            1PURF
  7          READ(5,101)C,D,Y,B,BAS,WRKF,HHLAB,SP,P,BV
 10          READ(5,102)E,DCAE,DRLSI,BOR,SAVG,QI  ,REALN,WK
 11          READ(5,102)EQPI,BLDI,RLSTI,CV,TLI,TII,TI,XIV
 12          READ(5,110)DMO,DMTW,DMT,DMF,VIV,UIV,FAMLO,FAMLT,PRLST
 13          READ(5,110)((AALF(K,L),K=1,40),L=1,10),((ACLFP(K,L),K=1,40),
            1L=1,10),((ACOWP(K,L),K=1,40),L=1,10),((ACU(K,L),K=1,40),L=1,10),
            2((AYK(K,L),K=1,40),L=1,10),((ACK(K,L),K=1,40),L=1,10),((ADK(K,L),
            3K=1,40),L=1,10),((AGMP(K,L),K=1,40),L=1,10)
114          READ(5,104)(WG(I),I=1,3)
121          READ(5,104)(R(J),J=1,3)
126          READ(5,104) PLC
127    100 FORMAT(F5.1,5F6.1,5F7.2)
130    101 FORMAT(3F6.1,F9.2,F8.1,2F7.1,2F7.4,F10.2)
131    102 FORMAT(7F10.2,F9.1)
132    104 FORMAT(3F5.2)
133    110 FORMAT(10F8.2)
134          DO 90 K=1,40
135          FAMLOQ(K)=FAMLO
136          FAMLTQ(K)=FAMLT
137          VIVQ(K)=VIV
140          UIVQ(K)=UIV
141          XIVQ(K)=XIV
142          BVQ(K)=BV
143          BASQ(K)=BAS
144          SPQ(K)=SP
145          CQ(K)=C
146          QIQ(K)=QI
147          DQ(K)=D
150          YQ(K)=Y
```

TABLE XXV (Continued)

```
ISN        SOURCE STATEMENT

151           PQ(K)=P
152           BQ(K)=B
153           EQ(K)=E
154           BORQ(K)=BOR
155           WKQ(K)=WK
156           EQPIQ(K)=EQPI
157           BLDIQ(K)=BLDI
160           RLSTIQ(K)=RLSTI
161           CVQ(K)=CV
162           TLIQ(K)=TLI
163           TIIQ(K)=TII
164           TIQ(K)=TI
165           WRKFQ(K)=WRKF
166           PURCQ(K)=PURC
167           SAVGQ(K)=SAVG
170           HHLABQ(K)=HHLAB
171           HLBQ(K)=HLB
172           DCAFQ(K)=DCAF
173           DRLSTQ(K)=DRLST
174           PRLSTQ(K)=PRLST
175           DMFQ(K)=DMF
176           DMTQ(K)=DMT
177           DMTWQ(K)=DMTW
200           DMOQ(K)=DMO
201           REALNQ(K)=REALN
202           PBCOQ(K)=PBCO
203           PBCTWQ(K)=PBCTW
204           PBCTQ(K)=PBCT
205           PBCFQ(K)=PBCF
206           PUROQ(K)=PURO
207           PURTWQ(K)=PURTW
210           PURTQ(K)=PURT
211           PURFQ(K)=PURF
212           PBCQ(K)=PBC
213        90 CONTINUE
215           DO 300 K=1,40
216           FAMLON(K)=FAMLOQ(K)
217           FAMLTN(K)=FAMLTQ(K)
220           VIVN(K)=VIVQ(K)
221           UIVN(K)=UIVQ(K)
222           XIVN(K)=XIVQ(K)
223           BASN(K)=BASQ(K)
224           BVN(K)=BVQ(K)
225           SPN(K)=SPQ(K)
226           BORN(K)=BORQ(K)
227           WKN(K)=WKQ(K)
230           EQPIN(K)=EQPIQ(K)
231           BLDIN(K)=BLDIQ(K)
232           RLSTIN(K)=RLSTIQ(K)
233           CVN(K)=CVQ(K)
234           TLIN(K)=TLIQ(K)
235           TIIN(K)=TIIQ(K)
236           TIN(K)=TIQ(K)
237           CN(K)=CQ(K)
240           DN(K)=DQ(K)
```

TABLE XXV (Continued)

```
      SOURCE STATEMENT

      YN(K)=YQ(K)
      PN(K)=PQ(K)
      BN(K)=BQ(K)
      EN(K)=EQ(K)
      QIN(K)=QIQ(K)
      WRKFN(K)=WRKFQ(K)
      PURCN(K)=PURCQ(K)
      HHLABN(K)=HHLABQ(K)
      DCAEN(K)=DCAEQ(K)
      DRLSTN(K)=DRLSTQ(K)
      SAVGN(K)=SAVGQ(K)
      HLBN(K)=HLBQ(K)
      PRLSTN(K)=PRLSTQ(K)
      DMFN(K)=DMFQ(K)
      DMTN(K)=DMTQ(K)
      DMTWN(K)=DMTWQ(K)
      DMON(K)=DMOQ(K)
      REALNN(K)=REALNQ(K)
      PBCN(K)=PBCQ(K)
      PBCON(K)=PBCOQ(K)
      PBCTWN(K)=PBCTWQ(K)
      PBCTN(K)=PBCTQ(K)
      PBCFN(K)=PBCFQ(K)
      PURON(K)=PUROQ(K)
      PURTWN(K)=PURTWQ(K)
      PURTN(K)=PURTQ(K)
      PURFN(K)=PURFQ(K)
  300 CONTINUE
      DO 600 I=1,3
      DO 600 J=1,3
      IF(R(J).EQ.0.9) GO TO 630
      IF(WG(I).EQ.9.0) GO TO 630
      RSV=R(J)-0.01
      RL=R(J)
      RI=R(J)+0.01
      DO 610 L=1,10
      DO 620 K=1,40
      ALF=AALF(K,L)
      CLFP=ACLFP(K,L)
      COWP=ACOWP(K,L)
      CU=ACU(K,L)
      YK=AYK(K,L)
      CK=ACK(K,L)
      DK=ADK(K,L)
      GMP=AGMP(K,L)
      FAMLO=FAMLOQ(K)
      FAMLT=FAMLTQ(K)
      VIV=VIVQ(K)
      UIV=UIVQ(K)
      XIV=XIVQ(K)
      BV=BVQ(K)
      BAS=BASQ(K)
      SP=SPQ(K)
      C=CQ(K)
      D = DQ(K)
```

TABLE XXV (Continued)

