2002

Expected returns from starting a large scale closed dairy cooperative under price and biological uncertainties

Marty James Dreischmeier
Iowa State University

Recommended Citation

Dreischmeier, Marty James, "Expected returns from starting a large scale closed dairy cooperative under price and biological uncertainties " (2002). *Retrospective Theses and Dissertations*. 368.
https://lib.dr.iastate.edu/rtd/368

INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

ProQuest Information and Learning
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
800-521-0600

UMI®

Expected returns from starting a large scale closed dairy cooperative under price and biological uncertainties

by

Marty James Dreischmeier

A dissertation submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of
DOCTOR OF PHILOSOPHY

Major: Agricultural Economics

Program of Study Committee
Roger Ginder, Major Professor
Arne Hallam
John Schroeder
James Kliebenstein
Lee Kilmer

Iowa State University

Ames, Iowa

2002

UMI Number: 3051459

ProQuest Information and Learning Company
300 North Zeeb Road
P.O. Box 1346
Ann Arbor, MI 48106-1346

Graduate College
Iowa State University

This is to certify that the doctoral dissertation of

Marty James Dreischmeier

has met the dissertation requirements of Iowa State University

Signature was redacted for privacy.

Major Professor

Signature was redacted for privacy.

For the Major Program

TABLE OF CONTENTS

CHAPTER 1. INTRODUCTION

General Introduction

There has been a great deal of change in the dairy industry over the last decade in the Midwest. This change has been characterized by a rapid increase in the size and specialization of dairy farms in the upper Midwest. In Wisconsin, the increase in the size of dairy herds has been dramatic. In 1993, only 5.7% of the herds had 200 or more cows. In 2000, 25% of the herds in Wisconsin had 200 or more cows. In 1997, the first year that the percentage of herds with more than 500 cows was reported, 3.5% of the herds in Wisconsin had 500 or more cows. The percentage of herds with more than 500 cows increased to 9% in 2000 (Wisconsin Agricultural Statistics Service, 2001). This rapid increase in the size of dairy farms has also been accompanied with a reduction in the number of dairy farms. Wisconsin had 34,000 dairy operations in 1990 compared with only 21,000 in 2000 (Wisconsin Agricultural Statistics Service, 2001).

There are several reasons for the increase in the size of dairy farms that has been observed. Economies of scale in the dairy industry have led to larger dairy operations. When economies of scale are present in the dairy industry, herd sizes will increase because the average cost of production decreases as the size of the dairy operation increases. Economies of scale are present in dairy operations in three major areas: 1) lower investments per cow, 2) lower per unit variable costs of production, 3) increased labor efficiency (Bailey et al., 1997). Jones (1997) showed that for Wisconsin dairy herds the average cost of production decreases as the size of the herd increases over the entire range of dairy farms in Wisconsin[1].

---

[1] In his research, Jones only reports farms with up to 1,000 cows. He did not find increasing average costs of production for any herd sized examined.

Technology has also been increasing the size of dairy herds. There has been a movement from the traditional tie stall stanchion barns with around-the-barn pipeline milking systems to a free-stall housing system with milking parlors. Milking parlor systems have been replacing traditional stanchion barns because they offer significant gains in labor efficiency. Typically, parlor systems allow a single operator to milk two to three times the number of cows per hour compared to traditional stanchion barn milking system. In addition, milking parlor systems have become more popular because they reduce the physical effort required in milking (Jones, 1997). The gains in technology have created an increase in the management intensity and specialization of management required to operate a modern dairy operation.

The movement toward larger herd sizes has also been fueled by lifestyle choices of dairy operators. Increasingly dairy operators are utilizing more hired labor to allow the dairy farm operator to enjoy some time off. Many dairy operators no longer want to be tied to the operation seven days a week throughout the entire year. As Gary Frank, agricultural economist at the Center for Dairy Profitability, UW-Madison said, "There are so many ways to support a family these days that Americans no longer have to work 365 days a year. Dairy farmers are beginning to see the attraction of lifestyles that include vacations, days off and chance to see their kid's ball games in the evening." (qtd. in Sandin, 2001).

The modern dairy operations with milking parlors and free-stall housing systems are expensive to build and require a high level of fixed costs. In addition to the high capital costs, significant managerial skills are needed to operate a large-scale modern dairy operation. With a large-scale dairy operation, managers will need to manage a labor force in addition to their dairy herd. Managing a labor force is one of the major hurdles to operating a large-scale dairy operation, especially for a farm operator currently in a family farm operation.

The high capital costs and significant managerial skills required to successfully operate a modern large-scale dairy operation have created major obstacles to starting and operating a successful modern dairy operation. This has limited the opportunities for small farmers to use dairy as a way to diversify their farm enterprises and add value to their crop enterprises. One possible way for small farmers to overcome the obstacles associated with starting a large-scale dairy operation and receive the added value a modern dairy operation provides is for the farmers to form a closed cooperative dairy operation. A large-scale closed cooperative dairy operation would give farmers access to the potential benefits of a modern. large-scale dairy operation without all of the financial risk or the required managerial expertise.

Objectives

The objective of this paper is to provide information about the expected returns from forming a large-scale closed dairy cooperative in the upper Midwest under price and biological uncertainties to farmers looking to add value to their crop enterprises. Simulations will be performed using distributions for price and biological variables based on historical observations. The simulations will be used to develop realistic distributions of returns on investment for farmers considering investing in or forming a closed dairy cooperative for a range of production growth paths for the dairy cooperative. The expected returns from the closed dairy cooperative along with the risks associated with investing in the closed dairy cooperative will be examined and reported.

The simulations will also be used to estimate the probability that the closed dairy cooperative will survive, or remain in operation, over the first 10 years. Continued operations requires the large-scale closed dairy cooperative to meet all of its cash obligations, while meeting lenders' requirements for solvency and debt service. This research will provide farmers with risk and reward trade-off information about forming or investing in a closed cooperative dairy operation not available using the typical static budgeting approaches. The impact of several key price and biological variables on the probability of survival of the large-scale closed dairy cooperative will be examined using a logit regression model.

The capital structure of the closed cooperative will also be examined. In determining an optimal capital structure for the closed cooperative there are tradeoffs involved with the level of equity used in the capital structure. A high level of equity invested in the cooperative will help the cooperative meet its cash obligations when unexpected adverse price or biological outcomes occur and reduce the risk associated with the investment in the cooperative. However, finance theory suggests that increased leverage will increase the return on the equity invested in the cooperative. The simulations will be performed with different capital structures for the cooperative to investigate the impact on expected returns and risks to the cooperative members associated with different levels of equity invested in the cooperative.

The development of novel analytical tools was necessary to fully achieve the objectives described above. A collateral objective of the research included development of a detailed farm level dairy model capable of evaluating startup or expansion opportunities for dairy operations. The financial model developed is an improvement to existing financial models. By incorporating biologically determined cow flows through the dairy operation into a true monthly financial model for the dairy operation it permits biological risks to be incorporated. The financial model developed is applicable to any dairy operation regardless of business structure. Although the application in this research is to cooperatives its use is not limited to closed cooperative dairy operations.

Organization

This remainder of the dissertation is organized as follows. Chapter 2 reviews the relevant literature on new generation cooperatives, previous evaluations of investing in value-added agribusinesses, the theoretical and empirical models used for evaluating different potential capital structures, and probability of failure models. Chapter 3 presents the methodology used in the research including the setup of the closed dairy cooperative, the financial dairy model developed, and the simulation methodology employed. Chapter 4 reports the empirical results for the returns of the large-scale closed dairy cooperative. Chapter 5 presents an empirical model to determine the impact of variables on the probability the cooperative is able to survive the first five years of operation.

CHAPTER 2. LITERATURE REVIEW

This chapter will provide a background on new generation[2] cooperatives along with recent evaluations of potential value added cooperatives. The literature covering evaluations of new generation cooperatives is quite thin. This is one of the reasons that this research was undertaken. Also, included in this chapter is a brief overview of the literature on the optimal capital structure for a cooperative, and probability of failure models. The literature covering research on optimal dairy size and dairy operations is covered in Chapter 3.

New Generation Cooperatives

Since the mid-1970s there have been a number of new generation cooperatives (NGC) that have been formed. At least 89 new generation cooperatives have been identified and operating in agriculture in the United States (Merrett, Holmes, Waner, 1999). The new generation cooperatives are involved in a wide variety of value added activities. These value added activities include, swine production, dairy production, aquaculture, bison slaughtering and processing, corn processing, organic dairy products, sugar beet processing, along with many other activities (Cropp, 1996) (Merett, Holmes, Waner, 1999).

Definition

New generation cooperatives are the newest wave of U.S. cooperatives. New generation cooperatives major focus is value-added processing, which represents a departure from the main objective of commodity marketing held by their predecessors (Kotov, 1999). The best way to define new generation cooperatives may be to compare them to traditional

---

[2] Throughout this paper the terms new generation cooperative, closed cooperative and value-added cooperative will be used interchangeably.

cooperatives. The following is a comparison between traditional open cooperatives and new generation, closed cooperatives.

> The *traditional open cooperative* is easy to join, and operates at market prices on a buy – sell basis. Member's equity is built through net savings retained as allocated patronage refunds. There is no volume or activity commitment and capacity is open to all members without regard to the amount of investment the member has made. Finally, it is easy to exit the traditional open cooperative without significant penalty or immediate financial consequence to the farmer.
>
> The *closed cooperative* requires that a cash investment be provided by the joining member before using the cooperative. The prices for goods sold or purchased from the cooperative are calculated using a formula or modified market price, and the closed cooperative usually does not operate on a strict buy-sell basis. There is usually a legally binding membership contract that specifies an exact volume requirement per contract period and guaranteed capacity utilization is usually provided with an equity unit. The cooperative's net savings are not a major source of equity. By specification of the membership contract, exiting could be difficult. Exiting members must sell their equity and rights to capacity to an eligible member in order to exit (Ginder, 1994).

Despite the differences outlined above, new generation cooperatives retain the principles of traditional cooperatives. The new generation cooperatives typically have democratic control through a one-member one-vote policy. The one-member one-vote policy need not hold for all states. However, it is true for the upper Midwest where the closed dairy cooperative in this research is anticipated to be located. The excess earnings are distributed among members as patronage refunds (dividends). The board of directors is elected from the membership by the membership (Cropp, 1996).

Increase in New Generation Cooperatives

According to a survey by the Illinois Institute for Rural Affairs, the main reasons given for starting a new generation cooperative are capturing more of the added value from crops and low commodity prices (Waner, 1999). The industrialization of agriculture has also led to the formation of new generation cooperatives. As agriculture has transformed from a nation of relatively small diversified family farms into fewer specialized highly technical corporate and private operations, the remaining traditional farms may be threatened because of an absolute size disadvantage and the management intensity required. Many farmers, by operating individually, are simply unable to expand operations to the scale necessary to become involved in processing. (Waner,1999). The same phenomenon is true for traditional farms wanting to continue or expand their operations to include livestock or dairy production. By pooling resources, as a cooperative, even small farmers may be able to benefit from the value added benefits of processing or livestock production.

Benefits of New Generation Cooperatives

There are a number of benefits that the individual farmer receives from joining a new generation cooperative. The benefits farmers receive include 1) access to capital 2) diversification of risk 3) labor specialization and 4) management expertise.

Access to Capital

The industrialization of agriculture has led to high capital requirements for both the production and processing of agricultural products. A new generation cooperative gives smaller farmers the ability to gain access to the capital necessary to participate in value added agricultural activities. Even if a farmer has the capital necessary to enter into large-scale livestock production or processing, a new generation cooperative may be a way to reduce the financial risk associated with investing in a value added process. The financial risk can be reduced through forming a closed cooperative, because the individual farmer will only be responsible for a portion of the capital requirements to start a large-scale livestock operation.

Diversification of Risk

By joining or forming a new generation cooperative members benefit by diversifying the returns from their production enterprises by entering into some value added process. Several new generation cooperatives are involved in livestock processing. The returns from processing can be more stable than from livestock production. Also, the margins from livestock processing can be inversely related to the returns from livestock production. When livestock prices are low the margins from livestock processing tend to be higher. By becoming involved in the value added processing, farmers can diversify their returns from production.

The same diversification can hold true for farmers who raise crops and use livestock production as a way to diversify their returns. Traditionally, farmers raised a variety of crops and livestock as a way to diversify their returns. With the increasing economies of scale in crops, livestock and dairy production, many farmers are no longer capable of achieving the benefits of diversification in this way. New generation cooperatives may be one way to achieve the benefits of diversification by permitting specialization in one or two core enterprises and participation in others through a cooperative.

Labor and Management

By joining a new generation cooperative farmers are able to focus their labor and managerial expertise on the enterprises they are familiar with. As agriculture becomes more and more industrialized, specialized labor is required for each agricultural enterprise. In addition, the managerial intensity required has become greater and more specialized management is also needed for each agricultural enterprise. By pooling together through a new generation cooperative farmers are able to have the resources necessary to hire the management expertise required for the value added activity that they want to undertake.

Evaluations of New Generation Cooperatives

The evaluation of many value added projects has taken on a fairly simplistic approach. In evaluating most proposed value added projects, a standard budgeting approach has been used. When monthly cash flows are examined they have been calculated from the annual projections and dividing by 12 without incorporating realistic monthly projections of revenues and expenses. In previous analysis, the economic, financial, biological and process variables have been assumed to be static with no attempts to incorporate uncertainty into the evaluation of the project. The growth path that the project will take is usually not well defined to those forming the project or to the lenders.

One recent evaluation of a value added agribusiness that incorporated uncertainty was performed by Jones, Fulton, and Dooley (1999). Jones Fulton and Dooley examined hog producers investment opportunities in hog production only, hog production and hog processing facility, hog production and investment in the stock market, and hog production and investment in treasury bills. Uncertainty in hog prices, corn price, soybean meal price, average live weight of slaughtered hogs, pork carcass yield, processor variable cost, processor fixed cost, pork processing capacity, S&P 500 % and treasury bills % was incorporated into the analysis. The expected returns and standard deviation of returns from different combinations of investments for different sized hog operations were reported and compared. Jones, Fulton and Dooley used several efficiency criteria to evaluate the results, Expected Value/Variance criteria, First Degree Stochastic Dominance efficiency criteria, and Second Degree Stochastic Dominance efficiency criteria. Investment in a hog processing facility was found to be an efficient investment. This implies hog producers should consider investing in a hog processing facility.

While taking a major step by incorporating uncertainty into evaluating investments in value added agribusinesses, Jones, Fulton and Dooley did not investigate the implications concerning equity required for purchasing a hog processing facility, cash flows, liquidity and leverage requirements as the authors point out in their suggestions for further research. Addressing several of the shortfalls in the research by Jones, Fulton and Dooley, the research undertaken here includes the development of a detailed cash flow model for the dairy cooperative to determine the cash flows for the operation based on the biologically driven dairy production process. The impact of different levels of equity financing on the expected returns and risk associated with investing into a value added process was also investigated in this research. In addition in this research, the probability of insolvency of the value added cooperative is calculated and the impact of key variables on the probability of failure is estimated. These additional evaluations provide a more comprehensive quantification of the risks involved in forming a value added cooperative.

Another recent study that has taken a more sophisticated approach to evaluating the feasibility of forming a new generation cooperative is by Poray (1997, 1999). In his research, Poray examined forming a closed swine production cooperative in Iowa to provide added value to corn. The research performed by Poray incorporated both price and biological uncertainties into a simulation of the returns to several types of large-scale closed swine production cooperatives. Poray examined forming a large-scale closed swine production under 12 different production and financial structures. The production structure was classified as either a farrow-to-finish or a farrow-to-wean operation. A multiplier herd was added as a possibility for each of these production structures for a total of four possible production structures. Each of the production structures was examined for 3 different equity level contributions for a total of 12 different combinations of financial and production structures.

The procedure used by Poray to empirically evaluate the performance of the 12 proposed hog operations was to simulate biological and price variables using @Risk. The stochastic biological variables used by Poray were farrowing rate, pigs weaned per litter, nursery mortality and finsher mortality. The stochastic price variables were corn, soybean meal, barrows and gilts, feeder pigs and weaner pigs. The simulated variables were used as input into the Swine Feasibility Analysis model developed by ISU Extension to calculate the projected financial statements for the swine production operations. Expected returns and risk were calculated for the 12 financial and productions structures examined by Poray. Poray used Target MOTAD and Mean-Variance analysis to determine the efficient choices among the different swine production and equity contribution combinations.

Poray obtained several interesting results. Overall, closed value added swine cooperatives appeared to be a viable alternative for Iowa grain producers as a means of adding value to grain production. Poray found that adding a multiplier herd to the swine production operation was universally superior to operations without a multiplier herd. Finally, Poray found that increasing the equity level of investment in the closed swine cooperative provided increased returns.

The research performed in this paper follows a methodology similar to that used by Poray. The closed cooperative setup is very similar, especially the way in which corn payments are distributed to members. In addition, the basic simulation methodology used is very similar to that employed by Poray. There are several ways in which this research deviates from that of Poray. First, there are biological and financial differences between swine and dairy production. This required a new financial model to be developed specifically for dairy production similar to the Swine Feasibility Analysis model. The much longer startup phase of a dairy operation compared with swine production required a longer planning horizon to be examined. Therefore, a 10-year planning horizon is examined in this research as opposed to the 5-year horizon investigated by Poray.

While using the same basic methodology, the simulations performed in this research incorporated more detail in specifying the correlation matrixes used in the simulation. Poray specified one correlation between each of the different price variables and assumed that it was constant for all months. Therefore, the correlation of January corn price with March soybean price, specified in the simulation, is equal to the correlation of January corn price with October soybean price. The research in this thesis accounts for differences in the correlation between prices by month. For example, the correlation between January corn price and March soybean prices will not necessarily equal the correlation between January corn price and October soybean price.

The simulations performed in this thesis have also benefited by recent research by Richardson (Richardson, 1999). Richardson details a number of simulation techniques for incorporating correlation matrixes into simulations performed using the @Risk software. In addition, Richardson describes an empirical probability distribution, which is used in the simulations performed in this thesis. The empirical distribution described by Richardson is useful in simulations when only a limited number of historical observations are available or relevant for use in the simulation.

Optimal Capital Structure

The literature reviewed in this section that covers the optimal capital structure for the cooperative focuses on the literature involving farm proprietors or cooperative and does not attempt to discuss the more extensive literature covering investor owned companies capital structures. The reason for not discussing the more general literature on optimal capital structures is because the way cooperatives gain, allocate, and return owner equity differs from an investor owned firm[3]. This makes it difficult to compare the optimal capital structures of the different business types.

A framework is needed to evaluate the choice of equity level used in the capital structure of the large-scale closed cooperative given the uncertainty of the returns from investing in the cooperative. In determining the capital structure of a business, typically increased use of leverage will increase the return on equity invested in the business. This is because the cost of debt is lower than the cost of equity due to risk factors and tax treatment. Increased use of debt also increases the probability of the business becoming insolvent. This is because lenders will be less likely to extend additional debt to a business that is already highly leveraged. When an unfavorable outcome forces a business to turn to additional financing to meet its cash obligations, a highly leveraged business may be forced into bankruptcy because of the lack of available financing. This means that there are important tradeoffs when deciding on the optimal capital structure of the cooperative (Forster, 1996).

Collins (1985) developed a theoretical model to examine the effect of business risk (variance of rate of return on assets) on the optimal capital structure for agricultural

---

[3] See Cobia (1989) for a summary of the differences in how equity is raised, allocated, and returned to owners in cooperatives and investor owned firms.

proprietors. In developing his model, Collins used the assumptions that 1) the proprietor's objective is to maximize the expected utility of the rate of return on equity, 2) the utility function of wealth is negative exponential, 3) a normal distribution exists for the rate of return on assets, and 4) taxes are ignored. The assumptions used by Collins enables the optimal capital structure to be examined in a linear mean-variance framework.