```
ISN          SOURCE  STATEMENT

335            Y=YQ(K)
336            P=PQ(K)
337            B=BQ(K)
340            E=EQ(K)
341            QI=QIQ(K)
342            WRKF=WRKFQ(K)
343            SAVG=SAVGQ(K)
344            HHLAB=HHLABQ(K)
345            HLB=HLBQ(K)
346            DCAE=DCAEQ(K)
347            DRLST=DRLSTQ(K)
350            PURC=PURCQ(K)
351            PRLST=PRLSTQ(K)
352            DMF=DMFQ(K)
353            DMT=DMTQ(K)
354            DMTW=DMTWQ(K)
355            DMO=DMOQ(K)
356            REALN=REALNQ(K)
357            PBCO=PBCOQ(K)
360            PBCTW=PBCTWQ(K)
361            PBCT=PBCTQ(K)
362            PBCF=PBCFQ(K)
363            PURO=PUROQ(K)
364            PURTW=PURTWQ(K)
365            PURT=PURTQ(K)
366            PURF=PURFQ(K)
367            PBC=PBCQ(K)
          C  COMPUTE  INVESTMENT
370            BOR=BORQ(K)
371            WK=WKQ(K)
372            EQPI=EQPIQ(K)
373            BLDI=BLDIQ(K)
374            RLSTI=RLSTIQ(K)
375            CV=CVQ(K)
376            TLI=TLIQ(K)
377            TII=TIIQ(K)
400            TI=TIQ(K)
401            XI=TLI+EQPI+ BV
402            PB=10.00
403            XB=0.83
          C    THIS  YEARS  OPERATION
404            XMISC=320.34439 +38.23115*C+4.3*D+9.4*Y
405            RINTI=DCAE*RI
406            RINTL=DRLST*RL
407            RINT= RINTL  +RINTI
410       200  FDC=2.27*ALF*C+0.000116*B*C*ALF+16.4*C*GMP+0.0027*B*GMP*C+14.0*C
411            FDD=7.0*GMP*D+1.5*ALF*D
412            FDY=11.0*GMP*Y+1.2*ALF*Y+16.0*Y
413            TAX=TI*0.0075
414            BDEP=(BLDI+CDBLD+YGBLD)*0.05
415            EDEP=EQPI*0.1
416            DEP=BDEP+EDEP
417            REP=(BLDI+CFBLD+YGBLD)*0.025+EQPI*0.03
420            HL=HLB*HHLAB
421            WLAB=HL*WG(I)
```

TABLE XXV (Continued)

```
      SOURCE  STATEMENT

      EX=FDC+FDD+FDY+DEP+TAX+REP+XMISC +WLAB        +RINT
      PRLST=PRLST+REALN*(RL/(1.0-(1.0/(1.0+RL)**20.0)))
      RLSTR=PRLST-RINTL
      DPC=(PURC-100.0)*PBC*0.2
      TPURC=PBC+PBCO+PBCTW+PBCT+PBCF
      AVPP=(PURF*PBCF+PURT*PBCT+PURTW*PBCTW+PURO*PBCO+PURC*PBC)/TPURC
      PPUR=TPURC/C
      CDP=DMF+DMT+DMTW+DMO+DPC
      AVDEP=CDP/TPURC
  210 CUL=CU+PLC
      CX=CK+CUL
      IF(CX.GT.0.30) CUL=0.30-CK
      PLUC=CUL-CU
      IF(PLUC.LT.0.0) PLUC=0.0
      SVX=RSV*SAVG
      VI=VIV
      UI=UIV
      GO TO 215
  212 PLUC=PLUC+1.0/C
      CUL=CU+PLUC
  215 CONTINUE
      SCOW=C*CUL
      ICOW=SCOW+0.5
      SCOW=ICOW
      BCALF=C*0.94
      ICALF=BCALF+0.5
      BCALF=ICALF
      RCALF=C*0.3
      ICALF=RCALF+0.5
      RCALF=ICALF
      DCALF=BCALF*DK
      ICALF=DCALF+0.5
      DCALF=ICALF
      SCALF=BCALF-DCALF-RCALF
      CDIED=C*CK
      ICOW=CDIED+0.5
      CDIED=ICOW
      YDIED=D*YK
      IY=YDIED+0.5
      YDIED=IY
      CT=C-SCOW-CDIED+Y
      ICOW =CT
      CT =ICOW
      IF (CT.EQ.0.0) CT=1.0
      CTT=CT
      IF(CT.LE.160.0) GO TO 290
  285 ADO=CT-160.0
      PLUC=PLUC+ ADO/C
      CUL=CU+PLUC
      GO TO 215
  290 CONTINUE
      SCX=SCOW*COWP
      SDX=SCALF*CLFP
      CGC=SCX+PPUR*C*(CUL+CK)*(AVDEP-AVPP)
      CU =CUL-PLUC
```

TABLE XXV (Continued)

```
ISN        SOURCE STATEMENT

521   241 IF(B.LT.9500.0) SIG=B*0.1756
524       IF(B.GE.9500.0.AND.B.LT.10500.0) SIG=B*0.1734
527       IF(B.GE.10500.0.AND.B.LT.11500.0) SIG=B*0.1712
532       IF(B.GE.11500.0.AND.B.LT.12500.0) SIG=B*0.1688
535       IF(B.GE.12500.0.AND.B.LT.13500.0) SIG=B*0.1666
540       IF(B.GE.13500.0.AND.B.LT.14500.0) SIG=B*0.1644
543       IF(B.GE.14500.0.AND.B.LT.15500.0) SIG=B*0.1622
546       IF(B.GE.15500.0.AND.B.LT.16500.0) SIG=B*0.16
551       IF(B.GE.16500.0.AND.B.LT.17500.0) SIG=B*0.1576
554       IF(B.GE.17500.0) SIG=B*0.1554
557       JC=C
560   250 DO 260 II=1,JC
561       CALL NORNUM(X)
562       QX(II) =B+X*SIG
563   260 CONTINUE
565       IC = SCOW-C*CU
566       KC =IC
567       DO 270 JJ=1,JC
570       ZZ=99997.0
571       DO 265 II=1,JC
572       IF(QX(II).LT.ZZ) ZZ=QX(II)
575       IF(QX(II).EQ.ZZ) KK=II
600   265 CONTINUE
602       YY(JJ) =ZZ
603       QX(KK)=99999.0
604   270 CONTINUE
606       SUMC=0.0
607       SUMCC=0.0
610       DO 280 LL=1,JC
611       IF(LL.LE.KC)  SUMCC=SUMCC+YY(LL)
614       SUMC=SUMC+YY(LL)
615   280 CONTINUE
617       TOT=SUMC-SUMCC
620       CHP=JC-KC
621   281 SMLK=SUMC-(C*188.0)
622       BAP=BAS*365.0
623       IF(BAP-SMLK) 282,283,283
624   282 SMX=BAP*P+(SMLK-BAP)*SP
625       GO TO 284
626   283 SMX=SMLK*P
627   284 SALE=SCX+SDX+SMX+SVX
630       BP=SUMC/C
631       AVE=TOT/CHP
632       BT=AVE*1.01
633       BAST=((BT-188.0)*XB*CT)/365.0
634       YT=D-YDIED
635       DT=RCALF
636       EQPIT=10490.03735+11.97403*CT +0.0062597*BT*CT
637       BLDIT=3565.37271+109.98355*CT +0.0017399*BT*CT
640       RLSTIT=994.73665+18.74742*CT
641       CFBLDT=45.47*DT
642       YGBLDT=36.74*YT
643       YGWRKT=114.89485 + 5.10126*YT
644       CFWRKT=138.41055 + 11.36206*DT
645       COWVT=240.22266*CT+0.01215*BT*CT-CDP
```

TABLE XXV (Continued)