Solving the utility maximization problem with the assumptions used by Collins results in the following optimal equity to asset ratio:

$$(1-\delta^{*}) = \rho \frac{\sigma_{A}^{2}}{[\bar{R}_{A} - K]} \tag{1}$$

Where

ρ = risk aversion parameter of the utility function

σ_{A}^{2} = variance of rate of return on assets

$\bar{R}_{A}$ = expected rate of return on assets

K = non-stochastic interest rate on debt

δ^{*} = optimal ratio of debt to assets (leverage)

The second order condition for the optimal equity to assets ratio is met if the proprietor is risk adverse. Differentiating equation (1) with respect to σ_{A}^{2} shows that an increase in business risk (variance in rate of return on assets) leads to an increase in the optimal equity to asset ratio and a corresponding decrease in leverage.

$$\frac{\partial \delta^{*}}{\partial \sigma_{A}^{2}} = -\frac{\delta}{[\bar{R}_{A} - K]} \tag{2}$$

Equation (2) is negative as long as risk aversion is assumed and the interest rate on debt does not exceed the rate of return on assets from the operation and capital gains.

Barton, Parcell and Featherstone (1996) added a stochastic interest rate to the Collins model and applied the model to the optimal capital structure in centralized agricultural cooperatives. Using data from local cooperatives in Kansas, the optimal solvency (equity to assets ratio) was determined for varying levels of the risk aversion coefficient. The authors found that the optimal solvency ratio was sensitive to business risk, the expected interest rate and the variability of interest rates. Ultimately, the optimal solvency to be used by the cooperative remains a function of the risk aversion assumed. By solving for the optimal solvency, the authors provided insights into the impact risks preferences have on the optimal levels of debt and equity used by the cooperative.

Featherstone, Moss, Backer, and Preckel (1988) applied the Collins model to examine the impact of farm policies on the optimal leverage and probability of equity loss by farmers. Many of the farm policies implemented were designed to reduce the price variability and augmenting farm incomes. These policies were implemented in response to the number of farm bankruptcies and disbandment of family farming operations. Using Collin's theoretical model the authors show that theoretically the reduction in price variability and income augmentation policies have the effect of increasing the optimal leverage for the farmers. Increasing the leverage of the farmers increases the financial risk the farmers face and has the potential to lead to increased numbers of bankruptcies. The paradox that the authors show is that farm policies that were designed to reduce the number of farm bankruptcies actually have the potential to increase the number of farm bankruptcies.

The above referenced articles are examples of how the optimal use of debt and equity can be examined for agricultural cooperatives and producers. Several of the factors that influence the optimal use of debt and equity were explored. This research will examine different debt and equity levels for the closed dairy cooperative modeled. While the returns reported for the closed dairy cooperative will be based on cash returns to the cooperative members, and therefore, deviate from the return on assets and equity discussed in the cited literature, the basic principals for the optimal leverage to be used by the cooperative will still apply. These principals are useful in examining the different equity levels assumed for the cooperative in this research.

Probability of Failure Models

Besides determining the expected returns for the large-scale closed dairy cooperative and the risk associated with those returns, this research looks at predicting the probability that the large-scale closed dairy cooperative will fail. Predictive models of business failures fall under the general category of qualitative response models. Qualitative models have the common characteristic that the dependent variable is a discrete variable. In this case the dependent variable is a binary variable, either a surviving business or a failing business. A common type of regression analysis used for estimating qualitative models is logit regression. Logit regression is a statistical method that relates the probability of occurrence of a binary event to one or more explanatory variables through a logistic cumulative distribution function.

Other statistical methods besides logit are available for estimating the probability of binary occurrence of an outcome to explanatory variables. Probit regression is also widely used. In probit regression, the probability of the occurrence of a binary event is related to one or more explanatory variables through a normal cumulative distribution function. In many applications the two regression methods yield very similar results.[4] Green (1993) provides the derivation of both the logit and probit regression models. Green also provides the references for all of the original development of the estimation techniques.

Several authors have applied logit regression to obtain predictive bankruptcy models. Collins and Green (1982) used logit regression to study bankruptcy for credit unions. McConnon (1989) and Staiert (1990) used logit regression for modeling grain elevator failures.

McConnon (1989) used a sample of 123 grain elevators, 40 of which failed between 1983 and 1986. Five variables were included in McConnon's models, 1) total debt to total assets, 2) asset turn-over, 3) return on assets, 4) adjusted working capital to sales and 5) adjusted cash flow to debt. McConnon compared the results of a linear discriminant model and a logit model for developing an early warning model for grain elevator failures. He found that the logit model had significant explanatory power and based on the data outperformed the linear discriminat model.

There were a couple of shortfalls in the results developed by McConnon. Two of the five variables had estimated coefficients that were not significantly different from 0 at the 5% significance level, one of which had the sign opposite of what was expected. Staiert (1990) used the logit model that McConnon used and developed a three variable model to eliminate the difficulties with McConnon's five variable model.

The probability of failure model developed in this paper will follow closely the work of McConnon and Staiert. However, the data used in this research is the simulated data developed to evaluate the returns to the large-scale dairy cooperative, and not historical data

---

[4] See Greene, 1993 for a basic comparison of the results from a logit and probit regression model.

from firms that actually either survived or were forced into bankruptcy. In addition, there are differences in the type of variables that are postulated to influence the probability of failure. McConnon and Staiert were developing an early warning model for regulators to audit a grain elevator and based on the financial statements make a determination on the likelihood of the elevator failing. This paper examines the effect of market conditions (price variables), management decision variables, and variables that in part are determined by the skill of management (milk production and culling rates). Despite the differences in data and variables examined, the basic outcome from the logit model provides a useful tool to examine the probability of failure.

CHAPTER 3. MEHTODOLOGY

Specific Closed Cooperative Structure

The large-scale closed dairy cooperative modeled in this research will be located in the upper Midwest, specifically, northeastern Iowa or southern Wisconsin. Although there are no known closed dairy cooperatives currently operating in the upper Midwest there has been interest by several groups in forming a closed dairy cooperative. In addition, there are two closed cooperative dairies currently operating in Kansas.[5]

The closed dairy cooperative will be designed to have between 1,100 to 1,200 Holstein cows. Previous research has indicated that this would be an appropriate sized dairy herd to capture existing economies of scale. Herd sizes of 500 and 1,000 cows were found to be feasible herd sizes for Missouri dairies and had economic advantages over smaller farms (Bailey, 1997). Research by Kriegl (1998) showed economic advantages for herds of 1,100 cows. Conversations with members of the Land O' Lakes Dairy Business Services group also suggested that a 1,200 cow dairy would be large enough to capture the economies of scale in the dairy industry.

The dairy operation will be constructed in such a way that allows for future expansions to double the size of the operation if the members decide that expansion is appropriate. The site chosen for the dairy cooperative will require an adequate water supply. access to a major highway for semi-truck access and be located near an available source of relatively inexpensive labor. The dairy cooperative will operate by purchasing all of its replacement heifers and sell all calves within a week of birth.

---

[5] Members of the 21st Century Alliance have created two large-scale closed dairy cooperatives in Kansas. 21st Century Dairy Cooperative is a 1,500-cow dairy near Linn, Kansas. Ladder Creek Dairy is a 2,600-cow dairy in Greeley County, Kansas.

General Business Structure

The large-scale closed dairy cooperative analyzed in this research will have the same basic business structure as other new generation cooperatives. Members are required to deliver a specified number of bushels of corn or equivalent tons of corn silage to the dairy cooperative to be used as feed in the dairy operation. The cash generated by the cooperative from the dairy operation will be returned to the members in the form of a value added payment based on the quantity of corn delivered to the cooperative. To obtain the right to deliver corn or corn silage to the cooperative and the corresponding proportional right to share in the value-added payments, members are required to purchase shares in the cooperative. Each share bestows upon the member the right and obligation to deliver a specified quantity of corn or corn silage to the cooperative. The cooperative will use the equity raised from selling the shares along with debt issued to the closed cooperative to finance the construction and startup of the dairy operation.

Given the projected annual feed requirements for the dairy operation, approximately 161,000 bushels of corn will be required in the form of corn silage and shell corn. Approximately 26% of the corn required by the cooperative will be shell corn and 74% will be corn silage. The cooperative will require 12,000 tons of corn silage, 60% moisture content, and 42,000 bushels of shell corn. By issuing 161 shares in the cooperative, each share would be associated with the delivery rights of 1,000 bushels of shell corn, or the equivalent amount of corn silage, which is approximately 105 tons[6]. All corn and corn silage delivered to the cooperative will have to meet certain minimum quality standards to avoid harming the other members through decreased milk production from the dairy operation.

All other feed required by the dairy cooperative will be purchased by the cooperative. This will eliminate any problems of having to convert the different feeds to an equivalent basis. While the majority of the feed requirement is corn silage, allowing members deliver shell corn as well as corn silage enables approximately 25% of the members to be located a longer distance from the cooperative. Members delivering corn silage need to be located within 4 or 5 miles of the dairy cooperative given the high transportation costs relative to the value of the corn silage.

Corn Payments

Members will deliver corn silage to the dairy cooperative each September, with shell corn delivered in September or October. While shell corn could be delivered on an as needed basis, in order to treat members delivering silage and shell corn on the same basis all corn is delivered at harvest time. The cooperative will pay the members for the corn silage and shell corn through three types of payments, 1) delivery payments, 2) quarterly payments and 3) value added payments. The price of corn and corn silage used to calculate the delivery payment is based on the Posted County Price (PCP) for corn in the county where the cooperative is located. The delivery payment for shell corn will simply be the PCP times the quantity of shell corn delivered to the cooperative. The following formula is used to convert the PCP to a price per ton for corn silage delivered to the cooperative, assuming the corn silage has 60% moisture content.

$$9.5 * (PCP) + \$1.25 \tag{3}$$

---

[6] Based on approximately 9.5 bushels of corn per ton of corn silage with a 60% moisture content.

Equation (3) is based on Iowa State Extension research and incorporates the additional fertilizer requirements for growing corn silage as opposed to shell corn since the stalks are removed when the silage is harvested.

Each quarter members will receive a quarterly payment for one-fourth of the shell corn or corn silage they delivered to the cooperative. The price for shell corn and corn silage used in calculating the quarterly payment is based on the difference between the quarterly average of the Tuesday through Thursday closing price at a local county elevator and the PCP used to calculate the delivery payment. The following formula is used to determine for the quarterly payment price per ton of silage delivered.

$$9.5 * (\text{QRTLY AVE} - \text{PCP}) \quad (4)$$

Where QRTLY AVE = average of all Tuesday through Thursday closing price for #2 yellow corn at a local county elevator in that quarter.

Together the delivery payment and the sum of the quarterly payments for the shell corn and corn silage delivered to the cooperative will approximate the payment the cooperative members would have received had they sold their corn crop at a local elevator evenly throughout the year. By structuring the quarterly payment in this manner, members also receive a marketing benefit from delivering their corn to the cooperative. Corn is priced uniformly rather than in large infrequent transactions, which can be a marketing benefit. Members receive a price equivalent to the annual average market price for corn in their local market without having to deal with any storage issues.

The combination of the first two types of payments to the cooperative members for the corn silage and shell corn will be capped at a price of $3.00/bushel for corn or $29.75/ton for corn silage. There are two reasons for capping the price for corn delivered to the cooperative. First, lenders of the cooperative may require a limit on the price of the corn delivered in order to insure the solvency of the cooperative. Without a cap on the price of corn delivered by the members, there is a potential for the cooperative to have to pay the members an extremely high price for the corn silage. This could be a severe drain on the cooperative's resources and leave the lender without the ability to recover its loan. Absent this kind of cap the lender may be less willing to provide debt capital to the cooperative. The cap on corn price helps protect the cooperative from situations such as those experienced in 1996 when corn prices spiked dramatically. Second, since the members are committed to a value added process, capping the corn price will benefit the dairy operation, which in turn will benefit the members through the value added payment. This provision makes the investment in the dairy operation a hard commitment. The commitment the members are making, through investing in the closed dairy cooperative, becomes nearly equivalent to the commitment of maintaining a dairy operation on their own farms. The dairy animals would be fed without regard to short-term spikes in grain prices.

The final payment each member will receive for delivering corn to the cooperative is an annual value added payment. The value added payment will be paid from the cash revenues of the dairy cooperative after paying all of the cash expenses for the cooperative. The value added payment will be tied directly to the quantity of corn delivered to the cooperative. Each share will be entitled to 1/161st of the cash value created by the cooperative for the year. The annual value added payment is the main benefit to the members of the cooperative from investing in the cooperative vs. marketing corn or silage into a cash market.

Facilities

The facilities required for a dairy cooperative of this size comprise the largest expenditure for the cooperative. The assumptions made for the dairy cooperative's facilities and their associated costs were taken from a variety of sources. Many of the facility costs were derived from spreadsheets developed by the Center for Dairy Profitability at the University of Wisconsin (Reinemann, Holmes and Frank, 2000). The facilities for the dairy operation include a free stall barn for the milking cows, dry cow barn, special needs/calving barn, milking parlor, manure storage, bunker silo, other feed and bedding storage sheds, and an equipment shop. All of the facilities and the land for the cooperative are expected to cost $3,977,600. The breakdown of the costs for all of the facilities and land can be found in Appendix A. The following paragraphs provide an explanation of the facilities and their associated costs.

Eighty acres of land is purchased to accommodate the facilities along with providing the area necessary for possible future expansions of the dairy operation. With only 80 acres of land, it is assumed that the cooperative can acquire rights to spread manure on surrounding farmland at zero cost (potentially this farmland could be the members cropland). The transportation costs associated with delivering the manure is accounted for as an operating expense. The price of land used is $1,800/acre based on the average price for agricultural land in southern Wisconsin with no buildings or improvements (WASS, 2000). The land for the dairy operation would require sufficient highway access to accommodate semi-trailer traffic, access to 3-phase electrical service and adequate water supply. The site would also need to be chosen such that an adequate pool of labor is available at a reasonable price.

Construction for site preparation and driveways are estimated to cost $55,000 and $82,000, respectively. Site preparation could vary due to differences in soil characteristics and topology. The manure storage system consists of a concrete storage area that is capable of 8 months of storage for the facility. It is estimated that the manure storage facility would cost $518,000 based on 6 cents per gallon for concrete storage, 30 gallons of waste/cow/day (including milk house waste water) and 1,200 cows for 8 months. It is anticipated the manure storage facility will be emptied every 6 months. The additional two months of storage provide additional capacity needed in the event of an extremely heavy rain and possible weather delays in emptying the storage due to field conditions.

The well water system, including drilling the well, pump, storage tank and a drip chlorination system, is estimated to cost $8,400. The cost of installing watering stations for the cows is included in the cost of the buildings. The dairy operation will be equipped with a backup propane or diesel generator. An operation of this size will need a 750-kva generator that is estimated to cost $50,000. Included in the $50,000 cost is the cost of a three-phase connection to the local electric utility and proper backup generator connection.

It is planned that the free stall barn will be stocked at 100%, i.e. one stall per cow, once the operation reaches a steady state of production. The free stall barn for the milking cows is planned to have 1,020 stalls given that on average approximately 15% of the herd will be dry at any time. This should provide adequate stalls for the milking cows, since many operations are designed to have a 110% stocking rate. With a 110% stock rate, there are 10% more cows than stalls. This is possible since all the cows are not bedded in a stall at the same time. The actual stocking rate of the free stall barn will vary depending on the actual percentage of dry and milking cows at any given time. The cost of the free stall barn is estimated to be $1,200 per stall. A dry cow barn with 180 stalls will be constructed at a cost of $1,200 per stall. A special needs and calving barn is estimated to cost $360,000.

The milking parlor, bulk tank and office together are anticipated to cost $984,000. The parlor will consist of a double 24-station parlor. It is anticipated 2 people will be required to run the parlor, and an additional worker to move cows into and out of the parlor, as well as, cleaning the parlor area. Each cow will be milked three times per day. It is estimated that actual milking time will be 18 to 19 hours per day, which allows for 5 to 6 hours of clean up and maintenance per day.

Feed storage equipment for the dairy operation will consist of a bunker silo, a feed shed for concentrates, two metal feed bins and a shed for bedding. It is estimated that the bunker silo will cost $139,000. The other feed storage items are anticipated to cost $90,000. Other facilities that will be included in the dairy operation are a fully equipped shop and machinery shed, which are estimated to cost $100,000.

Machinery and Equipment

The assumptions for the machinery and equipment used in this research were developed from conversations with members of the Land O Lakes Dairy Business Services. The machinery needed by the dairy cooperative include a TMR truck, TMR mixer, packing tractor, ¾ ton truck, payloader with bucket, and garden tractor/mower. The milking equipment was included in the parlor expenses. The other equipment needed by the cooperative includes cattle handling equipment consisting of a livestock trailer, crowd gate, and cattle ID and monitoring system, and other equipment such as bedding applicator, feed pusher upper, computer/software, washer/dryer, refrigerator/freezer and other office furnishings. The total cost of the machinery and equipment to start up the closed dairy cooperative is expected to be $315,800. Appendix A lists all of the machinery and equipment needed by the cooperative including the cost of each item.

Livestock

In order to populate the operation with livestock, first calf heifers will be purchased. All heifers purchased, both to initially stock the facility and replacements needed during operation, are assumed to cost $1,800/head based on current market prices. It is recognized that actual prices may vary somewhat around this assumed level. However, the calf price assumed for week old calves sold by the cooperative is only $90. When heifer prices increase above the assumed levels, typically an offsetting increase will be realized in heifer calf prices. The 1,200 heifers purchased to populate the dairy operation will cost the cooperative $2,160,000. All heifers purchased to replace cows that have been culled from the herd, including those culled during the startup phase of the operation are considered to be an operating expense and not a capital expenditure.

While many of the commodity prices used throughout this research are based on average prices over the past 11 years (September 1989 through August 2000), the market for springing heifers in the upper Midwest has changed considerably over the last several years. The trend toward larger dairy operations that typically have higher culling rates and longer intervals between calving than traditional smaller operations is expected to continue in the future. In the absence of sexed semen available at economical values, this trend will continue to reduce the supply and increase the demand for springing heifers. Availability of sexed semen at economic prices is uncertain. To be conservative, the current market price of replacement heifers is used instead of the long-term average for this research.

Working Capital

The cooperative will require enough working capital to make the delivery payment for corn silage and shell corn during the first month of operation. In addition, enough working capital will be budgeted to cover a typical month's cash expenses. For the cooperative analyzed, $550,000 of working capital would be required to meet the standards described above.

Equity Structure

The equity structure of the closed dairy cooperative differs between four classes of assets 1) facilities and land, 2) machinery and equipment, 3) livestock and 4) working capital. The total capital costs of the closed dairy cooperative are projected to be $7,003,400. Based on the equity and debt financing ratios described below for the four classes of assets, the cooperative will need $3,922,800 in equity to start up the cooperative, which is 56% of the capital requirements. Based on the 161 shares sold in the cooperative to fulfill the cooperative's corn requirements, the cost of each share in the cooperative will be $24,365.

It is assumed that long-term facilities and land will be 35% equity financed through the cooperative's members contributions and 65% financed by long-term debt issued to the cooperative. The members may provide their equity contribution to the cooperative from either cash or debt incurred by the member against the members' farm operations. The long-term debt incurred by the cooperative itself will have a twenty-year term and an interest rate of 9.75%.