```
ISN        SOURCE STATEMENT

646        CLFVT=22.7877*DT+0.00945*BT*DT
647        YLGVT=45.94519*YT+0.01971*BT*YT
650        BV=BAST*PB
651        TLIT=BLDIT+ RLSTIT +CFBLDT+YGBLDT
652        TIIT=EQPIT+COWVT+CLFVT+YLGVT+BV
653        TIT=TLIT+TIIT
654        IF(TLIT.LT.TLI) TLIT=TLI
657        XIT=TLIT+EQPIT+BV
      C TAX CONPUTATION
660        SEQX =0.0
661        IF(XIT-XI.LT.0.0) SEQX=XI-XIT
664        SCY =CGC +SEQX
665        SSINC=SALE-EX-CDP
666        SSTAX=SSINC*0.0615
667        IF(SSINC.GE.7800.0) SSTAX=479.70
672        IF(SSTAX.LT.0.0) SSTAX=0.0
675        TXINC=SSINC-SCX+(SCY*0.5)
676        DED=TXINC*0.1
677        IF(DED.GT.1000.0) DED=1000.0
702        EXP=2400.0
703        PTXI=TXINC-DED-EXP
704        IF(PTXI.GE.1000.0) GO TO 25
707        FTX=PTXI*0.154
710        GO TO 40
711     25 IF(PTXI.GE.2000.0) GO TO 26
714        FTX=154.0+0.165*(PTXI-1000.0)
715        GO TO 40
716     26 IF(PTXI.GE.3000.0) GO TO 27
721        FTX=319.0+0.176*(PTXI-2000.0)
722        GO TO 40
723     27 IF(PTXI.GE.4000.0) GO TO 28
726        FTX=495.0+0.187*(PTXI-3000.0)
727        GO TO 40
730     28 IF(PTXI.GE.8000.0) GO TO 29
733        FTX=682.0+0.209*(PTXI-4000.0)
734        GO TO 40
735     29 IF(PTXI.GE.12000.0) GO TO 30
740        FTX=1518.0+0.242*(PTXI-8000.0)
741        GO TO 40
742     30 IF(PTXI.GE.16000.0) GO TO 31
745        FTX=2486.0+0.275*(PTXI-12000.0)
746        GO TO 40
747     31 IF(PTXI.GE.20000.0) GO TO 32
752        FTX=3586.0+0.308*(PTXI-16000.0)
753        GO TO 40
754     32 IF(PTXI.GE.24000.0) GO TO 33
757        FTX=4818.0+0.352*(PTXI-20000.0)
760        GO TO 40
761     33 IF(PTXI.GE.28000.0) GO TO 34
764        FTX=6266.0+0.396*(PTXI-24000.0)
765        GO TO 40
766     34 IF(PTXI.GE.32000.0) GO TO 35
771        FTX=7810.0+0.429*(PTXI-28000.0)
772        GO TO 40
773     35 IF(PTXI.GE.36000.0) GO TO 36
```

TABLE XXV (Continued)

```
 ISN        SOURCE STATEMENT

 776           FTX=9460.0+0.462*(PTXI-32000.0)
 777           GO TO 40
1000       36  IF(PTXI.GE.40000.0) GO TO 37
1003           FTX=11374.0+0.495*(PTXI-36000.0)
1004           GO TO 40
1005       37  IF(PTXI.GE.44000.0) GO TO 38
1010           FTX=13354.0+0.528*(PTXI-40000.0)
1011           GO TO 40
1012       38  FTX=15460.0+0.55*(PTXI-44000.0)
1013       40  IF (FTX.LT.0.0) FTX=0.0
1014       45  FTX=FTX-((QI+EDEP)*0.07)
1017           IF(FTX.LT.0.0) FTX=0.0
1020           TOTX=(FTX*1.05)+SSTAX
1023           SAL=SALE+TIT-TI
1024           RT = SALE+     SEQX-EX-TOTX-RLSTR
1025           BTN=RT+TOTX+RLSTR
1026           RM=RT+RLSTR
1027           IF(RT.LT.VI) GO TO 212
1032      219  CONS=28.775768*(RT**0.59)
1033           IF(CONS.LT.VI) CONS=VI
1036           RORI=RT-CONS+SAVG+RLSTR
1037           RT=CONS
1040           GO TO 227
1041      218  IF(RT.GT.UI) GO TO 220
1044           IF(RT.GE.VI.AND.RT.LE.UI) GO TO 225
1047      220  RORI =RT-UI+ SAVG
1050           RT=UI
1051           GO TO 227
1052      225  RORI =SAVG+RLSTR
1053      227  DRLST=DRLST-RLSTR
1054           RORT=RORI-RLSTR
1055           IF(DCAE-RORT) 700,701,702
1056      700  SAVG=RORT-DCAE
1057           DCAE=0.0
1060           GO TO 703
1061      701  DCAE=0.0
1062           SAVG=0.0
1063           GO TO 703
1064      702  DCAE=DCAE-RORT
1065           SAVG=0.0
1066      703  IF(CT.GE.160.0) GO TO 370
1071      704  CONTINUE
1072           BIT=        DCAE+TIIT-TII
1073           IF(BIT.LT.0.0) BIT=0.0
1076      706  BLT=DRLST+TLIT-TLI
1077           ACI=0.0
1100           ACL=0.0
1101           BORT=BIT+BLT
1102           Z=TIIT*0.6
1103           IF(Z-BORT)212,369,35
1104      350  PZL=TLIT*0.5
1105           IF(PZL-BLT)369,369,360
1106      360  PLL= (PZL-BLT)*2.0
1107           PZI=TIIT*0.5
1110           IF(PZI-BIT) 369,369,365
```

TABLE XXV (Continued)

```
 ISN        SOURCE STATEMENT

 1111   365 PLI=(PZI-BIT)*2.0
 1112       ACI=(PLI)/(252.19669+0.0184097*BT+((PB*XB)/365.0)*(BT-188.0))
 1113       ACL=(PLL)/(128.73097+0.0017399*BT)
 1114   369 PSV=SAVG*2.0
 1115       ACS=PSV/(380.92766+0.0201496*BT+((PB*XB)/365.0)*(BT-188.0))
 1116       IF(ACI.LE.ACL) CTT=ACI+CT+ACS
 1121       IF(ACI.GT.ACL) CTT=ACL+CT+ACS
 1124       ICOW=CTT
 1125       CTT=ICOW
 1126       IF(CTT.GT.160.0) CTT=160.0
 1131       PBC=CTT-CT
 1132   370 WORKT=2013.7339+17.6039*CTT
 1133       TWRK=WORKT+YGWRKT+CFWRKT-WRKF
 1134       IF(TWRK.LE.0.0) GO TO 385
 1137       IF(TWRK.LE.HHLAB) GO TO 386
 1142       IF(TWRK.LE.2.0*HHLAB) GO TO 387
 1145       IF(TWRK.LE.3.0*HHLAB) GO TO 388
 1150       IF(TWRK.LE.4.0*HHLAB) GO TO 389
 1153       IF(TWRK.LE.5.0*HHLAB) GO TO 390
 1156       IF(TWRK.LE.6.0*HHLAB) GO TO 391
 1161       IF(TWRK.LE.7.0*HHLAB) GO TO 392
 1164   385 HLBT=0.0
 1165       GO TO 400
 1166   386 HLBT=1.0
 1167       GO TO 400
 1170   387 HLBT=2.0
 1171       GO TO 400
 1172   388 HLBT=3.0
 1173       GO TO 400
 1174   389 HLBT=4.0
 1175       GO TO 400
 1176   390 HLBT=5.0
 1177       GO TO 400
 1200   391 HLBT=6.0
 1201       GO TO 400
 1202   392 HLBT=7.0
 1203   400 IF(PBC.LE.0.0) GO TO 401
 1206       EQPIT=10490.03735+11.97403*CTT+0.0062597*BT*CTT
 1207       BLDIT=3565.37271+109.98355*CTT+0.0017399*BT*CTT
 1210       RLSTIT=994.73665+18.74742*CTT
 1211       COWVT=240.22266*CTT+0.01215*BT*CTT-CDP
 1212       BAST= ((BT-188.0)*CTT *XB)/365.0
 1213       BV=BAST*PB
 1214       TLIT=BLDIT+RLSTIT+CFBLDT+YGBLDT
 1215       TIIT=EQPIT+COWVT+CLFVT+YLGVT+BV
 1216       TIT=TLIT+TIIT
 1217       IF(TLIT.LT.TLI) TLIT=TLI
 1222   401 REST = TLIT-TLI
 1223       DRLSTT=DRLST+REST
 1224       ZL=TLIT*0.5
 1225       IF(DRLSTT.GT.ZL) GO TO 402
 1230       GO TO 403
 1231   402 SAVG=SAVG-DRLSTT+ZL
 1232       DRLSTT=ZL
 1233   403 DCAET=DCAE+TIIT-TII-SAVG
```

TABLE XXV (Continued)

```
 ISN          SOURCE STATEMENT

1234          IF(DCAET.LT.0.0) GO TO 404
1237          SAVG=0.0
1240          GO TO 405
1241     404  SAVG=DCAET*(-1.0)
1242          DCAET=0.0
1243     405  BORTT=DRLSTT+DCAET
1244          ET=TIT-BORTT+SAVG
1245          EP= ET /(TIT+SAVG)
1246          QI=EQPIT-EQPI
1247          IF(QI.LT.0.0) QI=0.0
1252          AX(1,K)=SAL  +SEQX
1253          AX(2,K)=EX
1254          AX(3,K)=BTN
1255          AX(4,K)=RM
1256          AX(5,K)  =RT
1257          AX(6,K)  =RORI
1260          AX(7,K)=COWVT+CLFVT+YLGVT
1261          AX(8,K)=BV
1262          AX(9,K)=EQPIT
1263          AX(10,K)=BLDIT+CFBLDT+YGBLDT
1264          AX(11,K)=RLSTIT
1265          AX(12,K)=SAVG
1266          AX(13,K)=TIT+SAVG
1267          AX(14,K)=DRLSTT
1270          AX(15,K)=DCAET
1271          AX(16,K)  = BORTT
1272          AX(17,K)  =ET
1273          AX(18,K)  =C
1274          AX(19,K)  = PBC
1275          AX(20,K)  = CTT
1276          AX(21,K)  = Y
1277          AX(22,K)  = YT
1300          AX(23,K)  = D
1301          AX(24,K)=  DT
1302          AX(25,K)=BP
1303          AX(26,K)=(SUMC-(C*188.0))/100.
1304          AX(27,K)=HL
1305          AX(28,K)=WK
1306          AX(29,K)=(SALE+SEQX)/C
1307          AX(30,K)=EX/C
1310          AX(31,K)=(SALE+SEQX-EX)/C
1311          AX(32,K)=TI/C
1312          AX(33,K)=(TI*100.0)/SUMC
1313          AX(34,K)=TI/WK
1314          AX(35,K)=(BTN+RINT-WRKF*WG(I))/TI
1315          AX(36,K)=(BTN-WRKF*WG(I))/ET
1316          AX(37,K)  =EP
1317          AX(38,K)=(BTN+WLAB-ET*RSV)/(HL+WRKF)
1320          AX(39,K)=AX(1,K)/AX(26,K)
1321          AX(40,K)=AX(2,K)/AX(26,K)
1322          AX(41,K)=AX(39,K)-AX(40,K)
1323          FAMLTQ(K)=FAMLO
1324          FAMLOQ(K)=RT
1325          VIVQ(K)  =VIV
1326          UIVO(K)  = UIV
```

TABLE XXV (Continued)

```
 ISN        SOURCE STATEMENT

1327             XIVQ(K)=XIV
1330             SPQ(K)=SP
1331             BVQ(K)=BV
1332             BASQ(K)=BASI
1333             OIQ(K)=OI
1334             CQ(K)=CTT
1335             DQ(K)=DT
1336             YQ(K)=YT
1337             PQ(K)=P
1340             BQ(K)=BT
1341             EQ(K)=ET
1342             WRKFQ(K)=WRKF
1343             PURCQ(K)= 240.22266     +0.01215*BT
1344             HHLABQ(K)=HHLABN(K)
1345             SAVGQ(K)=SAVG
1346             HLBQ(K)=HLBT
1347             BORQ(K)=BORTT
1350             WKQ(K)=TWRK+WRKF
1351             EQPIQ(K)=EQPIT
1352             BLDIQ(K)=BLDIT+CFBLDT+YGBLDT
1353             RLSTIQ(K)=RLSTIT
1354             CVQ(K)=COWVT+CLFVT+YLGVT
1355             TLIQ(K)=TLIT
1356             TIIQ(K)=TIIT
1357             TIQ(K)=TIT
1360             DCAEQ(K)=DCAET
1361             DRLSTQ(K)=DRLSTT
1362             PRLSTQ(K)=PRLST
1363             DMFQ(K)=DMT
1364             DMTQ(K)=DMTW
1365             DMTWQ(K)=DMO
1366             DMOQ(K)=DPC
1367             REALNQ(K)=REST
1370             PBCOQ(K)= PBC*(1.0-CX)
1371             PBCTWQ(K)= PBCO*(1.0-CX)
1372             PBCTQ(K)= PBCTW*(1.0-CX)
1373             PBCFQ(K)= PBCT*(1.0-CX)
1374             PUROQ(K)=PURC
1375             PURTWQ(K)=PURO
1376             PURTQ(K)=PURTW
1377             PURFQ(K)=PURT
1400        620  CONTINUE
1402             IF (L.NE.10) GO TO 410
1405        408  WRITE(6,801)L,WG(I),PLC,RSV,RL,RI
1406             WRITE(6,803)
1407             WRITE(6,750)((AX(M,K),K=1,10),M=1,6)
1420        750  FORMAT(10X,10F10.2)
1421             WRITE(6,811)
1422             WRITE(6,812)
1423             WRITE(6,750)((AX(M,K),K=1,10),M=7,13)
1434             WRITE(6,819)
1435             WRITE(6,750)((AX(M,K),K=1,10),M=14,17)
1446             WRITE(6,824)
1447             WRITE(6,750)((AX(M,K),K=1,10),M=18,28)
1460             WRITE(6,836)
```

TABLE XXV (Continued)