Machinery and equipment will be 80% equity financed through contributions by the cooperative's members and 20% financed by intermediate debt issued to the cooperative. The intermediate debt for machinery and equipment will have a five-year term and an interest rate of 9.0%. Livestock purchased to populate the facility will be financed through 80% equity contributions from the cooperative's members and 20% intermediate debt. The intermediate debt for livestock will have a seven-year term and an 8.5% interest rate. All replacements for cows that are culled will be treated as an operating expense.

Working capital for the cooperative will be funded from equity contributed by members through their shares purchased in the cooperative. Short falls in cash after working capital has been depleted will be financed by the cooperative through a line of operating credit that the cooperative establishes with a lending institution. It is assumed that the cooperative will pay an annual interest rate of 11% on the line of credit. Table 3.1 shows the total equity and debt positions for the dairy cooperative.

Alternative Equity Structures

The 56% equity level capital structure outlined above is based on conservative lending restrictions. The closed cooperative should be able find a lender willing to allow the cooperative to leverage a larger percentage of its capital requirements. This will reduce the equity needed from the cooperative's members. Conventional finance theory states that

Table 3.1. Total Equity and Debt Positions for Dairy Cooperative – 56% Equity

	Equity		Debt		Total
	%	$	%	$	$
Facility and Land	35%	$1,392,160	65%	$2,585,440	$3,977,600
Machinery & Equipment	80%	$ 252,640	20%	$ 63,160	$ 315,800
Livestock	80%	$1,728,000	20%	$ 432,000	$2,160,000
Working Capital	100%	$ 550,000	0%	$ 0	$ 550,000
Total	56%	$3,922,800	44%	$3,080,600	$7,003,400

leveraging a business to a higher degree will lead to a higher return on equity, because of the lower debt financing has a lower cost that equity financing. However increasing the percentage of leverage used in the capital structure increases the exposure of the cooperative to unexpected adverse outcomes. This increases the probability that the cooperative could become insolvent by being unable to meet its cash obligations. In order to investigate the tradeoffs associated with different capital structures for the cooperative, two lower equity levels capital structures were examined.

One conjecture examined in this research is that counter to conventional finance theory the cooperative may be better off by having a higher level of equity in the cooperative due to the uncertainty the cooperative is facing. Members may actually have a higher expected return on their equity invested in the closed dairy cooperative if the cooperative's capital structure has a higher level of equity. The increased equity in the cooperative will help insulate the cooperative during periods of poor milk prices or lower than expected milk production. In addition to potentially having a higher expected return on equity, by having a capital structure with a higher level of equity, it is anticipated the cooperative will have a lower probability of not being able to meet is cash obligations. Therefore, both a 46% equity level case and 40% equity level case are examined. Tables 3.2 and Table 3.3 show the breakdown of the capital structure for the closed dairy cooperative for each of these equity level cases.

By issuing more debt to the cooperative, the members are able to reduce the share price by more than 23%. It is likely that the lower share price will appeal to more farmers looking at investing in a closed dairy cooperative. This research will provide the trade-offs associated with having a higher debt level for the cooperative and lower share price

Table 3.2. Total Equity and Debt Positions for Dairy Cooperative – 46% Equity

	Equity		Debt		Total
	%	$	%	$	$
Facility and Land	35%	$1,392,160	65%	$2,585,440	$3,977,600
Machinery & Equipment	60%	$ 189,480	40%	$ 126,320	$ 315,800
Livestock	50%	$1,080,000	50%	$1,080,000	$2,160,000
Working Capital	100%	$ 550,000	0%	$ 0	$ 550,000
Total	46%	$3,211,640	54%	$3,791,760	$7,003,400

Table 3.3. Total Equity and Debt Positions for Dairy Cooperative – 40% Equity

	Equity		Debt		Total
	%	$	%	$	$
Facility and Land	30%	$1,193,280	70%	$2,784,320	$3,977,600
Machinery & Equipment	60%	$ 189,480	40%	$ 126,320	$ 315,800
Livestock	40%	$ 864,000	60%	$1,296,000	$2,160,000
Working Capital	100%	$ 550,000	0%	$ 0	$ 550,000
Total	40%	$2,796,760	60%	$4,206,640	$7,003,400

Table 3.4. Price per Share with Different Equity Contributions

Total Equity %	Total Equity Contributed	Price per Share
40%	$2,796,760	$17,371
46%	$3,211,640	$19,948
56%	$3,922,800	$24,365

compared with the more conservative higher equity level for the cooperative. Table 3.4 provides the total equity required and the price per share for the three different equity levels assumed for the closed dairy cooperative examined in this research.

Dairy Model

Motivation

In order to determine the feasibility of forming a large-scale closed dairy cooperative, a farm level financial model was developed. While there are a number of farm level financial models in existence, these models have the shortfall of not tracking the biological characteristics of the dairy herd on a monthly basis. Due to this short fall, the Dairy Model was developed to link the biologically determined cow flows through the dairy operation to the net cash flows of the cooperative.

It is important to link the cash flows of the dairy cooperative to the biologically determined cow flows when starting up a large-scale dairy cooperative for two reasons. First, the short length of time in which the dairy operation must reach full capacity creates unstable initial results. Second, the extended length of time it takes a dairy operation to reach a steady state of production necessitates careful modeling of cow flows in order to obtain accurate financial results during the startup phase. It is necessary to reach full capacity quickly because of the large fixed costs of the dairy operation. Operating at full capacity allows the operation to spread the high fixed costs over the maximum units of production (Kriegl, 1998). Conversations with members of the Land O Lakes Dairy Business services indicated that the operation should attempt to reach full capacity within four months.

Typically when starting or expanding a dairy operation, first lactation heifers are purchased. By reaching full capacity within four months, most of the heifers will be freshening with in a short time period. An individual cow's milk production follows a well-defined lactation curve. Milk production increases through the first 60 days or so after calving and then declines after reaching peak production. On average, after approximately 345 days in milk, the cow will enter a dry period for 60 days before calving again. What this means for a start-up or expansion herd is that revenues from milk sales will follow a similar pattern as the lactation curve, until over time through culling of cows and variations in actual milk cycles for individual cows the total milk production for the herd will become less variable from month to month.

Dairy Model Overview

The following sections describe the Dairy Model developed to determine the feasibility of forming a large-scale closed cooperative dairy. The Dairy Model consists of three main sections: 1) cow flow model 2) data input section 3) cash flow reports. The specifications and assumptions for the closed dairy cooperative modeled in this research are included in the description of the Dairy Model provided below.

Cow Flow Model

The first step in linking the biological factors to the dairy cooperative's cash flows was to develop a model of the cow flows through the dairy operation. In the cow flow model. groups of cows are tracked on a monthly basis through their lactation cycles based on the month in which the cows first enter the herd. A typical cow's lactation cycle was broken down into stages based on Dairy Herd Improvement (DHI) records kept by Dairy Records Management Systems (DRMS). DHI records track the stage of lactation profile by dividing the lactation cycle into the following five stages: 40 days or less, 41 to 100 days, 101 to 199 days, 200 to 305 days, and 306 and greater for 1st lactation, 2nd lactation and 3rd + lactation cows (DRMS, 1997). In order to simplify the cow flow model and still capture the important differences in milk production during the different stages of lactation, the following groups of cows are tracked in the cow flow model: 40 days or less – transition stage, 41 to 200 days – early lactation stage, 200 to 345 days – late lactation stage, and 345 to 405 days – dry cows. These groups are tracked for both primiparous (heifers – 1st lactation cows) and multiparous (mature cows – 2nd + lactation cows).

In the cow flow model, it is assumed that each month has exactly 30 days. Each cow has a lactation cycle of exactly 405 days (345 days milking and 60 days dry). In any month, the number of cows freshening is calculated by assuming that the cows freshen during the month following a uniform distribution (i.e. an equal number of cows freshen each day of the month). In the start-up phase of the operation it is assumed that the cows delivered to the operation freshen in the month they are received. It is assumed that all cows are delivered to the operation on the 1st day of the month.

Cows are assumed to leave the herd based on an annual culling rate input by the user of the model. The annual culling rate is allowed to vary by year. This feature allows for a higher culling rate to be applied during the first year when culling rates are typically higher. It is also possible to see the impact of allowing the annual culling to be a stochastic variable as was done in this research. The cow flow model assumes that all culling occurs on the last day of the month. The culling rate is applied in such a way that the same percentage of cows from each stage of lactation and age class is assumed to leave the herd each month. Replacements are purchased on the last day of the month. After the initial 4 months of operation when dairy is stocking the facility with cows, the replacement heifers are assumed to freshen uniformly between a month and two months after they are delivered to the herd.

During the 4-month stocking phase of the facility, it is assumed that the heifers freshen during the month they are delivered to the facility. This is because it is assumed that initially the heifers will be contracted for before delivery to the facility. Until they freshen, the replacement heifers are counted as dry cows in the cow flow model.

The number of cows in each stage of lactation in any month is calculated based on the number cows remaining in the stage from the previous month after the culling rate is applied, the number of cows leaving that lactation stage, and the number of cows entering that lactation stage. For the cows that freshened in month 1, the percentage of cows in each stage of lactation was graphed for the first two lactation cycles in Figures 3.1 and 3.2.

Figure 3.1 shows the daily percentage of cows in each stage of lactation for the 1st 405 days for a group of cows that freshen uniformly throughout month 1. Since cows freshen uniformly throughout the month, the average number of cows in each stage of lactation can be calculated for each month using Figure 3.1. For example, it can be seen from the area under the transition stage line that during the first month on average ½ of the cows for this group will be in the transition stage while the other half will be in the dry stage.

At the end of month 1, cows will be culled from the group of cows that freshened in month 1 based on the monthly culling rate for the herd. Therefore, in month 2, only 1 minus the monthly culling rate times the number of the cows freshening in month 1 will still be remaining in the herd. Of these remaining cows in month 2, from the area under the transition stage line, on average 7/9ths of the cows will be in the transition stage. The other 2/9ths of the cows will have moved into the early lactation stage. For month 3, only 1 minus the monthly culling rate times the number of the cows from this group in month 2 will be left

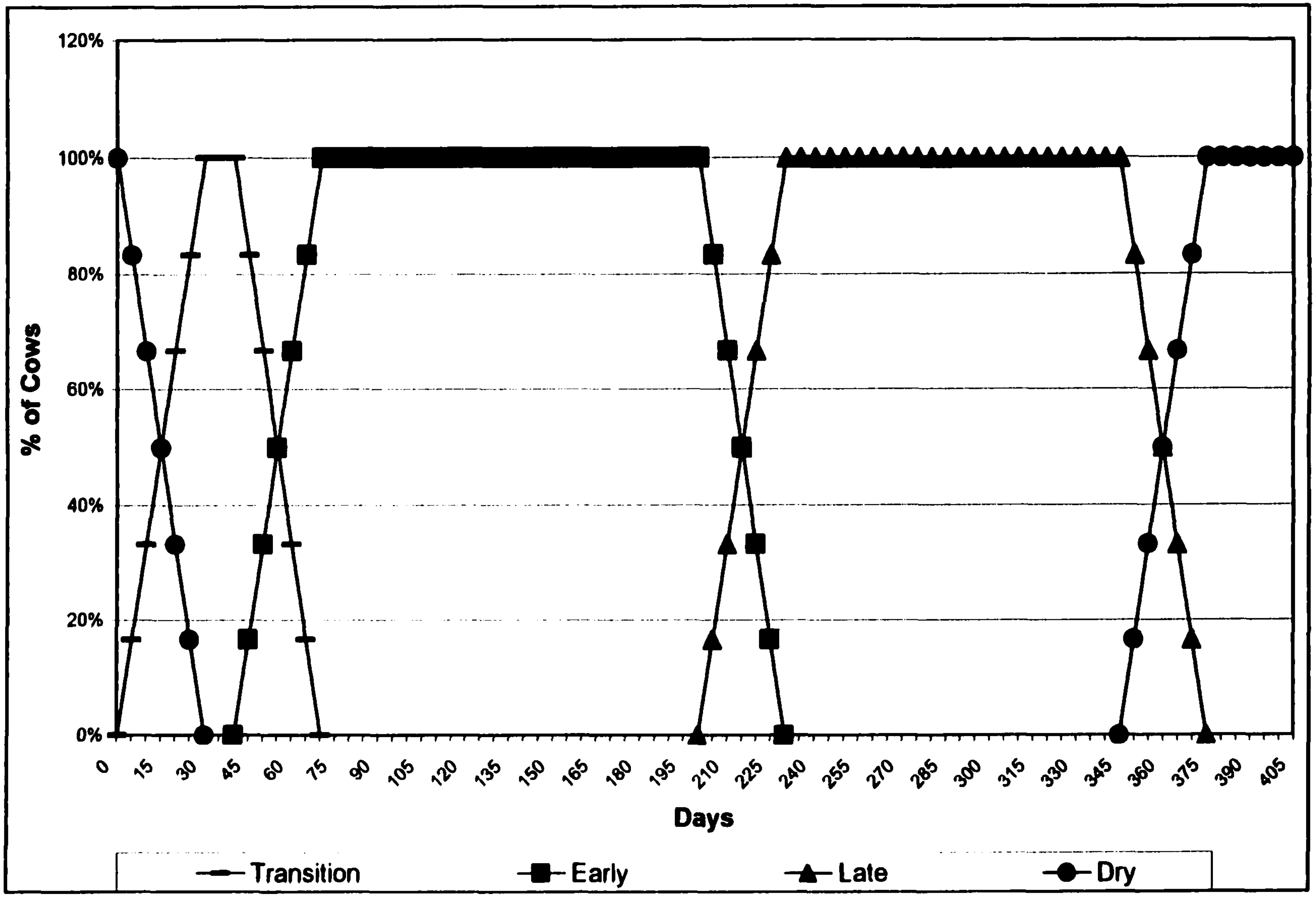


Figure 3.1. Percentage of Cows in Each Lactation Stage by Day for Cows that Freshen in Month 1 - 1st Lactation Cycle

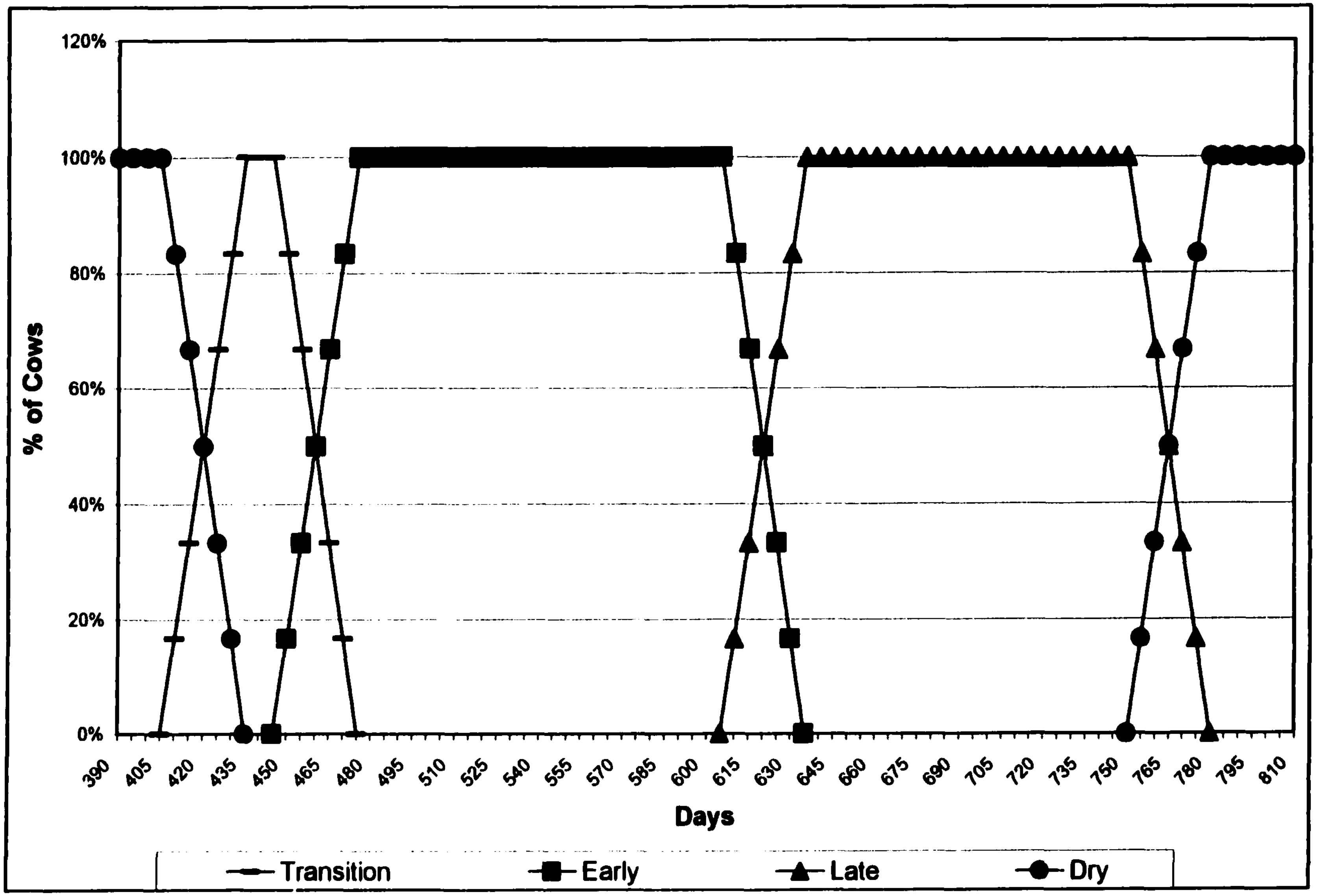


Figure 3.2. Percentage of Cows in Each Lactation Stage by Day for Cows that Freshen in Month 1 - 2nd Lactation Cycle

in the herd. Of the remaining cows, from the area under the transition stage line on average 1/18th of the cows that freshened in month 1 will be in the transition stage while 17/18ths of the cows still in the herd that freshened in month 1 will be in the early transition stage. This process is repeated for the remainder of the first two lactation cycles.

Since the lactation cycle is 13.5 months in length, the percentage of cows in each stage of lactation for those cows still remaining in the herd from the group of cows that freshened in month 1 will be the same in month 28 as month 1. Table 3.5 shows the fraction of cows that freshened in month 1 in each stage of lactation for the first 27 months.

Table 3.5 is the basis for tracking the number of cows in each stage of lactation through the cow flow model. Cows that freshen in month 2 follow the same progression through the lactation cycle and Table 3.5 was used to determine the fraction of cows in each stage of lactation for this group of cows as well. While Table 3.5 outlines the fraction of cows that freshened in month 1 in each stage of lactation, the culling rate for the herd was taken into account in order to determine the actual number of cows in each stage of lactation.

As mentioned above, the cow flow model allows for a different annual culling rate to be applied to the herd each year (culling rates refer to cows sold and died). In order to incorporate the loss of cows from the herd due to culling, a matrix was developed to track the percentage of cows remaining in the herd based on the month they entered the herd. For example, for cows entering the herd in month 1 there will only be 1 – (annual culling rate/12) of these cows left in the herd in month 2. By tracking the percentage of cows remaining in the herd for each group based on when the cows entered the herd, the number of cows in each stage of lactation was determined.