```
 ISN        SOURCE STATEMENT

1461        WRITE(6,750)((AX(M,K),K=1,10),M=29,41)
1472        WRITE(6,801)
1473        WRITE(6,803)
1474        WRITE(6,750)((AX(M,K),K=11,20),M=1,6)
1505        WRITE(6,811)
1506        WRITE(6,812)
1507        WRITE(6,750)((AX(M,K),K=11,20),M=7,13)
1520        WRITE(6,819)
1521        WRITE(6,750)((AX(M,K),K=11,20),M=14,17)
1532        WRITE(6,824)
1533        WRITE(6,750)((AX(M,K),K=11,20),M=18,28)
1544        WRITE(6,836)
1545        WRITE(6,750)((AX(M,K),K=11,20),M=29,41)
1556        WRITE(6,801)
1557        WRITE(6,803)
1560        WRITE(6,750)((AX(M,K),K=21,30),M=1,6)
1571        WRITE(6,811)
1572        WRITE(6,812)
1573        WRITE(6,750)((AX(M,K),K=21,30),M=7,13)
1604        WRITE(6,819)
1605        WRITE(6,750)((AX(M,K),K=21,30),M=14,17)
1616        WRITE(6,824)
1617        WRITE(6,750)((AX(M,K),K=21,30),M=18,28)
1630        WRITE(6,836)
1631        WRITE(6,750)((AX(M,K),K=21,30),M=29,41)
1642        WRITE(6,801)
1643        WRITE(6,803)
1644        WRITE(6,750)((AX(M,K),K=31,40),M=1,6)
1655        WRITE(6,811)
1656        WRITE(6,812)
1657        WRITE(6,750)((AX(M,K),K=31,40),M=7,13)
1670        WRITE(6,819)
1671        WRITE(6,750)((AX(M,K),K=31,40),M=14,17)
1702        WRITE(6,824)
1703        WRITE(6,750)((AX(M,K),K=31,40),M=18,28)
1714        WRITE(6,836)
1715        WRITE(6,750)((AX(M,K),K=31,40),M=29,41)
1726    409 CONTINUE
1727    410 DO 70 K=1,40
1730        VMIN(17)=1.0E38
1731     70 VMAX(17)=-1.0E38
1733        DO 76 K=1,40
1734        IF(AX(17,K)-VMIN(17))77,78,78
1735     77 VMIN(17)=AX(17,K)
1736        KN=K
1737     78 IF(AX(17,K)-VMAX(17))76,76,80
1740     80 VMAX(17)=AX(17,K)
1741        KX=K
1742     76 CONTINUE
1744        DO 71 M=1,41
1745        VMAX(M)=AX(M,KX)
1746        VMIN(M)=AX(M,KN)
1747        TOTAL(M)=0.0
1750     71 SD(M)=0.0
1752        DO 72 M=1,41
```

TABLE XXV (Continued)

```
 ISN        SOURCE STATEMENT

1753           DO 72 K=1,40
1754        72 TOTAL(M)=TOTAL(M)+AX(M,K)
1757           DO 81 M=1,41
1760        81 TOTAL(M)=TOTAL(M)/40.0
1762           DO 82 M=1,41
1763           DO 82 K=1,40
1764        82 SD(M) = SD(M) + (AX(M,K)-TOTAL(M))**2
1767           DO 83 M=1,41
1770        83 SD(M)=(SD(M)/39.0)**0.5
1772           DO 84 M=1,41
1773           XSD=SD(M)*1.96
1774           TMIN(M)=TOTAL(M)-XSD
1775        84 TMAX(M)=TOTAL(M)+XSD
1777           WRITE(6,801)L,WG(I),PLC    ,RSV,RL,RI
2000       801 FORMAT(1H1,1X,4HYEAR,I3,1X,4HWAGE,F6.2,1X,19HPLANNED CULLING O/O,F
              15.2,1X,20HSAVINGS INTEREST O/O,F6.3,1X,21HLONGTERM INTEREST O/O,F6
              2.3,1X,21HINTERMED.TERM INT O/O,F6.3)
2001           WRITE(6,802)
2002       802 FORMAT(1H0,54X,4HHIGH,4X,12HAVE.+ 2 S.D.,2X,7HAVERAGE,3X,12HAVE.-
              22 S.D.,4X,3HLOW,7X,7HS. DEV.)
2003           WRITE(6,803)
2004       803 FORMAT(1H0,48X,7HPART  I,3X,16HINCOME STATEMENT)
2005           WRITE(6,805) VMAX(1),TMAX(1),TOTAL(1),TMIN(1),VMIN(1),SD(1)
2006       805 FORMAT(1H ,2X,12HGROSS INCOME,36X,6F12.2)
2007           WRITE(6,806) VMAX(2),TMAX(2),TOTAL(2),TMIN(2),VMIN(2),SD(2)
2010       806 FORMAT(1H ,2X,13HGROSS EXPENSE,35X,6F12.2)
2011           WRITE(6,807) VMAX(3),TMAX(3),TOTAL(3),TMIN(3),VMIN(3),SD(3)
2012       807 FORMAT(1H ,2X,10HNET INCOME,38X,6F12.2)
2013           WRITE(6,808) VMAX(4),TMAX(4),TOTAL(4),TMIN(4),VMIN(4),SD(4)
2014       808 FORMAT(1H ,2X,22HNET INCOME AFTER TAXES,26X,6F12.2)
2015           WRITE(6,809) VMAX(5),TMAX(5),TOTAL(5),TMIN(5),VMIN(5),SD(5)
2016       809 FORMAT(1H ,2X,13HFAMILY LIVING,35X,6F12.2)
2017           WRITE(6,810) VMAX(6),TMAX(6),TOTAL(6),TMIN(6),VMIN(6),SD(6)
2020       810 FORMAT(1H ,2X,31HNET FOR REINVESTMENT OR SAVINGS,17X,6F12.2)
2021           WRITE(6,811)
2022       811 FORMAT(1H0,46X8HPART  II,3X,19HNET WORTH STATEMENT)
2023           WRITE(6,812)
2024       812 FORMAT(1H ,58X,6HASSETS)
2025           WRITE(6,813) VMAX(7),TMAX(7),TOTAL(7),TMIN(7),VMIN(7),SD(7)
2026       813 FORMAT(1H ,2X,15HLIVESTOCK VALUE,33X,6F12.2)
2027           WRITE(6,804) VMAX(8),TMAX(8),TOTAL(8),TMIN(8),VMIN(8),SD(8)
2030       804 FORMAT(1H ,2X,10HBASE VALUE,38X,6F12.2)
2031           WRITE(6,814) VMAX(9),TMAX(9),TOTAL(9),TMIN(9),VMIN(9),SD(9)
2032       814 FORMAT(1H ,2X,15HEQUIPMENT VALUE,33X,6F12.2)
2033           WRITE(6,815) VMAX(10),TMAX(10),TOTAL(10),TMIN(10),VMIN(10),SD(10)
2034       815 FORMAT(1H ,2X,24HBUILDING AND FENCE VALUE,24X,6F12.2)
2035           WRITE(6,816) VMAX(11),TMAX(11),TOTAL(11),TMIN(11),VMIN(11),SD(11)
2036       816 FORMAT(1H ,2X,16HREALESTATE VALUE,32X,6F12.2)
2037           WRITE(6,817) VMAX(12),TMAX(12),TOTAL(12),TMIN(12),VMIN(12),SD(12)
2040       817 FORMAT(1H ,2X,7HSAVINGS,41X,6F12.2)
2041           WRITE(6,818) VMAX(13),TMAX(13),TOTAL(13),TMIN(13),VMIN(13),SD(13)
2042       818 FORMAT(1H ,2X,12HTOTAL ASSETS,36X,6F12.2)
2043           WRITE(6,819)
2044       819 FORMAT(1H ,55X,11HLIABILITIES)
2045           WRITE(6,820) VMAX(14),TMAX(14),TOTAL(14),TMIN(14),VMIN(14),SD(14)
```

TABLE XXV (Continued)

```
          SOURCE STATEMENT

      820 FORMAT(1H ,2X,14HLONGTERM LOANS,34X,6F12.2)
          WRITE(6,821) VMAX(15),TMAX(15),TOTAL(15),TMIN(15),VMIN(15),SD(15)
      821 FORMAT(1H ,2X,23HINTERMEDIATE TERM LOANS,25X,6F12.2)
          WRITE(6,822) VMAX(16),TMAX(16),TOTAL(16),TMIN(16),VMIN(16),SD(16)
      822 FORMAT(1H ,2X,17HTOTAL LIABILITIES,31X,6F12.2)
          WRITE(6,823) VMAX(17),TMAX(17),TOTAL(17),TMIN(17),VMIN(17),SD(17)
      823 FORMAT(1H ,2X,26HNET WORTH AT CLOSE OF YEAR,22X,6F12.2)
          WRITE(6,824)
      824 FORMAT(1H0,22X,9HPART  III,3X,67HLIVESTOCK INVENTORY GROWTH, PRODU
         1CTION, AND HIRED LABOR INFORMATION)
          WRITE(6,825) VMAX(18),TMAX(18),TOTAL(18),TMIN(18),VMIN(18),SD(18)
      825 FORMAT(1H ,2X,29HCOWS IN HERD DURING THIS YEAR,19X,6F12.2)
          WRITE(6,826) VMAX(19),TMAX(19),TOTAL(19),TMIN(19),VMIN(19),SD(19)
      826 FORMAT(1H ,2X,14HCOWS PURCHASED,34X,6F12.2)
          WRITE(6,827) VMAX(20),TMAX(20),TOTAL(20),TMIN(20),VMIN(20),SD(20)
      827 FORMAT(1H ,2X,27HCOWS IN HERD AT END OF YEAR,21X,6F12.2)
          WRITE(6,828) VMAX(21),TMAX(21),TOTAL(21),TMIN(21),VMIN(21),SD(21)
      828 FORMAT(1H ,2X,34HYEARLINGS IN HERD DURING THIS YEAR,14X,6F12.2)
          WRITE(6,829) VMAX(22),TMAX(22),TOTAL(22),TMIN(22),VMIN(22),SD(22)
      829 FORMAT(1H ,2X,32HYEARLINGS IN HERD AT END OF YEAR,16X,6F12.2)
          WRITE(6,830) VMAX(23),TMAX(23),TOTAL(23),TMIN(23),VMIN(23),SD(23)
      830 FORMAT(1H ,2X,31HCALVES IN HERD DURING THIS YEAR,17X,6F12.2)
          WRITE(6,831) VMAX(24),TMAX(24),TOTAL(24),TMIN(24),VMIN(24),SD(24)
      831 FORMAT(1H ,2X,29HCALVES IN HERD AT END OF YEAR,19X,6F12.2)
          WRITE(6,832) VMAX(25),TMAX(25),TOTAL(25),TMIN(25),VMIN(25),SD(25)
      832 FORMAT(1H ,2X,18HPRODUCTION PER COW,30X,6F12.2)
          WRITE(6,833) VMAX(26),TMAX(26),TOTAL(26),TMIN(26),VMIN(26),SD(26)
      833 FORMAT(1H ,2X,18HCWT. MILK MARKETED,30X,6F12.2)
          WRITE(6,834) VMAX(27),TMAX(27),TOTAL(27),TMIN(27),VMIN(27),SD(27)
      834 FORMAT(1H ,2X,20HHOURS OF HIRED LABOR,28X,6F12.2)
          WRITE(6,835) VMAX(28),TMAX(28),TOTAL(28),TMIN(28),VMIN(28),SD(28)
      835 FORMAT(1H ,2X,29HTOTAL HOURS OF LABOR REQUIRED,19X,6F12.2)
          WRITE(6,836)
      836 FORMAT(1H0,45X,8HPART  IV,3X,21HAVERAGE RELATIONSHIPS)
          WRITE(6,837) VMAX(29),TMAX(29),TOTAL(29),TMIN(29),VMIN(29),SD(29)
      837 FORMAT(1H ,2X,20HGROSS INCOME PER COW,28X,6F12.2)
          WRITE(6,838) VMAX(30),TMAX(30),TOTAL(30),TMIN(30),VMIN(30),SD(30)
      838 FORMAT(1H ,2X,16HEXPENSES PER COW,32X,6F12.2)
          WRITE(6,839) VMAX(31),TMAX(31),TOTAL(31),TMIN(31),VMIN(31),SD(31)
      839 FORMAT(1H ,2X,18HNET INCOME PER COW,30X,6F12.2)
          WRITE(6,840) VMAX(32),TMAX(32),TOTAL(32),TMIN(32),VMIN(32),SD(32)
      840 FORMAT(1H ,2X,18HINVESTMENT PER COW,30X,6F12.2)
          WRITE(6,841) VMAX(33),TMAX(33),TOTAL(33),TMIN(33),VMIN(33),SD(33)
      841 FORMAT(1H ,2X,33HINVESTMENT PER CWT. MILK PRODUCED,15X,6F12.2)
          WRITE(6,842) VMAX(34),TMAX(34),TOTAL(34),TMIN(34),VMIN(34),SD(34)
      842 FORMAT(1H ,2X,28HINVESTMENT PER HOUR OF LABOR,20X,6F12.2)
          WRITE(6,843) VMAX(35),TMAX(35),TOTAL(35),TMIN(35),VMIN(35),SD(35)
      843 FORMAT(1H ,2X,17HRETURN TO CAPITAL,31X,6F12.2)
          WRITE(6,849) VMAX(36),TMAX(36),TOTAL(36),TMIN(36),VMIN(36),SD(36)
      849 FORMAT(1H ,2X,22HRETURN TO OWNER EQUITY,26X,6F12.2)
          WRITE(6,844) VMAX(37),TMAX(37),TOTAL(37),TMIN(37),VMIN(37),SD(37)
      844 FORMAT(1H ,2X,15HNET WORTH RATIO,33X,6F12.2)
          WRITE(6,845) VMAX(38),TMAX(38),TOTAL(38),TMIN(38),VMIN(38),SD(38)
      845 FORMAT(1H ,2X,24HRETURN PER HOUR OF LABOR,24X,6F12.2)
          WRITE(6,846) VMAX(39),TMAX(39),TOTAL(39),TMIN(39),VMIN(39),SD(39)
```

TABLE XXV (Continued)