Table 3.5. Fraction of Cows Freshening in Month 1 in Each Lactation Stage for the First Two Lactations

	1st Lactation				Mature Cows		
Month	Transition	Early	Late	Dry	Transition	Early	Late
1	1/2			1/2			
2	7/9	2/9					
3	1/18	17/18					
4		1					
5		1					
6		1					
7		17/18	1/18				
8		2/9	7/9				
9			1				
10			1				
11			1				
12			7/8	1/8			
13			1/8	7/8			
14				7/8	1/8		
15				1/8	31/36	1/72	
16					25/72	47/72	
17						1	
18						1	
19						1	
20						1	
21						47/72	25/47
22						1/72	71/72
23							1
24							1
25							1
26				1/2			1/2
27				1			

Figures 3.3 through 3.6 show the number of cows in each stage of lactation for the first four years of operation. In creating the figures the assumptions follow those outlined in the Data Input Section. An annual culling rate of 44% is assumed for the first year and 34% each year thereafter. The dairy will reach full capacity within four months with all animals delivered to the cooperative as first calf heifers.

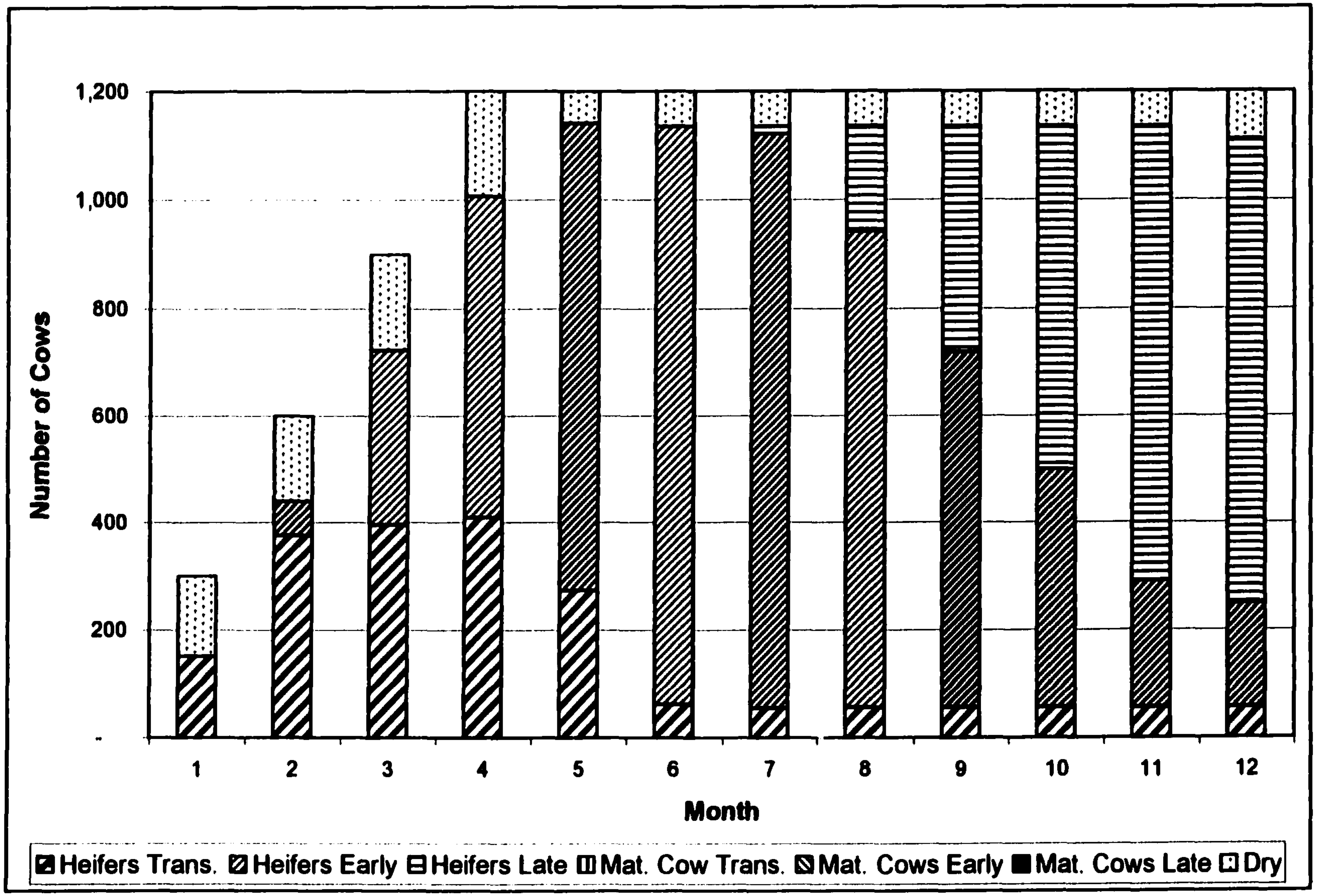


Figure 3.3. Number of Cows in Each Lactation Stage - Year 1

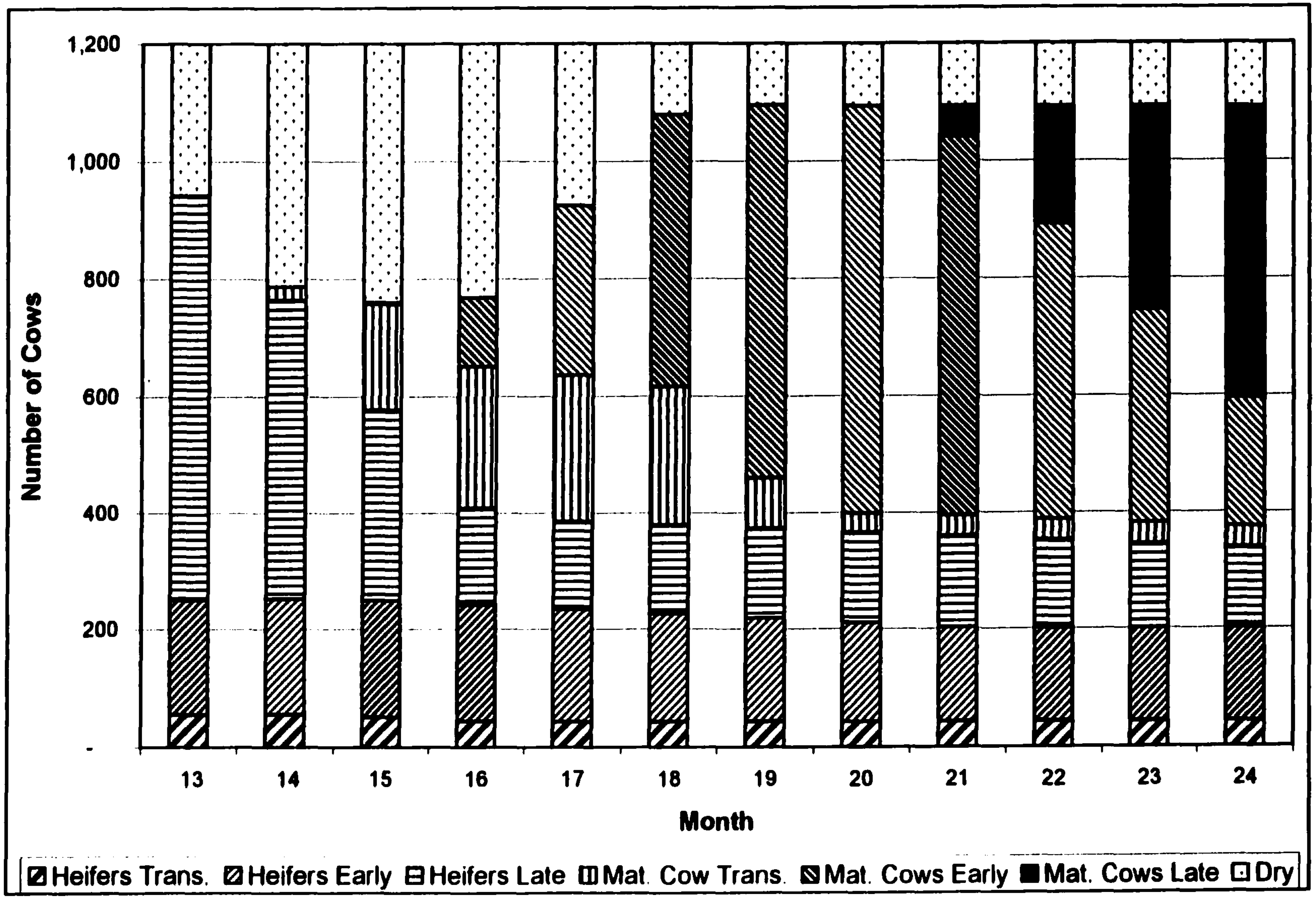


Figure 3.4. Number of Cows in Each Lactation Stage - Year 2

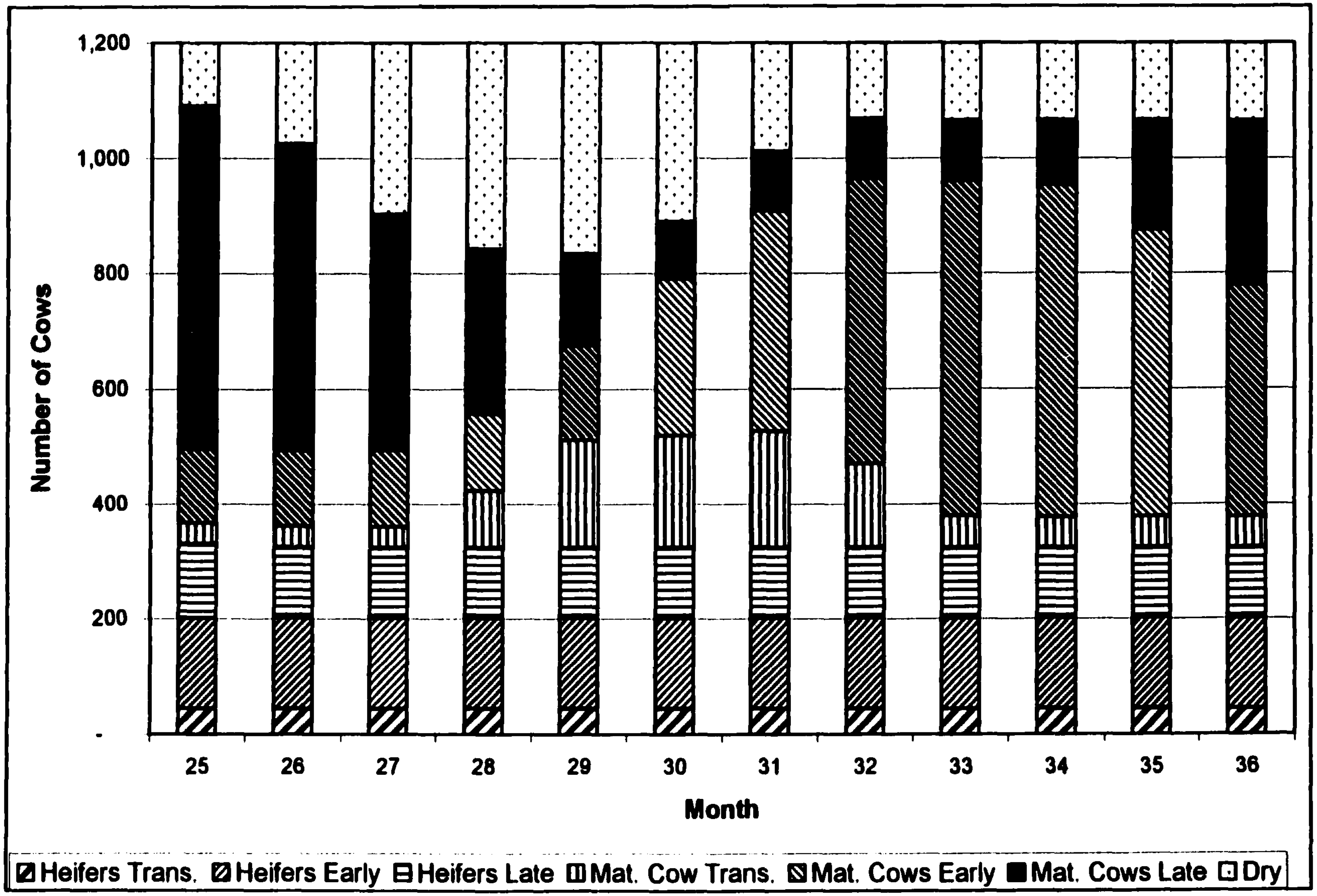


Figure 3.5. Number of Cows in Each Lactation Stage - Year 3

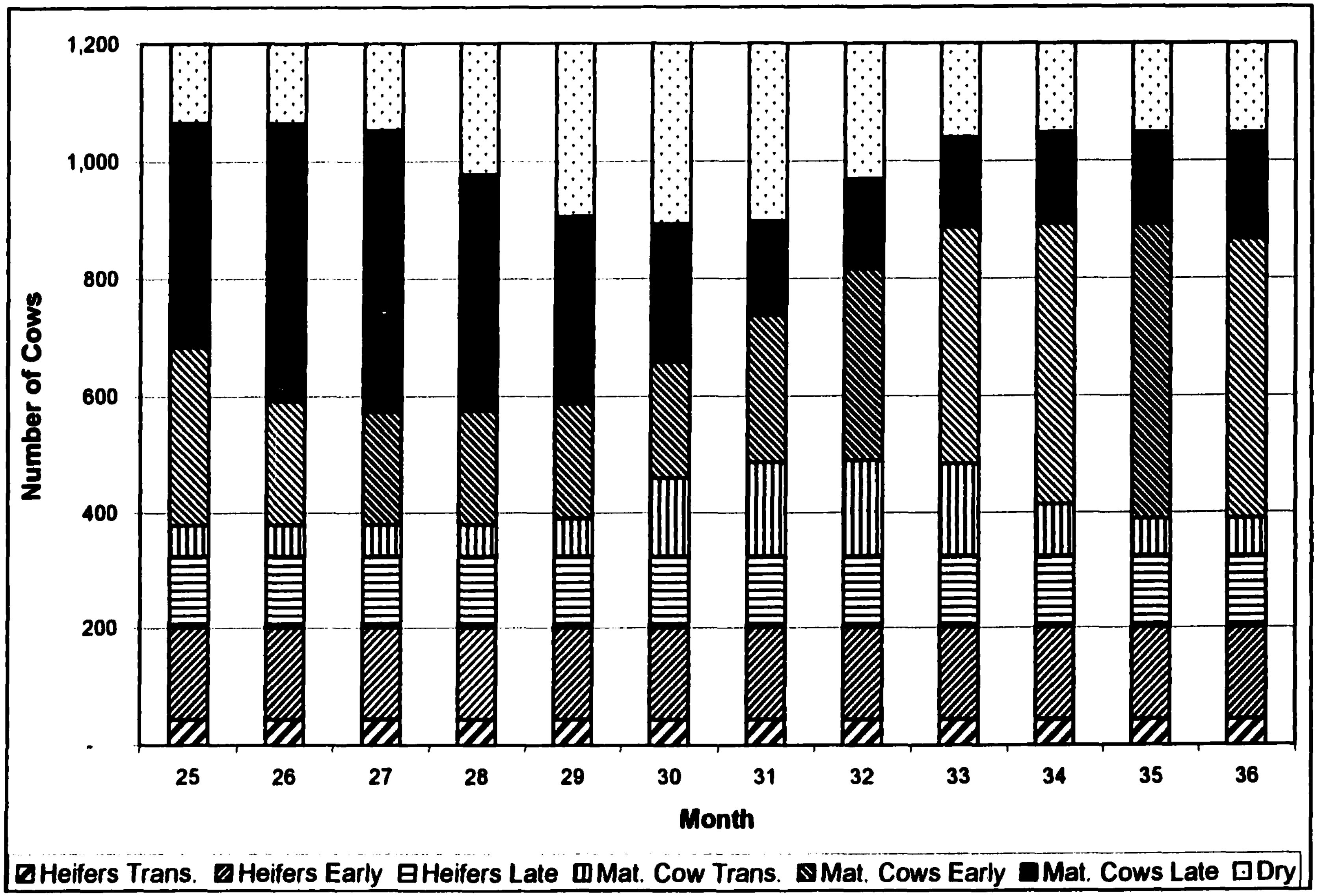


Figure 3.6. Number of Cows in Each Lactation Stage - Year 4

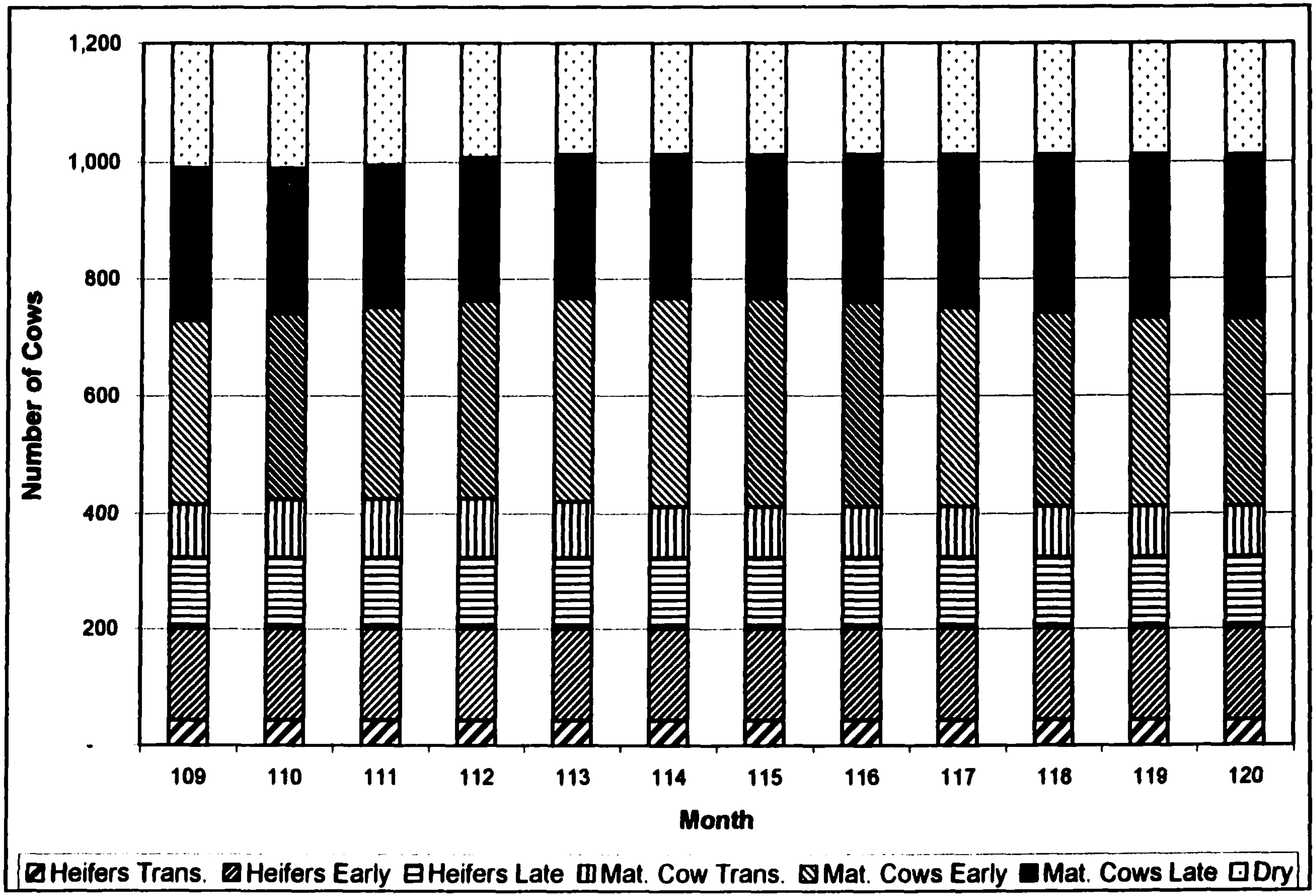


Figure 3.7. Number of Cows in Each Lactation Stage - Year 10

As seen in Figures 3.3 through 3.6, there is a large variation in the number of cows in each stage of lactation. Given the differences in milk production during the different stages of lactation, this will translate into large variations in the revenues from milk sales. Figure 3.7 shows the number of cows projected to be in each stage of lactation during year 10. By inspecting Figures 3.3-3.7 it is easy to see that in year 10 the monthly variation in the number of cows in each lactation stage has been almost completely eliminated. This shows that typical budgeting models may adequately represent a herd depicted in Figure 3.7. However, typical budgeting models miss the variability caused by the biological nature of milk production especially for the early years of a dairy operation.

Data Input Section

Appendix A shows the complete data input section for the Dairy Model used the assumptions in this research under the 56% equity level case for the cooperative. The milk production data that appears in Appendix A represents the medium production level case as defined later. The data assumptions in the data input section of the model follow those outlined in the cooperative section discussed earlier for facilities, machinery and equipment.

Price Information

Table 3.6 shows the feed prices, dry matter percentages and price per pound of dry matter for the feeds used in the dairy rations. The prices shown in Table 3.6 are based on the last 11 years average prices - September 1989 through August 2000 - for corn (corn silage and shell corn), and hay (WASS, various issues). Soybean meal prices are based on USDA/AMS data. The 11-year price series was based on 44% protein soybean meal. In order to compensate for the 48% protein used in the ration the price was increased by 5%

Table 3.6. Feed Prices for Dairy Ration

Ingredient	Price/Ton	Price/lb (DM)	% Dry Matter
Shell Corn	$132.16	$0.075	88%
Corn Gluten Feed	$120.00	$0.067	90%
Corn Silage	$23.67	$0.030	40%
Soybean Meal, 48%	$189.99	$0.106	90%
Whole Cotton Seed	$207.00	$0.113	92%
Alfalfa Hay, Early Bloom	$71.23	$0.04	90%
SoyPlus	$240.00	$0.135	89%
Calcium Carbonate	$149.00	$0.075	100%
Fat	$600.00	$0.306	98%
Sodium Bicarbonate	$380.00	$0.190	100%
Salt	$128.00	$0.064	100%
Urea	$400.00	$0.200	100%
Dairy Micro Premix	$2,000.00	$1.00	100%
Dicalcium Phosphate 18.5	$346.00	$0.173	100%
Magnesium Oxide	$318.00	$0.159	100%
Dry Cow Supreme PX	$1,460.00	$0.793	92%
Soybean Hulls	$120.00	$0.067	90%
Magnesium Sulf.	$520.00	$0.260	100%

based on the current price differential between 44% and 48% protein soybean meal. The other ration ingredients are based on local cooperative prices in July 2001.

Based on the milk price during the September 1989 through August 2000 time period, the average milk price is $13.51/cwt. The milk is based on the average mailbox price received by Wisconsin farmers before any hauling and marketing expenses are removed (WASS, various issues). While data on the price series used in this research is available for many years prior to 1990, in 1990 there was a major change in federal dairy policy. Government purchase of dairy products to support price was greatly reduced and there is little reason that there will be a return to pre-1990 policies. Milk prices have behaved significantly different since 1990. Examination of the milk prices over the last 20 years shows a considerable increase in the variability of milk prices since 1990. For this reason. price series for all of the variables that are simulated in this research were restricted to the 1989 through 2000 time frame to attempt to use a historical time period that is relatively consistent with expected future prices.

The price received for all calves sold is $90/head. At the current time the calf price may be low, but the replacement price will be higher than the $1,800/head assumed. The spread between calf prices and replacement heifers is anticipated to remain fairly constant. Cull cow prices are simulated as well in the model. The average cull price at the historical price of $41.88/cwt, based on prices from September 1989 through August 2000 as reported by WASS (various issues). Replacement heifers, as well as, the heifers purchased to start the operation, are assumed to cost $1,800/head based on current market prices given the changes in the replacement heifer market discussed earlier.

Table 3.7. Feed Rations

Ingredient	Transition Day 1-40 Lbs.	Early Lactation Day 41-199 Lbs.	Late Lactation Day 200 + Lbs.	Dry Cows Lbs.
Shell Corn	1.76	6.88	4.40	0.00
Corn Gluten Feed	4.50	6.30	6.30	0.00
Corn Silage	22.40	21.92	22.92	21.90
Soybean Meal, 48%	4.50	4.05	4.54	1.56
Whole Cotton Seed	2.76	3.68	1.84	0.00
Alfalfa Hay, Early Bloom	3.60	3.60	3.60	3.60
SoyPlus	2.58	2.48	0.00	0.00
Calcium Carbonate	0.70	0.78	0.61	0.05
Fat	0.36	0.46	0.00	0.00
Sodium Bicarbonate	0.40	0.35	0.35	0.00
Salt	0.18	0.20	0.19	0.04
Urea	0.15	0.20	0.20	0.00
Dairy Micro Premix	0.10	0.11	0.10	0.00
Dicalcium Phosphate 18.5	0.10	0.09	0.10	0.00
Magnesium Oxide	0.02	0.02	0.00	0.04
Dry Cow Supreme PX	0.00	0.00	0.00	0.12
Soybean Hulls	0.94	0.00	1.82	0.09
Magnesium Sulf.	0.00	0.00	0.00	0.10
$/lb	$3.06	$3.55	2.88	$1.21
DMI	45.05	51.12	47.01	27.50
Cost/lb. Of DMI	$0.063	$0.066	$0.057	$0.040

Feed Rations

Table 3.7 shows the feed rations for the different groups of cows based on stage of lactation. All ration ingredients are shown in pounds of dry matter. The rations shown are based on a 1,350 lb cow producing 73 lbs of milk per day in the transition stage, 90 lbs in the early stage, and 60 lbs in the late stage. The rations were developed assuming the fat content of milk produced is 4%. The rations were provided from a local Land O' Lakes dairy nutritionist. The NRC Dairy Cattle Program (NRC, 2001) was used to verify the rations.

A key feature of the Dairy Model is that the dry matter intake (DMI) of the cows is tied directly to the milk production input into the model for each stage of lactation. The daily dry matter intake in each stage of lactation is predicted based on the 2001 National Research Council (NRC) recommendations (NRC, 2001). The NRC formula for predicting dry matter intake for lactating Holsteins regardless of age is:

$$\text{DMI (kg/d)} = (0.372 * \text{FCM} + 0.0968 * \text{BW}^{0.75}) * (1 - e^{(-0.192 \cdot (\text{WOL} + 3.67))}) \tag{5}$$

where

FCM = 4% fat corrected milk (kg/day),

BW = the body weight (kg),

WOL = week of lactation,

$(1 - e^{(-0.192 \cdot (\text{WOL} + 3.67))})$ = correction factor for depressed DMI during early lactation.

For dry cows the following formula is used for predicting the dry matter intake.

$$\text{DMI (kg/d)} = (1.97 - (0.75 * e^{(0.16 \cdot \text{DaysPreg} - 280)}) / 100) * \text{BW} \tag{6}$$

where

DaysPreg = the number of days the cow is pregnant.

The NRC formula for dry matter intake is used to scale the rations shown in Table 3.7 based on the milk production input into the model, fat content of 3.7%[7], week of lactation[8], and body weight.

After calculating the DMI based on the milk production input into the model the feed rations shown in Table 3.7 are scaled to the correct level of dry matter intake. This is a very important step in obtaining accurate feed cost for each individual draw in the simulation. When a different milk production level is drawn, the feed intake will automatically adjust. In this way, additional milk production will only come at the expense of higher feed costs.

The Dairy Model only accounts for scaling the feed rations to account for changes in milk production levels. The feed rations are not changed due to changes in relative feed prices or milk prices. There are several reasons why the feed rations are not allowed to change in the model. First, in the closed cooperative member agreement, the quantity of corn silage and shell corn delivered to the cooperative is predetermined based on the members' obligations[9]. Therefore, it is not practical to dramatically change the percentage of shell corn or corn silage in the feed ration. Second, given the high capital costs involved in this type of modern dairy operation, it is in the best interest of the manager to attempt to maximize milk production with the ration being fed without regard to the milk price received over wide ranges of milk prices. Third, attempting to make short-term adjustments to feed rations to optimize on changes in relative feed prices can have long-term milk production consequences for the herd. Finally, in the upper Midwest the opportunity to incorporate a number of

---

[7] Based on WI statewide average butterfat test (WASS, 2001).

[8] For each stage of lactation the correction factor is calculated for each week in that stage of lactation. The correction factor is then averaged over the weeks in each stage of lactation to calculate the correction factor used in the Dairy Model for predicting dry matter intake for each stage of lactation.

different alternative feeds into the ration is much more limited than in the western, southwestern, or southeastern United States.

Table 3.8 shows the body weights used along with defining the stages of lactation in terms of days in the lactation. The body weights are based on DHI estimates for Holstein cows based on age (DRMS, 2001).

Milk Production Data

The simulated milk production for each stage of lactation and age class are based on distributions developed using actual herd DHI production records from the Dairy Record Management Systems (DRMS) for herds in New York, Pennsylvania, Iowa and Wisconsin. These states were chosen because they have similar climates and dairy operations in these states have similar management styles. Also, these states had a sufficient number of large (>300 cow) dairies to develop meaningful distributions. The data set received from DRMS contains DHI records for herds from January 1, 1998 through May 15, 2001. Only the data

Table 3.8. Average Body Weight of Cows by Age and Stage of Lactation

		Average Body Weight (lbs.)	
Stage of Lactation	Days in Milk	1st Calf Heifers	Mature Cows
Transition	1-40	990	1,215
Early	41-199	1,100	1,350
Late	200+	1,210	1,418
Dry	345-405	1,375[a]	

[a] Dry cow body weight is based on the weighted average of cows in the herd that are dry and replacement heifers prior to calving.

---

[9] The cooperative will purchase either shell corn or corn silage in the market if due to higher than expected milk production there is a short fall based on the members' delivery obligations.

from January 1, 1998 through December 31, 2000 was used in the sample to enable a full years worth of observations for each herd to be incorporated into the distribution.

In order to create the distribution from the all of the herd data that was supplied by DRMS, only herds that had an annual average of 300 cows or more were included in the sample. This was to insure that similar management and technology is being used as the dairy operation we are modeling. Only herds that milked cows three times per day were kept in the sample. After these herds were selected, only the upper 50% percentile of the herds, determined using the rolling herd average for milk production based on the last available test, were kept in the sample. The reason for only keeping the highest 50% percentile is that the dairy operation we are modeling will use the best technology available, a professional dairy manager is hired to run the dairy operation, and BST will be used to increase milk production. Such an operation needs to have a high level of production performance to justify these added costs.

Since the model developed is a monthly model, it required monthly production data for an entire year for a single herd. The DRMS data set provided the monthly data that was linked together by herd. However, given the nature of DHI testing and some missing data for herds, several herds did not have data for every month for the entire time period. In order to maximize the number of useful observations, an attempt was made to fill in some of the missing data. If only one month of data was missing for the herd during a year, the previous and next months records were averaged to fill in the missing observation. In total 50 missing monthly observations were replaced with average values. Remaining in the sample were 120 years of monthly data, for a total of 1,440 observations. The average of the rolling herd averages for the herds remaining in the sample is 24,642 lbs of milk.

Table 3.9. Average Daily Milk Production by Age and Stage of Lactation

		Average Daily Milk Production (lbs.)	
Stage of Lactation	Days in Milk	1st Calf Heifers	Mature Cows
Transition	1-40	64.4	90.2
Early	41-199	78.9	93.4
Late	200+	68.0	65.4

Table 3.9 shows the annual average milk production per day for each lactation stage and age class for the distributions created from the DRMS data set.

Three different milk production levels were examined to help capture the uncertainty involved with the skill level of management that will be hired by the cooperative. In each of the three milk production levels a learning progression is mapped for the cooperative to capture improvements over time. Efficiency gains due to better genetics and production practices anticipated over the study period are also included in the different production level paths. To construct the different production level cases, the milk production for each stage of lactation and age class was scaled by the factors shown in Table 3.10.

The reason for scaling the production levels is to develop a realistic growth path of milk production per cow for the dairy operation. During the first few years of operation, additional stress on the cows along with inexperience with the new operating systems can result in lower production. After the dairy cooperative has been operating it is anticipated milk production per cow will increase. Since the milk production data from the DRMS data set consists mostly existing herds, the first few years was scaled by less than 100% in order to capture the lower expected production with a startup herd. Depending upon the

Table 3.10. Milk Production Cases

	High Production Case		Medium Production Case		Low Production Case	
Year	Factor	Lbs/cow/year[a]	Factor	Lbs/cow/year[a]	Factor	Lbs/cow/year[a]
1	95.00%	22,977	85.00%	20,558	80.00%	19,349
2	100.00%	23,995	90.00%	21,595	85.00%	20,396
3	102.50%	24,355	95.00%	21,974	90.00%	20,758
4	105.06%	25,152	100.00%	23,940	95.00%	22,743
5	107.69%	25,856	102.00%	24,490	100.00%	24,010
6	110.38%	26,622	104.04%	25,092	101.00%	24,359
7	113.14%	27,397	106.12%	25,697	102.01%	24,702
8	115.97%	28,195	108.24%	26,317	103.03%	25,049
9	118.87%	28,872	110.41%	26,817	104.06%	25,275
10	121.84%	29,529	112.62%	27,294	105.10%	25,472

[a] Based on Dairy Model projections for the number of cows in each lactation stage for that year.

production level case constructed the herd will reach the expected level of production derived from the DRMS data set between years 2 and 5. After that production is anticipated to increase as discussed above. Once the herd reached its expected production level for the DRMS data set, the production levels were increased each year by 1% in the low production case, 2% in the medium production case and 2.5% in the high production case.

This increase in milk production per cow represents gains from learning by management, and increased technology efficiency. The Wisconsin statewide average production per cow has increased 2.9% per year since 1996 (WASS, 2001). While some of the increase in the statewide average production per cow is from lower producing herds leaving the industry, some of the increase can be attributed to efficiency gains by existing herds. The herds in the DRMS data set used to create the milk production distributions used in this study had an average increase in milk production per cow of 2.1% each year from 1998 to 2000.

Other Biological Data

The annual culling rate for the herd will also be a stochastic variable based on the DHI herd data provided by DRMS. The annual average culling rate for the sample of herds used is 34%. Of the 34% culling rate 4.5% is the average death rate and the remaining 29.5% are sold. In this study all cows sold will be sold for slaughter at cull cow prices. The herds in the DRMS data set consist mostly of established herds. It is generally accepted that culling rates in newly assembled herds are likely to be higher than average during the first year of operation. Therefore, the culling rate for the first year is assumed to be 10% higher than the culling rate drawn from the distribution created from the DRMS set.

Milk loss from mastitis and other diseases is calculated based on 12% of the milking herd being infected with mastitis annually requiring 4 days of treatment. Other diseases are assumed to infect 2% of the herd annually and require 7 days of treatment. Losses due to decreased production after being infected with mastitis is assumed to be captured from the DHI data used to create the distributions for milk production by stage of lactation. Calf mortality is assumed to be 12.5%.

Average Annual Non-Feed Variable Expenses

Repair and maintenance for building and equipment expenses are assumed to be 2% of the initial value of the assets (Kreigel, 1998). The non-feed variable expenses[10] are shown

---

[10] Variable Expenses are based on the $/cow expenses in Frank, G. and Vanderlin, J., "Milk Production Costs in 1999 on Selected Wisconsin Dairy Farms" Center for Dairy Profitability, College of Agriculture and Life Sciences, and Cooperative Extension, University of Wisconsin-Madison, July 31, 2000.

in Appendix A. It was assumed that BST would be used on the herd at an annual expense of $242,000.

The dairy cooperative will require 40-labor hours/cow/year. With a herd of 1,200 cows, 48,000 labor hours are needed for each year. Labor is paid $8.75/hour. Including 30% for employer taxes and benefits, the cooperative faces a labor expense of $10.75/labor hour. Total annual labor costs are $516,000. The labor expense does not include the manager's salary of $70,000 per year, which includes all benefits and employer taxes. Labor expenses are assumed to increase at 2% per year.

Manure management expenses are calculated by assuming 30 gallons of waste/day/cow, including milk house wastewater. Cost of application is $0.0075/gallon (Edwards, 2001). The expenses for manure application occur in the months of October and April. It is assumed that manure rights are obtained for the cost of application and no positive income is derived by the cooperative from selling manure rights.

Simulation Methodology

In order to perform a simulation to calculate the net cash flows for the dairy cooperative, @Risk was used to generate 1,000 data sets each consisting of 10 years of monthly corn prices, milk prices, soybean meal price, cull cow price, culling rate, and milk production for each stage of lactation and age class. It was assumed that the price and biological variables are independent for the simulation performed. While it is possible that as the milk to feed ratio increases individual farmers may change feed rations to increase milk production, the true biological relationship between feed intake and milk production will be unaffected by the price of feed or milk prices. This is consistent with the way the

Dairy Model is set up to scale the dry matter intake on milk production level, while leaving the feed rations unchanged.

Price Variables

There are a total of 48 price variables that are each simulated for 10 years. The 48 price variables consist of 12 monthly variables for each of four different prices. The four prices considered stochastic in this simulation are: 1) corn price, 2) soybean meal, 3) milk price and 4) cull cow price. The summary statistics for the historical values of the 48 price variables are reported in Appendix B-1.

A multivariate empirical distribution was specified as the probability distribution for the monthly price variables in order for @Risk to perform the Monte Carlo simulation. The multivariate empirical distribution was chosen because of the relatively small number of observations for each monthly price variable. As described earlier the distributions for the price variables were specified using data from September 1989 through August 2000. Major changes to the milk price series took place in 1990, therefore, the milk prices before 1990 are really not relevant to what is expected for future milk prices. Because the historical time series used was short, only 11 observations are present for each monthly price variable.

Richardson (1999) provides a description of the multivariate empirical probability distribution. Richardson explains how to incorporate a correlation matrix into an @Risk simulation when the empirical probability distribution is assumed. Other authors have used the empirical distribution when the number of observations is limited. Elberhri and Yonkers (1995) used the empirical distribution when performing a Monte Carlo simulation to determine the impact of BST on milk production.

In defining the parameters for the multivariate empirical distribution @Risk allows for a correlation matrix to be specified. The correlation between each monthly price variable was estimated based on the historical correlation calculated between all 48 of the price variables to be simulated. For example, the correlation between September corn price and October corn price is used in the simulation as well as the correlation between September corn price and November milk price. By specifying a multivariate distribution the relationships that exist between the different price series including the correlations across all of the 48 price variables will also be present in the simulated data the @Risk generates. Appendix B-2 shows the price variable correlations for the data set that are used by @Risk in generating the simulated data set.

Biological Variables

Earlier the data set constructed from the DRMS data set was described. In total 120 observations are available for each monthly stage of lactation milk production variable. Since this is a fairly large number of observations, the monthly biological variables were assumed to follow a multivariate normal distribution. The mean, standard deviation and correlation matrix[11] was specified for the multivariate normal distribution based on the sample statistics calculated. There are a total of 84 biological variables specified in the multivariate normal distribution (daily average milk production for the 1st lactation transition stage, 1st lactation early lactation stage, 1st lactation late lactation stage, mature transition stage, mature early lactation stage, mature late lactation stage and culling rate for all 12 months). Appendix B-1 reports the summary statistic of the historical values for the 84

---

[11] @Risk automatically calculates the covariance matrix for a multivariate normal distribution based on the mean, standard deviation and correlation matrix provided as input.

biological variables. Appendix B-3 shows the biological variable correlations for the data set that are used by @Risk in generating the simulated data set. Appendix B-4 shows the distributions for each stage of lactation and age class. The distributions shown in Appendix B-4 were created by combining all of the monthly distributions into an annual distribution for each stage of lactation. In the simulation, the monthly distributions are used as the basis for performing the simulation.