```
 ISN        SOURCE STATEMENT

2134    846 FORMAT(1H ,2X,35HGROSS RETURN PER CWT. MILK MARKETED,13X,6F12.2)
2135        WRITE(6,847) VMAX(40),TMAX(40),TOTAL(40),TMIN(40),VMIN(40),SD(40)
2136    847 FORMAT(1H ,2X,30HEXPENSE PER CWT. MILK MARKETED,18X,6F12.2)
2137        WRITE(6,848) VMAX(41),TMAX(41),TOTAL(41),TMIN(41),VMIN(41),SD(41)
2140    848 FORMAT(1H ,2X,34HNET RETURNS PER CWT. MILK MARKETED,14X,6F12.2)
2141    610 CONTINUE
2143        DO 301 K=1,40
2144        FAMLOQ(K)=FAMLON(K)
2145        FAMLTQ(K)=FAMLTN(K)
2146        VIVQ(K)=VIVN(K)
2147        UIVQ(K)=UIVN(K)
2150        XIVQ(K)=XIVN(K)
2151        BVQ(K)=BVN(K)
2152        BASQ(K)=BASN(K)
2153        SPQ(K)=SPN(K)
2154        CQ(K)=CN(K)
2155        QIQ(K)=QIN(K)
2156        DQ(K)=DN(K)
2157        YQ(K)=YN(K)
2160        PQ(K)=PN(K)
2161        BQ(K)=BN(K)
2162        EQ(K)=EN(K)
2163        BORQ(K)=BORN(K)
2164        WKQ(K)=WKN(K)
2165        EQPIQ(K)=EQPIN(K)
2166        BLDIQ(K)=BLDIN(K)
2167        RLSTIQ(K)=RLSTIN(K)
2170        CVQ(K)=CVN(K)
2171        TLIQ(K)=TLIN(K)
2172        TIIQ(K)=TIIN(K)
2173        TIQ(K)=TIN(K)
2174        WRKFQ(K)=WRKFN(K)
2175        PURCQ(K)=PURCN(K)
2176        SAVGQ(K)=SAVGN(K)
2177        HHLABQ(K)=HHLABN(K)
2200        HLBQ(K)=HLBN(K)
2201        DCAEQ(K)=DCAEN(K)
2202        DRLSTQ(K)=DRLSTN(K)
2203        PRLSTQ(K)=PRLSTN(K)
2204        DMFQ(K)=DMFN(K)
2205        DMTQ(K)=DMTN(K)
2206        DMTWQ(K)=DMTWN(K)
2207        DMOQ(K)=DMON(K)
2210        REALNQ(K)=REALNN(K)
2211        PBCOQ(K)=PBCON(K)
2212        PBCTWQ(K)=PBCTWN(K)
2213        PBCTQ(K)=PBCTN(K)
2214        PBCFQ(K)=PBCFN(K)
2215        PUROQ(K)=PURON(K)
2216        PURTWQ(K)=PURTWN(K)
2217        PURTQ(K)=PURTN(K)
2220        PURFQ(K)=PURFN(K)
2221        PBCQ(K)=PBCN(K)
2222    301 CONTINUE
2224    600 CONTINUE
```

TABLE XXV (Continued)