After specifying the distributions that are used to simulate the variables, @Risk was used to create 1,000 sets each consisting of 10 years of monthly data. Each set of price and biological variables were then input into the Dairy Model to determine the net cash flows for the dairy cooperative in each case.

CHAPTER 4. RESULTS

The simulated price and biological variables were used as inputs in the Dairy Model to calculate the first 10 years of net cash flows to the large-scale closed dairy cooperative for each of the 1,000 iterations that were simulated. From the net cash flows, the corn payments to the cooperative members and the rate of return on the investment made by the cooperative members were calculated. The results were calculated for the three alternative equity levels established for the closed cooperative, 56%, 46% and 40%, and the three assumed production levels, high, medium and low. In addition, the simulation results were used to develop an estimate of the probability that the large-scale closed dairy cooperative would survive under the different equity and production level scenarios.

Probability of Survival

Survival is defined as the cooperative remaining in operation. In order to continue operating, the cooperative must meet all of its cash obligations and maintain solvency criteria specified by creditors. To calculate the probability of the cooperative surviving, it was assumed that the cooperative would have access to a predetermined line of credit. The level of credit that the cooperative can access depends on the initial equity level of the cooperative. Each cooperative draw was allowed to have access to a line of credit such that its total debt level would not exceed 80% of its initial asset value, excluding any working capital the cooperative had initially. It is further assumed that all working capital would be utilized before drawing on a line of credit. During the simulation, if in any month the cooperative would exceed a line of credit that would result in an 80% debt position the iteration was counted as a failed cooperative. The cooperative is forced into bankruptcy as a result of inadequate cash.

In all of the cases examined the cooperative started with total assets of $7,003,400. After the working capital is depleted, the cooperative has total assets of $6,453,400. In the 56% equity level case, the total starting debt is $3,080,600. Applying an 80% debt-to-asset ratio as the criteria for determining the maximum line of credit available, the cooperative can have total debt outstanding equal to $5,180,600. Subtracting the initial level of debt yields a maximum line of credit equal to $2,100,000. Using the same 80% debt-to-assets criteria for determining the line of credit available to the cooperative for the other equity level cases results in a line of credit equal to $1,400,000 available to the cooperative in the 46% equity level case and $1,000,000 available to the cooperative in the 40% equity level case.

The additional initial equity investment by the members allows the cooperative to access a larger line of credit to cover short-term variability in cash flows, and temporary unfavorable price or production conditions. The cooperative with lower capitalization already faces higher debt costs. This represents an additional cash liquidity limitation cooperatives with lower capitalization must face.

The probability of survival was calculated by summing the number of iterations where the cooperative exceeded its available line of credit. The probability of the cooperative failing was calculated by dividing the total number of iterations where the cooperative exceed the available credit by the total number of iterations (i.e. 1,000). The probability of survival is simply one minus the probability failure. The probability of survival was calculated at three time intervals; the first three years, the first five years and the first ten years. Looking at the three different time frames yields insights about when the cooperative will have the most difficult time surviving. The first three years of operation correspond to the startup phase for the cooperative. During this stage of operation the dairy operation is struggling with higher culling rates, more variable monthly cash flows and learning how the new system operates. From the third to fifth year, the dairy operation is approaching a steady state of production, however, it is still saddled with the initial debt incurred to stock the operation with livestock. The fifth year through tenth year gives an indication of how the cooperative will fare once steady state production has been reached. While it is assumed milk production per cow will continue to increase each year, it will not increase as quickly as it increased during the startup phase. During this period the debt on the initial purchase of livestock will be paid off. Tables 4.1, 4.2 and 4.3 show the probability of the large scale-dairy cooperative surviving through the first three years, the first five years and the first ten years, respectively.

Table 4.1. Probability of Cooperative Surviving Through First 3 Years

		Production Levels	
Equity Levels	Low	Medium	High
40%	69.1%	90.7%	99.8%
46%	94.5%	99.6%	100.0%
56%	100.0%	100.0%	100.0%

Table 4.2. Probability of Cooperative Surviving Through First 5 Years

		Production Levels	
Equity Levels	Low	Medium	High
40%	36.1%	77.1%	98.6%
46%	76.8%	95.2%	99.9%
56%	99.2%	100.0%	100.0%

Table 4.3. Probability of Cooperative Surviving Through First 10 Years

	Production Levels		
Equity Levels	Low	Medium	High
40%	33.7%	69.9%	98.5%
46%	65.4%	91.5%	99.9%
56%	97.9%	99.9%	100.0%

Tables 4.1, 4.2 and 4.3 show that increased equity invested by members corresponds to an increased probability of the cooperative surviving regardless of the production level achieved by the cooperative. The importance of increasing the level of equity invested in the cooperative is most significant in the low production case. In the low production case with only 40% equity invested in the cooperative there is only a 33.7% chance that the cooperative will survive through the first 10 years. However, if 56% equity is invested in the cooperative there is a 97% chance that the cooperative will still be operating after the first 10 years. While this result is not surprising, it points out the need for high production if leverage is used. If the cooperative members insist on a low level of equity investment, they must insure a high production level path is achieved by the cooperative or face a significant probability of failure.

In comparing the different time periods shown in Tables 4.1, 4.2, and 4.3, the cooperative stands a reasonable chance of surviving the first 3 years, except when the production level is low and only 40% equity is invested, because of the way the initial financing of the cooperative is structured. It is between year 3 and year 5 of operation that unfavorable outcomes of prices and biological variables along with low production levels start to impact the probability of survival and we see a large percentage of the failures occurring. While, there are outcomes that can cause the cooperative to fail after year 5, once the cooperative reaches year five the probability of failure decreases dramatically in most of the equity and production level cases. The only exceptions are in the cases where the cooperative is well positioned from an equity and production standpoint and only the extreme outliers in prices and biological variables cause a cooperative failure. In these extreme cases. the cooperative faces approximately an equal chance of failure during any stage of operation. This indicates that the failure resulted from an unusually unfavorable combination of price and biological outcomes.

Assuming that a 10% chance of failure is the maximum acceptable risk that cooperative members are willing to undertake, the cooperative will be limited to investing only 40% equity if they can achieve a high production level. If members are willing to invest 46% equity in the cooperative they would be able to meet the 10% criterion in either the medium or high production level cases. Under a 56% equity level of investment the cooperative will be safely below the 10% chance of failure criterion at all three levels of production assumed in this research.

Table 4.4 shows the number of cooperatives that failed in each year for all the production and equity levels. The information reported in Table 4.4 was used to calculate Tables 4.1, 4.2 and 4.3. Table 4.4 shows in most cases the initial financing will provide the necessary cash to remain in operation for the first two years. The exception is when only 40% equity is invested in the cooperative. Generally, years 3 through 5 are when the cooperative faces the greatest risk of failure. After year 8, the probability of failure for the cooperative is reduced dramatically.

Table 4.4. Number of Cooperatives that Failed by Year

	High Production Level			Med. Production Level			Low Production Level		
Year	40%	46%	56%	40%	46%	56%	40%	46%	56%
1	0	0	0	0	0	0	0	0	0
2	0	0	0	8	0	0	46	0	0
3	2	0	0	85	4	0	263	55	0
4	3	0	0	82	30	0	175	103	1
5	9	1	0	54	14	0	81	74	7
6	0	0	0	39	19	0	56	53	3
7	1	0	0	16	13	1	18	39	2
8	0	0	0	16	3	0	17	17	3
9	0	0	0	0	1	0	6	3	3
10	0	0	0	1	1	0	1	2	2
Total Failed	15	1	0	301	85	1	663	346	21
Percent Surviving	98.5%	99.9%	100%	69.9%	91.5%	99.9%	33.7%	65.4%	97.9%

In this research, the production levels are not considered a choice variable for the cooperative. There were no additional capital expenditures associated with the higher production levels. However, increased feed costs were associated with higher production levels. The different production levels are meant to provide a range of possible average production growth paths for the cooperative. This underscores the importance of investing a higher equity level when starting up the cooperative, since there are no assurances that the cooperative will be able to follow the high production level. If the cooperative achieves the higher production levels, leverage can usually be increased through deliberate borrowing if members desire to do so.

Returns from the Cooperative

From the simulated monthly net cash flows of the large-scale dairy cooperative, several measures of the returns to the members from the cooperative are calculated and compared for the different equity levels and production levels. All of the results are reported on a discounted basis to insure that the time value of money is reflected in the calculations. All calculations use a 6% discount rate. The discounted results are reported in 1st year dollars. That is no discounting is applied to the first year cash flows.

As discussed in the previous section, there are iterations in the simulation where the cooperative was unable to continue operating because it exceeded the predetermined line of credit. In reporting the returns from the cooperatives for a particular year, only those cooperative draws that had not exceeded their line of credit in that year (or any previous year) were used in calculating the returns from the cooperative. Once a cooperative exceeded its line of credit, it was removed from the calculation of the returns from the cooperative for that year and all remaining years of the simulation. The 10-year annual average returns are based on the average over the number of years that the cooperative was operating. For example a cooperative that failed in year 5, the 10-year annual average return for that cooperative draw is the average returns over the 4 years that it was operating. This implies that the returns reported ignore any losses incurred by cooperative member's initial investment in a failed cooperative. Since a cooperative doesn't fail until the debt-to-assets ratio reaches 80%, it is unlikely that cooperative members would recover any significant fraction of the their initial cash investment in a failed cooperative. Selling a specialized asset such as a dairy at full book value can be very difficult in a bankruptcy situation. These losses were not calculated into the 10-year cash flows or other returns reported for the cooperative. The returns reported are to be interpreted as the returns from the cooperatives that are in operation at the time.

Net Cash Flows

The first measure of returns from the cooperative reported is the discounted annual net cash flows for the large-scale dairy cooperative. Net cash flows are an important indicator of the returns from the cooperative in that they show the ability of the cooperative to continue to meet all of its cash obligations. Moreover, the value added payment to the members from delivering corn (corn silage) to the cooperative is paid to the members from the annual net cash flows of the cooperative after its cash obligations are met. Net cash flows are defined as follows.

$$\text{Net Cash Flows} = \text{Cash Revenues} - \text{Cash Expenses} \tag{7}$$

Cash Expenses include, operating cash expenses, interest expense, principal payments and the cost of replacement heifers (the initial 1,200 heifers purchased are capitalized). Cash Expenses do not include depreciation expense, but do include appropriate repair and maintenance of fixed assets.

Table 4.5 shows the summary statistics for the discounted annual net cash flows over the first 10 years of operation for the cooperative assuming a medium production level and 56% starting equity level. Table 4.5 also shows the discounted pool of cash the cooperative that would have accumulated over the first 10 years of operation. Stated differently, this is the value of the cash the cooperative would have accumulated if no annual value added payments were made to its members. In addition, the standard deviation of the net cash flows for each year is reported in Table 4.5. The standard deviation provides a measure of the spread or dispersion in the distribution of the net cash flows. A smaller value of the standard deviation suggests that a value close to the mean or expected value is likely. A higher value for the standard deviation implies a larger probability of realizing a net cash flow that is not close to the mean (Freund, 1992). Therefore, for distributions with identical expected values, there is more risk or uncertainty associated with the distribution with a higher standard deviation.

Table 4.5. Discounted Net Cash Flows – Med. Production Level – 56% Equity Level

Year	Expected	St. Dev.	Min	Max	# Failed
1	($103,788)	285,191	($816,021)	$898,088	0
2	($1,634)	293,664	($744,821)	$864,237	0
3	$101,062	291,181	($664,839)	$1,190,855	0
4	$213,649	295,378	($549,862)	$1,155,848	0
5	$237,911	275,671	($452,971)	$1,149,908	0
6	$287,061	274,167	($396,946)	$1,217,667	0
7	$312,058	262,781	($364,755)	$1,088,959	1
8	$390,682	250,625	($255,774)	$1,197,630	0
9	$397,862	246,480	($264,971)	$1,276,138	0
10	$397,737	232,203	($175,072)	$1,148,829	0
Total	$2,231,100	1,014,152	($2,116,526)	$5,137,391	1

In Table 4.5 the "# Failed" column represents the number of iterations during the simulation that a cooperative would be forced out of operation for exceeding its line of credit. In the medium production level case and 56% equity level case there is only one iteration out of the 1,000 iterations performed where the cooperative would be forced out of operation. Table 4.5 shows that the cooperative's annual discounted net cash flows are not expected to be positive until the 3rd year of operation. This is due to the length of time it takes for the milk production of the cooperative to reach a level where the cooperative is able to generate a positive net cash flow. Investing in a large-scale dairy cooperative with relatively high capitalization needs to be viewed as a long-term investment. The cooperative is likely to require several years to reach a steady state level of production and produce favorable returns to the members. The annual discounted net cash flows for the other production and equity level cases can be found in Appendix C-1.

Value Added Payments

From the annual discounted net cash flows of the dairy cooperative, the value added payments to the cooperative members are calculated. The value added payments are made from the net cash returns of the cooperative after all cash expenditures are paid. Before any value added payments are made to members, the line of credit taken out (for working capital) by the cooperative will be paid back. In other words, the "required" working capital will be replenished to the original $550,000 level. This ensures the cooperative is not making value added payments to members by borrowing against the equity invested in the cooperative and that it will maintain an adequate level of working capital. The total returns from the cooperative available to be distributed to the members in the form of value added payments are converted to a $/bushel payment by dividing the total value added payments by the 161,000 bushel of corn delivered to the cooperative by the members.

Table 4.6 shows the discounted expected value added payments to members ($/bu.) along with the standard deviation for the value added payments. Also included in Table 4.6, is the discounted expected total corn price received from the cooperative by members (delivery payment + quarterly payments + value added payment), the discounted expected market corn price and the discounted expected premium that members receive from the cooperative over the market corn price for the medium production level and 56% equity level case. Table 4.6 also reports the standard deviation for the all the discounted corn prices reported. Appendix C-2 reports the information in Table 4.5 for the other production level and equity cases.

The difference between the expected local market corn price and the total corn price received from the cooperative is the $/bu. premium that members receive by investing in the cooperative. Calculating the benefit from the cooperative as the corn price premium accounts for the opportunity cost of joining the cooperative because the cooperative caps its quarterly and delivery price paid to the members at $3.00/bu. In the simulation, there are times when the market price drawn exceeds the $3.00/bu cap. In these cases, members receive a combined delivery price and quarterly payment price that is less than the market price of corn. Members incur an opportunity cost by delivering the corn to the cooperative since the delivery payment and quarterly payments from the cooperative will be less than the price members could have received if they had sold their corn in the market. This occurs because members have committed to delivering their corn to the cooperative.

As described above, by capping the combined delivery and quarterly payment price at \$3/bu, members may receive a lower price from the cooperative compared to the local market price. However, the value added payment to the members will be higher than if the delivery payment and quarterly payment prices were not capped. To determine the returns from the cooperative, the difference between the total corn price from the cooperative and the market price is calculated. Using just the value added payment from the cooperative, the opportunity to sell into a higher priced market will be ignored and the benefit from joining the cooperative will be overstated in draws where the market price exceeds \$3/bu. Members will be receiving a higher value added payment but a lower corn price from the cooperative. A portion of the value added payment paid by the cooperative includes the difference between the market price and the combined delivery and quarterly payments.

As seen in Table 4.6, members can expect a discounted 10-year average premium of \$1.39/bu. from corn delivered to the cooperative over what they would have received selling their corn into the local market. This is a substantial premium over delivering the corn directly into the local market. Table 4.6 shows that the premium the members received from the cooperative is fairly low during the initial years of operation. This, once again, emphasizes the longer-term nature of this type of investment.

In Table 4.6, all of the values are discounted. The discounting was applied after the nominal returns from the cooperative were calculated. In the simulation, the expected nominal market corn price is \$2.36/bu. in each year. The discounted market corn price shown in Table 4.6 is used to show what portion of the discounted total corn price from the cooperative is in excess of what members would have received on a discounted basis from delivering corn at a local market.

Table 4.6. Discounted Expected Corn Payments from Cooperative – Medium Production Case – 56% Equity Level (Standard Deviation in Parentheses)

Year	Discounted Value Added Payment		Discounted Corn Price from Cooperative		Discounted Market Corn Price		Discounted Premium	
1	$0.45	(0.888)	$2.76	(0.940)	$2.36	(0.382)	$0.40	(0.898)
2	$0.48	(0.962)	$2.66	(0.940)	$2.22	(0.366)	$0.44	(0.966)
3	$0.64	(1.114)	$2.69	(1.133)	$2.10	(0.343)	$0.60	(1.125)
4	$1.02	(1.408)	$2.96	(1.428)	$1.98	(0.324)	$0.98	(1.416)
5	$1.22	(1.449)	$3.05	(1.472)	$1.87	(0.303)	$1.18	(1.452)
6	$1.58	(1.596)	$3.30	(1.597)	$1.76	(0.288)	$1.54	(1.606)
7	$1.78	(1.554)	$3.41	(1.570)	$1.66	(0.273)	$1.74	(1.558)
8	$2.27	(1.551)	$3.80	(1.575)	$1.57	(0.256)	$2.23	(1.549)
9	$2.42	(1.517)	$3.86	(1.532)	$1.48	(0.232)	$2.38	(1.516)
10	$2.44	(1.446)	$3.81	(1.458)	$1.39	(0.227)	$2.41	(1.447)
Average	$1.43	(0.592)	$3.23	(0.592)	$1.84	(0.098)	$1.39	(0.596)

Return on Investment

The returns in Table 4.6 provide the premium the cooperative members are expected to receive for corn they deliver to the cooperative. However, members have to invest a substantial amount of equity to receive that premium. In the 56% equity level case, members need to contribute $24,365 per share in the cooperative, which entitles them to deliver 1,000 bu. of corn or an equivalent quantity of corn silage to the cooperative. Therefore, the rate of return on the investment (ROI) made by the members is calculated from the premium the members receive for their corn delivered to the cooperative over what they would have received selling their corn into the market. The ROI calculation allows members to compare the investment in the large-scale dairy cooperative with other potential investment opportunities.

In order to calculate the annual ROI, the total annual premium that all of the cooperative members received in the form of a increased corn price from the cooperative compared to the market corn price for corn delivered to the cooperative was divided by the required equity that members invested in the cooperative to earn it. The discounted annual ROI is calculated using a 6% discount rate. This occurs as a consequence of discounting the net cash flows as described earlier. Equation (8) specifies how the discounted annual ROI is calculated.

$$ROI = ((TCP - MCP) * 161{,}000 \text{ bu.}) / \text{Total Equity} \qquad (8)$$

Where

TCP = the discounted total corn price paid to the cooperative members,

MCP = the discounted market corn price for the year,

161,000 bu = the number of bushels of corn delivered to the cooperative by members.

Total Equity = to the initial total equity contribution by members in the cooperative. The Total Equity is equal to $3,922,800 in the 56% equity level case, $3,211,640 in the 46% equity level case and $2,796,760 in the 40% equity level case.

Table 4.7 reports average expected annual discounted ROI, the standard deviation for the discounted annual ROI, along with the minimum and maximum ROI for the 1,000 iterations performed in the simulation. Table 4.7 also shows the 10-year average of the expected annual discounted ROI and the standard deviation of the 10-year average of the annual discounted ROI. The results shown in Table 4.7 for the other production level and equity level cases can be found in Appendix C-3.

The minimum returns shown in Table 4.7 are the result of the cooperative having a negative cash flow for the year. This implies no value added payments are made to the members. In addition, in some draws the members receive a lower corn price from the cooperative than they would have from the local cash market, because the delivery and quarterly corn payments are capped at $3/bu. As seen in Table 4.7 the expected returns on

Table 4.7. Annual Discounted Rate of Return on Investment – Medium Production Case – 56% Equity

Year	Expected Rate of Return	Standard Deviation	Minimum	Maximum
1	1.65%	3.69%	-2.52%	22.90%
2	1.80%	3.96%	-2.38%	21.76%
3	2.44%	4.62%	-2.24%	28.17%
4	4.03%	5.81%	-2.12%	29.10%
5	4.86%	5.96%	-2.00%	29.38%
6	6.32%	6.59%	-1.88%	31.04%
7	7.16%	6.40%	-1.78%	27.76%
8	9.17%	6.36%	-1.42%	30.53%
9	9.79%	6.22%	-1.12%	32.45%
10	9.90%	5.94%	-0.87%	29.29%
Average	5.71%	2.44%	-0.43%	13.09%

the investment made by the cooperative members are quite low for the first three years as the dairy operation is building up to a steady state level.

The ROI shown in Table 4.7 does not include the equity losses from cooperatives that are forced out of operation because they have exceeded their line of credit limit. The equity lost is insignificant in the medium production and 56% equity level case shown in Table 4.7. Since, in this case only 1 iteration had a cooperative failure. The results for ROI reported in Table 4.7 represents the actual ROI from cooperatives that are in operation during each year reported. This is important to remember when looking at the results in Appendix C-3. Since in several equity levels and production levels combinations, there is a high probability the cooperative may not be in operation by the end of the 10 years. In those cases where the cooperative is forced out of operation, members stand to lose a large percentage of the equity they had invested in the cooperative when the cooperative's assets are liquidated.

Figure 4.1 graphs the distribution of the 10-year average of discounted annual return on investment to the members for the medium production and 56% equity level case. The 10-year average of the discounted annual ROI in this case take on approximately a normal shaped distribution with the center of the distribution at the mean of 5.7%. Appendix C-4 shows the graphs of the distribution of the 10-year average of discounted annual ROI for the other 8 production and equity level combinations that were examined.

Different Equity Levels

In order to help determine the optimal initial level equity level cooperative members should invest in the cooperative, different equity levels were examined. As discussed earlier three equity levels (40%, 46% and 56%) were analyzed. The ultimate equity level the cooperative members decide to use when forming the cooperative will depend on the

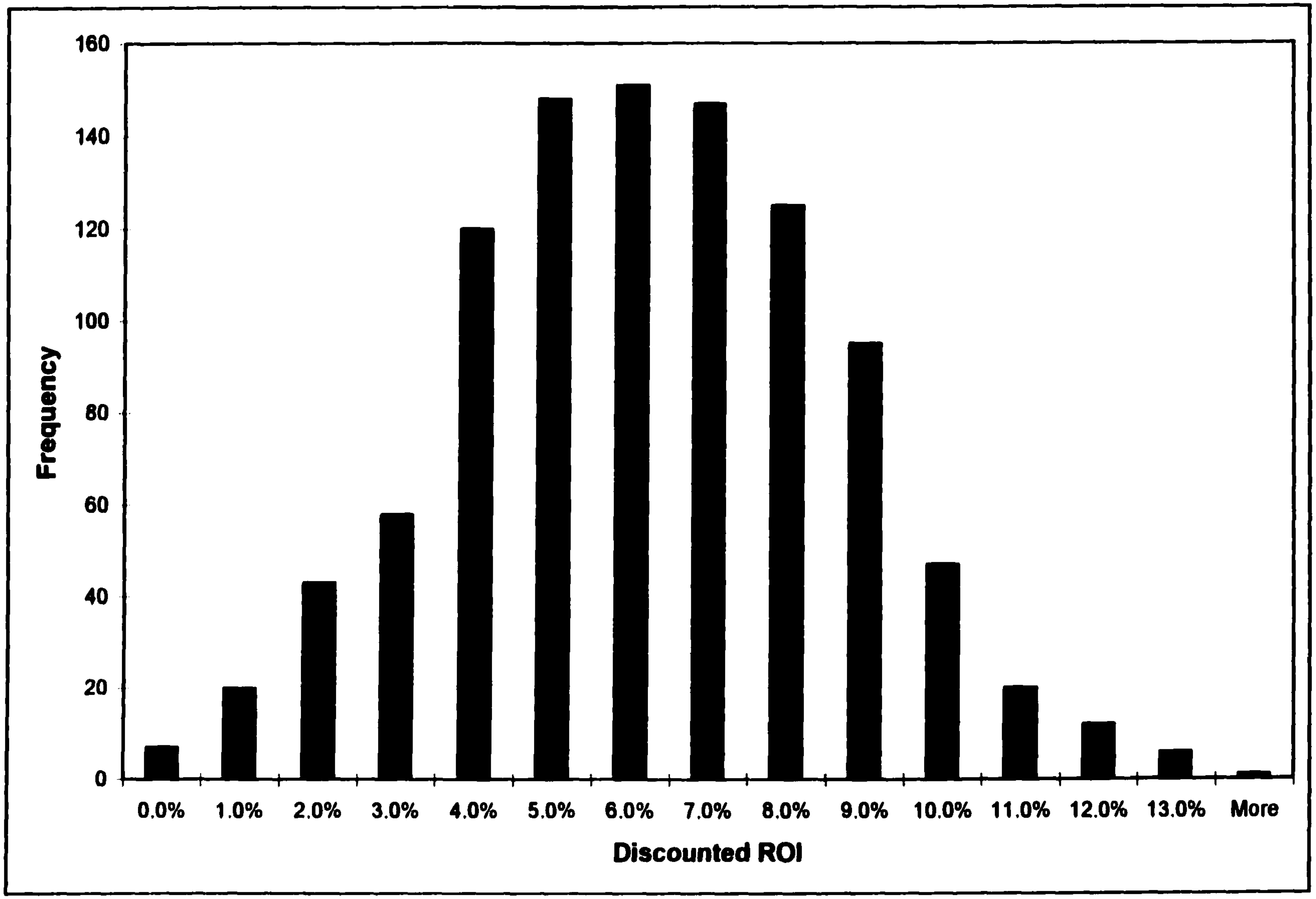


Figure 4.1. 10-Year Average of Discounted Annual ROI - Medium Production - 56% Equity

collective risk preferences of the individual cooperative members forming the cooperative. The results in this section allow farmers planning to invest in a large-scale closed dairy cooperative with the risk reward trade offs for the different equity level contributions.

Table 4.8 reports the expected discounted pool of cash the cooperative would have accumulated over the first 10 years of operation if no value added payments were made for the different production levels and equity levels. The standard deviation for the accumulated cash from the cooperative is also shown for the different cases. The importance of achieving a high level of production can be seen from the expected discounted accumulated cash. In the low production case only when 56% equity is invested in the cooperative does the cooperative even accumulate a positive level of cash after the first 10 years. When the high

Table 4.8. 10-Year Discounted Accumulated Cash for Different Equity and Production Levels

Case	Expected 10-Year Discounted Accumulated Cash	Standard Deviation
High Production – 56% Equity	$4,242,132	1,038,045
High Production – 46% Equity	$3,474,202	1,059,040
High Production – 40% Equity	$3,038,647	1,143,629
Medium Production – 56% Equity	$2,231,100	1,014,152
Medium Production – 46% Equity	$1,305,525	1,245,175
Medium Production – 40% Equity	$645,124	1,378,618
Low Production – 56% Equity	$892,948	1,107,676
Low Production – 46% Equity	($160,976)	1,202,994
Low Production – 40% Equity	($552,254)	930,649

production level is achieved, under all equity levels, the expected discounted accumulated cash is over $3,000,000. In addition, the impact of the different equity levels can be seen for each of the production levels. Increased equity levels reduce debt costs incurred by the cooperative. This is true for both the initial debt cost and the added debt in the line of credit, which is drawn on more frequently in the low equity cases. Debt from both these sources adds initial expense and reduces the level accumulated cash. Absence of this debt results in higher levels of accumulated cash for the higher equity levels. The tradeoffs associated with the increased initial expense to the farmers when starting up the cooperative with a higher equity level will be examined later with the return on investment calculation for the different equity levels.

Table 4.9 reports the average discounted corn price premium that members can expect over the first 10 years along with the standard deviation of the corn price premium. These results mirror the results from the discounted accumulated cash with higher equity levels and higher production levels leading to higher corn price premiums from the cooperative. However it may be useful to some potential investors to examine the cash flows in terms of premiums on corn prices.

Table 4.10 shows the discounted expected annual ROI over the first 10 years of operation for the different equity and production levels. The standard deviation of the 10-year average of the discounted annual ROI is also reported. By reporting the standard deviation of the 10-year average of the discounted annual ROI, the implicit assumption is that farmers looking to invest in the cooperative are concerned about the risk over a longer time horizon and not as concerned about the annual variability in their returns.

Table 4.9. 10-Year Average of Corn Price Premium from the Cooperative for Different Equity and Production Levels

Case	10-Year Average of Discounted Corn Premium	Standard Deviation
High Production – 56% Equity	$2.60	0.643
High Production – 46% Equity	$2.41	0.644
High Production – 40% Equity	$1.88	0.664
Medium Production – 56% Equity	$1.39	0.596
Medium Production – 46% Equity	$0.92	0.593
Medium Production – 40% Equity	$0.64	0.596
Low Production – 56% Equity	$0.68	0.520
Low Production – 46% Equity	$0.30	0.417
Low Production – 40% Equity	$0.14	0.330

As seen in Table 4.10, the discounted expected ROI depends heavily on the production level. This emphasizes the extreme importance that must be placed on managing the dairy operation for a high production level. The returns from the low production case are such that forming a large-scale closed cooperative dairy makes little economic sense regardless of the initial investment in equity given the risk associated.

For the medium production level cases, the discounted expected rate of return on investment for the cooperative members is such that investing in a large-scale closed dairy cooperative is still worth considering. An interesting result in the medium production cases is that increasing the initial equity level increases the discounted expected returns and lowers

Table 4.10. 10-Year Average of Discounted Annual ROI for Different Equity and Production Levels

Case	10-Year Average of Discounted Expected Annual ROI	Standard Deviation of 10-year average annual ROI
High Production – 56% Equity	10.69%	2.64%
High Production – 46% Equity	10.72%	3.23%
High Production – 40% Equity	10.85%	3.82%
Medium Production – 56% Equity	5.71%	2.44%
Medium Production – 46% Equity	4.62%	2.97%
Medium Production – 40% Equity	3.66%	3.43%
Low Production – 56% Equity	2.78%	2.14%
Low Production – 46% Equity	1.48%	2.09%
Low Production – 40% Equity	0.80%	1.90%

the standard deviation of the returns. Stochastic Dominance Efficiency Criteria were applied to determine if a preferred equity level for forming the cooperative could be found. The First Order Stochastic Dominance criteria could not determine an optimal ranking of the equity contribution levels. The Second Order Dominance could rank the initial equity levels. The 56% equity level case dominated the 46% equity level case. which dominated the 40% equity level case. The same ranking of beginning equity levels was obtained when a Mean-Variance Efficiency Criteria was applied.

For the high production level cases, the three efficiency criteria (First Order Stochastic Dominance, Second Order Stochastic Dominance and Mean-Variance) could not classify any of the three starting equity levels as an inefficient choice. In the high production level cases, increasing the level of starting equity, decreased the expected ROI and reduced the standard deviation of the returns. Therefore, there is a classic risk reward trade-off that can only be answered by the individual based on their risk preference. While the three efficiency criteria could not distinguish among the three equity levels, it does appear that the increase in expected annual ROI of 0.16% when going from 56% equity to 40% equity is associated with a considerable amount of risk. The increase in standard deviation is 1.18%. This is a considerable increase in variation for the increase in expected ROI. However, the ultimate decision under the high production case would be up the individuals and their collective risk tolerances. In practice, it may come down to a question of whether or not the additional equity can be raised.

CHAPTER 5. SURVIVAL MODEL

Background

In order to assess the impact of economic and biological variables on the expected probability that the cooperative will fail, a logistic probability model was estimated. By assessing the impact of variables on the probability of failure, farmers who are considering forming a closed dairy cooperative have another key piece of data to assess the risk of the operation they plan to form. The results of this estimation will also provide farmers considering a closed dairy cooperative with critical levels for several variables important to the cooperative's success. The use of these variables permits a group to match their risk tolerances to the risk of failure with more precision.

It is very difficult to obtain actual financial and biological data on a significant number of failed dairy operations under any form of organization. Therefore, the estimates for the closed dairy cooperative derived from the simulated data can be very useful in assessing the probability of failure for a large-scale dairy operation. Moreover, the risks are likely to be applicable for firms other than cooperatives. The variables examined would provide useful information for a dairy organized under any business structure. The key to survival for any business structure is the ability of the dairy operation to meet its cash obligations while meeting the solvency criteria imposed by lenders. The solvency restrictions used in this model (an 80% debt-to-asset restriction) would be a reasonable solvency restriction for any dairy operation business structure.

Caution must be used when applying the results for the corn price variable to large-scale dairy operations with different business structures. In the cooperative model used here the corn payment to members was capped at $3/bu. This could distort the effect high corn prices might have on the probability of failure when the large-scale dairy operation is actually exposed to corn prices above $3/bu. In order to make the corn price results applicable to other business structures, dairy operators would need to purchase some type of financial hedge to protect themselves from corn price spikes above the $3.00/bushel level. In many cases an option could be purchased at a reasonable price.

The data generated from the medium production level simulations were used to estimate the parameters of the logit model. The data set consisted of 3,000 observations. There are 1,000 observations for each starting equity level (40% equity, 46% equity and 56% equity). When the cooperative exceeded its predetermined line of credit as described in Chapter 4, the cooperative was counted as a failed cooperative. The dependent variable in each case was assigned a "0" if the cooperative survived for the first five years and "1" if it failed during the first 5 years. Of the 3,000 observations, a total of 277 failed cooperatives are observed in the data set during the first 5 years of operation.

Logit Function

This section provides an overview of the derivation of the logit model and follows the work of McConnon (1989). Greene (1993) provides a similar description of the logit model as well as a complete set of references for the derivation of the logit model.

Consider a set of N independent, binary random events

$Y_1, Y_2, \ldots, Y_N$ where,

$Y_i = 1$ if the ith event occurs, and

$Y_i = 0$ if the ith event does not occur

Define,

$$P_i = \text{Prob}(Y_i = 1) \tag{9}$$

$$1 - P_i = \text{Prob}(Y_i = 0) \tag{10}$$

Assume the value of P_i for the ith event is related to a vector of explanatory variables

$$X_i = [X_{1i,} X_{2i,\ldots,} X_{qi}] \tag{11}$$

For the ith event we observe

$$(Y_i, X_{1i}, X_{2i}, \ldots, X_{qi}) \text{ where } i = 1, 2, \ldots, N \tag{12}$$

Suppose the conditional probability that the event occurs under conditions specified by (X_{1i}, X_{2i}, . . ., X_{qi}) can be expressed as

$$P_i = F(\beta' X_i) \tag{13}$$

Where

P_i = the true conditional probability that the event will occur

F = a cumulative distribution function

B = q x 1 vector of fixed parameters

X_i = q x 1 vector of explanatory variables

Now consider the logistic cumulative distribution function

$$F(U) = \frac{\exp(U)}{1 + \exp(U)} \tag{14}$$

Setting $U = \beta' X_i$

$$P_i = F(\beta' X_i) = \frac{\exp(\beta' X_i)}{1 + \exp(\beta' X_i)} = [1 + \exp(-\beta' X_i)]^{-1} \tag{15}$$

and

$$1 - P_i = 1 - F(\beta' X_i) = \frac{\exp(-\beta' X_i)}{1 + \exp(-\beta' X_i)} = [1 + \exp(\beta' X_i)]^{-1} \tag{16}$$

Estimate

$$P_i = [1 + \exp(-\beta' X_i)]^{-1} \qquad (17)$$

To estimate the marginal effect of X_{iq} on P_i the derivative of P_i with respect to X_{iq} is calculated to be

$$\frac{\partial P_i}{\partial X_{iq}} = \frac{\exp(\beta' X_i)}{[1 + \exp(\beta' X_i)]^2} * \beta_q \qquad (18)$$

As seen in equation 5.10 the marginal effect of X_{iq} on P_i is not constant but varies depending on the value of X_i.

Model Estimated

The following model was estimated to determine the impact of several variables on the probability that the large-scale dairy cooperative failed during the first 5 years of operation.

$$P_i = [1 + \exp(-\beta' X_i)]^{-1} \qquad (19)$$

where:

P_i = the conditional probability that large-scale closed dairy cooperative i will fail

$\exp(\beta' X_i)$ = the constant e ($e \approx 2.718$) raised to the power $\beta' X_i$

$\beta' X_i = \beta_0 + \beta_1 SEQU + \beta_2 MPRO + \beta_3 CULL + \beta_4 MILK + \beta_5 CORN$

β_i = coefficients to be estimated

SEQU = starting equity level as percentage of initial total assets of the cooperative

MPRO = average annual milk production per cow in lbs of milk

CULL = average annual culling rate for the herd (including death losses)

MILK = average annual milk price

CORN = average annual market corn price

The average values for the independent variables defined above are the average value over the years that the cooperative was in operation. For example in a cooperative that survived the first 5 years, the average was taken over the first 5 years. For a cooperative that failed in year 3, the average was taken over the first two years. The reason year 3 was not included in the average is that most of the failures occurred on the first month of the fiscal year (September) when the corn delivery payment at the Posted County Price was due. Therefore, the observed independent variables in the year that the cooperative failed have little impact on the probability of failure.

The parameters for the logit model in Equation (19) were estimated using TSP4.4. TSP4.4 utilizes Newton's method to maximize the log likelihood function with respect to the parameter vector β. The estimated coefficients of the logit model can be interpreted in the same manner they would be interpreted in a multiple linear regression equation, where the dependent variable is $\ln[P_i / (1 - P_i)]$ and where P_i is the conditional probability of failure defined in Equation (19). Therefore, the coefficient of an independent variable of the logit model can be interpreted as the change in the logarithm of the odds ratio associated with a one unit change in the independent variable, ceteris paribus. In order to assess the impact of a change in the value of an independent variable, ceteris paribus, on the conditional probability of failure, Equation (18) must be employed.

Results

The results from estimating the large-scale closed dairy cooperative failure model using the logit regression model are presented in Table 5.1. The estimated coefficients are expressed in terms of the outcome of insolvency or failure. Each coefficient estimates the marginal effect on the conditional probability that the large-scale closed dairy cooperative will become insolvent during the first 5 years of operation relative to the effect on the probability that the large scale closed dairy cooperative will not become insolvent during the first 5 years of operation. The asymptotic standard errors and associated t-statistics are also reported in Table 5.1.

Overall the logit model estimated had a significant level of explanatory power. The likelihood ratio statistic, which can be used to test the hypothesis that all β's are equal to zero (except the β_0 for the constant term), was significant at the 0.01 level. Thus the hypothesis that all of the β's are equal to zero is rejected. Collectively, the independent variables specified in the model have a significant level of explanatory power for the variation in the observed variation in the log odds ratio.