```
 ISN        SOURCE STATEMENT

2227    630 STOP
2230        END
```

APPENDIX C

APPENDIX C

Data collected in the grade A dairy farm survey was used to derive many of the equations employed in the firm growth simulation. The equations were derived by least-squares estimating precedures. The estimated investment equations with accompanying R^2 and "t" values are presented in Table XXVI. Table XXVII includes the estimated expense equations with accompanying R^2 and "t" values.

The independent variables in Table XXVI are as follows: RLSTI is the investment in land; EQPI is the investment in all equipment; BLDI is the investment in cow herd housing, milk parlor, milk room, feed storage and fences; YGBLD is the investment in housing for yearlings; CFBLD is the investment in housing for calves; COWV is the value per cow; YLGV is the value per yearling; CLFV is the value per calf. The independent variables for the investment functions are as follows: C is the number of cows; Y is the number of yearlings; D is the number of calves; B is the average annual pounds of 3.5 percent fat test milk produced per cow.

The dependent variables in Table XXVII are previously defined are as follows: XMISCO is the miscellaneous expense for the cow herd which includes health and breeding fees, and general overhead items such as electricity, fuel, magazines, telephone and records; XMISY and SMISD are the miscellaneous expenses for the yearlings and calves respectively; WORK, YGWRK, and CFWRK are the amount of hours of labor required by the cow, yearling and calf herds respectively; FHC is the hay required by each cow; FGC is the concentrate required by each cow.

TABLE XXVI

LEAST-SQUARES ESTIMATES OF GRADE A DAIRY FARM INVESTMENT EQUATIONS WITH ACCOMPANYING R^2 AND "T" VALUES

Estimated Equation	R^2
RLSTI = 994.73665 + 18.74742C (8.14853)	.971
EQPI = 10490.03735 + 11.97403C + 0.0062597BC (1.48776) (10.54195)	.986
BLDI = 3565.37271 + 109.98355C + 0.0017399BC (29.58101) (6.34306)	.978
YGBLD = 18.60402 + 34.7404Y (3.46791)	.812
CFBLD = 32.3834 + 44.4711D (4.40075)	.874
COWV = 240.22266 + 0.01215B (2.37912)	.396
YLGV = 45.94519 + 0.01971B (3.91545)	.374
CLFV = 22.7877 + 0.00945B (2.73686)	.324

TABLE XXVII

LEAST-SQUARES ESTIMATES OF GRADE A DAIRY FARM EXPENSE EQUATIONS WITH ACCOMPANYING R^2 AND "T" VALUES

Estimated Equation	R^2
XMISCO = 302.31589 + 38.23115C (61.60868)	.996
XMISY = 7.98014 + 9.39683Y (20.64811)	.984
XMISD = 10.04836 + 4.30025D (14.73092)	.976
WORK = 2013.7339 + 17.6039C (2.90125)	.808
YGWRK = 114.89485 + 5.10126Y (1.9864)	.664
CFWRK = 138.41055 + 11.36206D (4.41302)	.907
FHC = 2.27 + 0.000116B (2.323266)	.889
FGC = 16.4 + 0.0027B (4.67667)	.937

APPENDIX D

APPENDIX D

Forty replications were conducted for each of the twenty-seven ten-year simulated growth runs discussed throughout the study. Table XXVIII presents the frequency distributions of the tenth-year net worth values of the forty replications for each of the twenty-seven simulations. The specific sets of key variables used in each of the simulation runs are shown in Table XXIX.

TABLE XXVIII

FREQUENCY DISTRIBUTION OF REPLICATED TENTH YEAR FIRM NET WORTH VALUES AT VARIOUS KEY VARIABLE LEVELS

Tenth Year Net Worth Values	Simulation Run Number1/																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
<25						1	2								1												
25-30		2	2	3	3	3	8								7												
30-35	4	4	5	3	5	3	5				1			1	3												
35-40	5	4	4	4	3	3	7	1		2		1	1		6	1	1	2									
40-45	6	7	4	7	5	11	8	5		1			1	2	5		3	6									
45-50	10	11	8	5	8	3	5	12	2	1	4		3	4	6		5	2									
50-55	6	5	6	9	7	8	2	8	1		1	2	2	7	4		4	2	1						2		
55-60	6	1	6	4	4	4	3	9	5	3	2	5	4	2	3		3	12	2								
60-65	3	3	3	2	3	4		3		4	10	4	4	8	3		6	4	3						2		
65-70		1	1	2	1			2	4	4	3	4	2	3	1	2	5	4	1						2	1	
70-75		2	1		1				5	5	5	1	8	5	1	2	3	4	7						3		
75-80				1					2	5	3	4	8	5		4	4		5					1	4		
80-85									5	4	3	3	2				2	3	5			1		1	5		1
85-90									4		2	3		1			1	1	7		1	1			5	2	
90-95									4	2	2	6	2	1					2						3	3	
95-100									1	2	1	4				1	2		3		1	1	1	2	7	1	1
100-105										4	1		1			2	1		3			1	1		4	3	
105-110									2			1	1	1		3						1			2	2	5
110-115									3	1	1	1	1			1					2	1		3			5
115-120									1	1	1					2			1	1	3	1	4	1	1	4	4
120-125																3					1		2	2		3	3

TABLE XXVII (Continued)

Tenth Year Net Worth Values	Simulation Run Number[1/]																										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
125-130										1						4					2	2	1	3		4	3
130-135																2					2		1			3	5
135-140									1			1				3				2	3	2	3	1		4	4
140-145																				1	1	4	3	3		2	3
145-150																				1	1	6	3	1		2	6
150-155																				1	4	3		1		1	
155-160																2				1	4	3	3	5		3	
160-165																1				2		1	2	5		1	
165-170																1				4	1	3	1	1		1	
170-175																1				5	3	1	4	5			
175-180																2				1	1	1		1			
180-185																				2	1	2	3				
185-190																				2	1	1	1				
190-195																1				2	1	2					
195-200																2				2	1		1	2			
200-205																				2	1	1	2	1			
205-210																				1	2		2				
210-215																				1	1	1					
215-220																				4	1						
> 220																				5	1		2	1			

[1/] Description of the simulation runs can be found in Table XXIX.

TABLE XXIX

DESCRIPTION OF SIMULATION RUNS ANALYZED IN THIS STUDY

Run No.	Level of Production (#)	Consumption Function	Per Cent Class I Marketing	Long Term Interest Rate	Wage Rate ($)	Price of Class I Base ($)
1	9,000	Rigid	83	6	1.75	10
2	9,000	Rigid	83	7	1.75	10
3	9,000	Rigid	83	8	1.75	10
4	9,000	Rigid	83	7	1.50	10
5	9,000	Rigid	83	7	2.00	10
6	9,000	Rigid	70	7	1.75	10
7	9,000	Equity-Labor	83	7	1.75	10
8	9,000	Income	83	7	1.75	10
9	11,000	Rigid	83	6	1.75	10
10	11,000	Rigid	83	7	1.75	10
11	11,000	Rigid	83	8	1.75	10
12	11,000	Rigid	83	7	1.50	10
13	11,000	Rigid	83	7	2.00	10
14	11,000	Rigid	70	7	1.75	10
15	11,000	Rigid	50	7	1.75	10
16	11,000	Rigid	83	7	1.75	0
17	11,000	Rigid	83	7	1.75	15
18	11,000	Equity-Labor	83	7	1.75	10
19	11,000	Income	83	7	1.75	10
20	13,000	Rigid	83	6	1.75	10
21	13,000	Rigid	83	7	1.75	10
22	13,000	Rigid	83	8	1.75	10
23	13,000	Rigid	83	7	1.50	10
24	13,000	Rigid	83	7	2.00	10
25	13,000	Rigid	50	7	1.75	10
26	13,000	Equity-Labor	83	7	1.75	10
27	13,000	Income	83	7	1.75	10

APPENDIX E

TABLE XXX

COMPUTED CLASS I MILK BASE VALUES BASED ON THE DIFFERENCES BETWEEN CLASS I AND CLASS II MILK PRICES USING THE ANNUITY VALUE FORMULA 1/

Difference Between Class I and Class II price	Length of Income Stream (Years) 1	3	5	10
	- - - - - - - - - - - - - - - - -dollars	- - - - - - - - - - - - - - - - -		
1.00	3.36	9.28	14.29	23.69
1.25	4.20	11.60	17.85	29.59
1.50	5.04	13.94	21.46	35.56
1.75	5.88	16.25	25.02	41.47
2.00	6.72	18.56	28.58	47.38
2.25	7.55	20.88	32.15	53.28
2.50	8.40	23.22	35.75	59.25
2.75	9.24	25.53	39.31	65.15
3.00	10.07	27.84	42.87	71.06

1/ The discounted value includes 8 percent interest and 0.75 percent taxes.

APPENDIX F

INDIVIDUAL DAIRY FARM SIMULATION

QUESTIONNAIRE

A. Livestock Numbers
   1. Number of cows in milking herd______
   2. Number of replacement heifers over one year of age______
   3. Number of replacement heifers less than one year of age______

B. Average milk production per cow______pounds at______% butterfat

C. Cost Items
   1. Wage rate $______ per hour
   2. Intermediate term interest rate______%
   3. Long-term interest rate ______%
   4. Price of daily class I base $______ per pound
   5. Hours of family labor supplied annually ______

D. Milk Prices
   1. Class I price $______ per cwt.
   2. Surplus price $______ per cwt.
   3. Percentage of milk marketed under a class I base ______%

E. Net Worth Position
   1. Value of long-term assets (buildings, equipment and real-estate for buildings and lots) $______
   2. Value of other dairy assets $______
   3. Long-term loans (amount) $______
   4. Intermediate term loans (amount) $______
   5. Minimum net worth ratio (net worth/assets) you would desire ______%

F. Family Living
   1. Minimum annual income for family living $______
   2. Maximum (you would invest amounts above this figure rather than use it for family living) annual income for family living $______
   3. Number in family ______

Figure 25: Questionnaire for Obtaining Input Variables Necessary for Specific Firm Growth Simulation

VITA

Hollis Dean Hall

Candidate for the Degree of

Doctor of Philosophy

Thesis: AN ECONOMIC ANALYSIS OF THE GROWTH OF OKLAHOMA GRADE A DAIRY FARMS USING THE GROWTH SIMULATION TECHNIQUE

Major Field: Agricultural Economics

Biographical:

Personal Data: Born at Lebanon, South Dakota, August 11, 1934, the son of Lloyd M. and Allyce M. Hall.

Education: Graduated from Faulkton High School, Faulkton, South Dakota, in May, 1952; received the Bachelor of Science degree from South Dakota State University with a major in Dairy Science in March, 1956; received the Master of Science degree from South Dakota State University with a major in Economics in June, 1964; completed requirements for the Doctor of Philosophy degree at Oklahoma State University in August, 1969.

Professional Experience: Extension Dairy Specialist, South Dakota State University, 1956-66; Graduate Research Assistant, Department of Agricultural Economics, Oklahoma State University, 1966-68; Extension Economist, South Dakota State University, 1969.

Organizations: American Agricultural Economics Association; American Dairy Science Association; Dairy Shrine; Gamma Sigma Delta; Epsilon Sigma Phi.