All of the estimated coefficients in the model individually were statistically significant at the 0.01 level as determined by the t-statistic. The estimated coefficients

Table 5.1. Parameter Estimates from Logit Failure Model

Independent Variable	Estimated Coefficient	Estimated Standard Error	Estimated t-statistic
Constant	115.199	9.0812	12.685**
SEQU	-51.610	5.597	-9.221**
MPRO	-0.291E-02	0.230E-03	-12.643**
CULL	29.929	5.996	4.992**
MILK	-3.584	0.371	-9.668**
CORN	2.307	0.755	3.055**

** Significant at the 0.01 level

had the expected sign. The estimated coefficients for starting equity level, milk production, and milk price had the expected negative signs, which implies higher values for these variables decreased the probability of the large scale closed dairy cooperative failing. The estimated coefficients for the culling rate and corn price had the expected positive sign, which implies higher values for these variables increased the probability of the large scale closed dairy cooperative failing.

In order to assess the impact of a change in one of the independent variables on the conditional probability of failure, ceteris paribus, equation 5.10 was used. As discussed earlier, the marginal effect of the independent variables in the logit model is not constant and must be calculated at selected levels of the other independent variables. The marginal effect of each independent variable on the conditional probability of failure is shown in Table 5.2.

In Table 5.2 the marginal effect of each of the independent variables of the logit model is calculated at the overall means for each of the other independent variables. The marginal effect can be interpreted as the change in the conditional probability of failure associated with a one unit change in the independent variable away from its mean while holding the remaining independent variables constant at their mean values.

The marginal effect of SEQU is estimated to be –0.0448. This implies that an increase (decrease) in SEQU of .01 from its mean value is associated with a decrease (increase) in the conditional probability of the closed dairy cooperative failing by 0.000448. The marginal effect of MPRO was estimated to be -0.00000253. This implies that an increase (decrease) in MPRO of 1,000 lbs from its mean value is associated with a decrease (increase) in the conditional probability of the closed dairy cooperative failing by 0.00253. The marginal effect of CULL was estimated to be 0.0260. This implies that an increase

Table 5.2. Marginal effect of each independent variable on the conditional probability of failure evaluated at the mean of all independent variables

Independent Variable	Estimated Coefficient	Overall Sample Mean	Marginal Effect
Constant	115.199**		
SEQU	-51.610**	0.473	-0.0448
MPRO	-0.291E-02**	22495.672	-0.253E-05
CULL	29.929**	0.356	0.0260
MILK	-3.584**	13.495	-0.00311
CORN	2.307**	2.357	0.00200

** Significant at 0.01 level.

(decrease) in CULL of .01 from its mean value is associated with an increase (decrease) in the conditional probability of the closed dairy cooperative failing by 0.000260. The marginal effect of MILK was estimated to be -0.00311. This implies that an increase (decrease) in MILK of $1/cwt. from its mean value is associated with a decrease (increase) in the conditional probability of the closed dairy cooperative failing by 0.00311. The marginal effect of CORN was estimated to be 0.00200. This implies that an increase (decrease) in CORN of $1/bu from its mean value is associated with an increase (decrease) in the conditional probability of the closed dairy cooperative failing by 0.00200.

When evaluated at the mean of all the independent variables, each individual independent variable has a fairly small marginal impact on the probability of failure. One way to interpret these results is at the average values for all of the independent variables, the probability of failure is not impacted to a large degree by a marginal change in any one of the independent variables. Stated differently, if the cooperative has average performance for the independent variables, the large-scale closed dairy cooperative is quite insulated from the possibility of failure.

The marginal effects of the individual independent variables can be calculated for any level for an independent variable not just the mean. It is useful to calculate the marginal effects on the conditional probability of failure for each of the independent variables as a means to evaluate decisions or performance will affect probability of failure. For example, this technique can be used to evaluate a hypothesized leverage decision such as SEQU set equal to 0.40 (starting equity = 40%). SEQU is a choice variable that is determined when the large-scale closed dairy cooperative is formed. In forming a value-added business, or any business for that matter, investors typically try to invest as little equity as feasible. Table 5.3 shows the marginal effects on the conditional probability of failure evaluated at SEQU set to 0.40 with all the values of the other independent variables fixed at their means.

The following describes the marginal effect of the independent variables on the conditional probability that the large-scale dairy cooperative fails evaluated at SEQU equal to 0.4 and the other independent variables equal to their respective means. The marginal effect of SEQU is estimated to be –1.832. This implies that an increase (decrease) in SEQU of .01 from its mean value is associated with a decrease (increase) in the conditional probability of the closed dairy cooperative failing by 0.01832. The marginal effect of MPRO was estimated to be -0.000103. This implies that an increase (decrease) in MPRO of 1,000 lbs from its mean value is associated with a decrease (increase) in the conditional probability of the closed dairy cooperative failing by 0.103. The marginal effect of CULL was estimated to be 1.0624. This implies that an increase (decrease) in CULL of .01 from its mean value is

Table 5.3. Marginal effect of each independent variable on the conditional probability of failure evaluated at SEQU equal to 0.4

Independent Variable	Estimated Coefficient	Level Used to Calculate Marginal Effect	Marginal Effect
Constant	115.199**		
SEQU	-51.610**	0.400	-1.832
MPRO	-0.291E-02**	22495.672	-0.103E-03
CULL	29.929**	0.356	1.062
MILK	-3.584**	13.495	-0.127
CORN	2.307**	2.357	0.0819

** Significant at 0.01 level.

associated with an increase (decrease) in the conditional probability of the closed dairy cooperative failing by 0.010624. The marginal effect of MILK was estimated to be -0.1272. This implies that an increase (decrease) in MILK of $1/cwt. from its mean value is associated with a decrease (increase) in the conditional probability of the closed dairy cooperative failing by 0.1272. The marginal effect of CORN was estimated to be 0.0819. This implies that an increase (decrease) in CORN of $1/bu. from its mean value is associated with an increase (decrease) in the conditional probability of the closed dairy cooperative failing by 0.0819.

Evaluated at SEQU equal to 0.4 (starting equity = 40%), the marginal effects of the independent variables on the conditional probability that the large-scale dairy cooperative fails are considerable higher than when SEQU is evaluated at its mean which is equal to 0.47. This implies that when the cooperative is started up with the lower level of equity the probability of failure is much more sensitive to marginal changes in the value of the other independent variables around their mean values. Starting the cooperative with a lower level of equity therefore puts the cooperative at a higher risk of failing in the event there is an adverse move (away from the mean) for any of the other independent variables examined.

Predictive Equation

Information provided by the marginal effects reported above is useful but logit can provide additional useful information. The results from the logit estimation can be used to as a predictive model to for the probability of failure by those considering investing in a large-scale closed dairy cooperative, or any other large-scale dairy operation with a different business structure. By replacing β in Equation (19) with the estimated $\hat{\beta}$, shown in Table 5.1, the resulting equation can be used as predictive equation to obtain the probability of failure for any large-scale dairy operation based on the specific values for the independent variables that the operation is facing. Equation (20) shows the resulting predictive equation.

$$P_i = \left[1 + \exp(-\hat{\beta}'X_i)\right]^{-1} \qquad (20)$$

where:

P_i = the conditional probability that large-scale closed dairy cooperative i will fail

$\exp(\hat{\beta}' X_i)$ = the constant e ($e \approx 2.718$) raised to the power $\hat{\beta}' X_i$

$\hat{\beta}'X_i = 115.199 - 51.610{*}\text{SEQU} - 0.00291{*}\text{MPRO} + 29.929{*}\text{CULL} - 3.584{*}\text{MILK}$

$+ 2.307{*}\text{CORN}$

Using Equation (20), Figures 5.1 – 5.4 were created to graph the impact on the conditional probability of failure over a range of each independent variable, holding the other independent variables held constant at their means. In addition a graph is shown for the conditional probability of failure for a range of each independent variable with all other variables at their mean and SEQU = 0.4 (starting equity = 40%). This allows potential investors to evaluate the impact of starting the operation with a low level of equity more precisely. It shows the impact on the probability of failure for each of the other independent variables when SEQU = 0.4 and SEQU equal to its mean (0.47). In all cases, the values for each of the other independent variables will need to take on a more favorable outcome when a lower equity level is used to allow the cooperative to remain a the same probability of failure as when the starting equity level is at its mean. While this is not a surprising result, the graphs quantify the outcome for each of the independent variables necessary to achieve the same probability of failure under both starting equity levels.

Figure 5.1 shows the graph of the conditional probability of failure for varying levels of annual milk production per cow evaluated with the other variables held constant at their means. Figure 5.1 also shows the graph of the conditional probability of failure for varying levels of annual milk production per cow evaluated with the other variables held constant at their means and SEQU established at 40%. The means of the independent variables can be found in Table 5.2. Figure 5.1 shows that with all other independent variables evaluated at their mean levels the probability of failure approaches 0 when annual milk production exceeds 22,000 lbs of milk per cow. Annual milk production per cow must exceed 23,500 lbs when the starting equity is equal to 40% to reduce the probability of failure to a level that approaches 0. If the large-scale dairy cooperative is going to start with a low level of equity, annual milk production per cow will have to be approximately 1,500 lbs higher to achieve the same predicted probability of failure for the operation as one that started with 47% equity, assuming all of the other variables are at their mean levels.

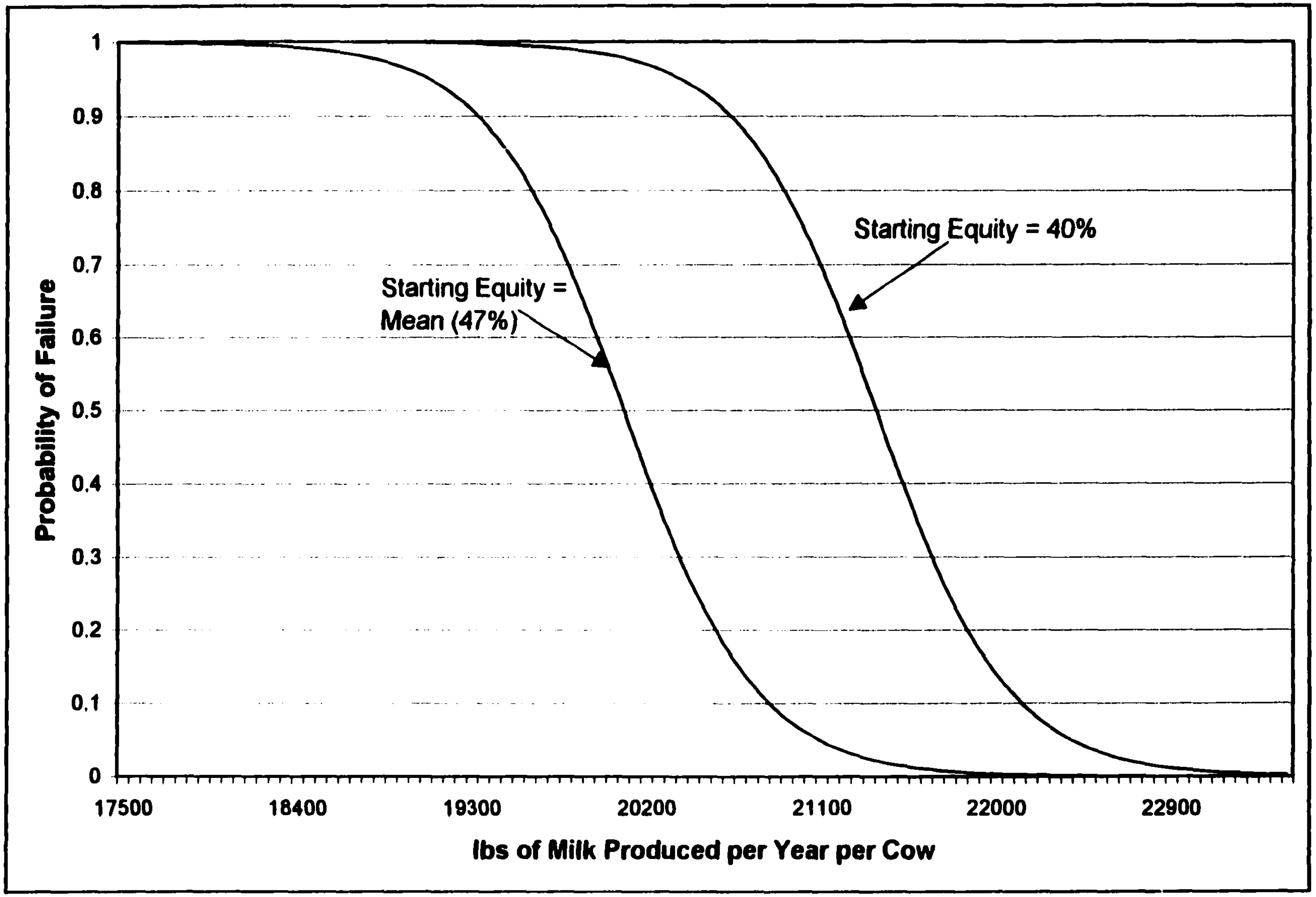


Figure 5.1. Projected Probability of Failure with Varying Levels of Milk Production per Cow All Other Variables at Their Means (SEQU = 0.4)

Figure 5.2 shows the graph of the conditional probability of failure for varying levels of annual culling rate evaluated at the means of the other variables. In addition, Figure 5.2 shows a graph of the conditional probability of failure for varying levels of annual culling rate evaluated the means of the other variables and at SEQU = 0.4 (40% starting equity). The conditional probability of failure for different levels of culling rate is very sensitive to the initial level of starting equity. Using a 10% probability of failure as a reference point and setting starting equity equal to its mean value (47%), the annual culling rate can be as high as 52% without exceeding the predicted probability of failure level of 10%. When starting equity is reduced to 40%, the culling rate must be below 39% to have the predicted probability of failure standard of less than 10%. The increased starting equity provides a significant level of protection for the operation from a failure caused by higher culling rates if it is assumed that all of the other values are fixed at their mean levels. Operations expecting to have a high culling rate (> 40%) and a low level of starting equity (40%) will need to achieve a higher than average level of milk production (or face a market with higher than average milk price, or lower than average corn price) otherwise they will face a high probability of failure.

Figure 5.3 shows the graph of the conditional probability of failure for varying levels of milk price with the other variables evaluated at their means. A graph of the conditional probability of failure for varying levels of milk price with the other variables evaluated at their means and starting equity set to 40%, is also shown in Figure 5.3. The predicted probability of failure approaches 0 for a milk price of $13.10/cwt with all other variables evaluated at their mean. If the starting equity is reduced to 40% a milk price of $14.10/cwt is needed before the probability of failure approaches 0 (with the other variables

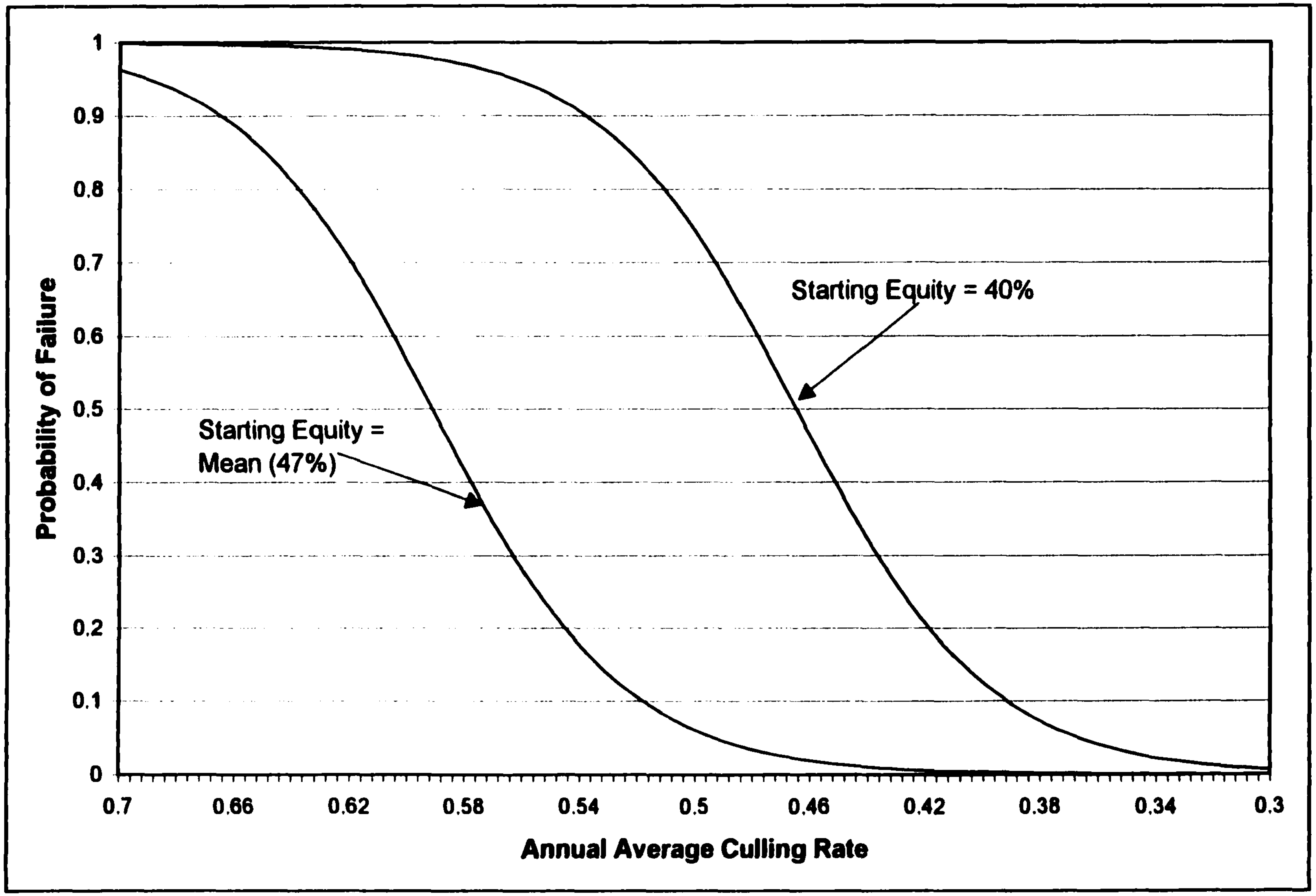


Figure 5.2. Projected Probability of Failure with Varying Levels of Culling Rate All Other Variables at Their Means (SEQU = 0.4)

held constant at their mean levels). The increased equity clearly provides protection against lower than average milk prices. The average milk price was $13.50/cwt. Therefore, starting with a 40% equity level the operation requires a higher than average milk price before the probability will approach 0, unless the other variables perform at better than their mean levels.

Figure 5.4 shows the graph of the conditional probability of failure for varying levels of corn price with all other variables evaluated at the means of the other variables. Figure 5.4 also shows the graph of the conditional probability of failure for varying levels of corn price with the other variables evaluated at their means and starting equity set to 40%. While the other independent variables discussed above apply regardless of business structure used by the dairy operation, corn price is somewhat different. The cooperative structure capped the corn payments to members at $3.00/bu to protect the balance sheet and assure lenders that equity would not be withdrawn through high corn prices. It should be noted that any operation could hedge its corn prices to achieve the same effect, however, the associated cost of hedging would not be accounted for in this analysis. Figure 5.4 shows that at $3.00/bu, the large-scale dairy cooperative faces approximately a 0 probability of failure when all of the other variables are at their means. When the starting equity is reduced to 40%, the predicted probability of failure increases to 15% at the $3.00/bu corn price.

There are three graphs shown in Figure 5.5. The middle graph is the predicted probability of failure for the large-scale dairy cooperative for varying levels of starting equity with the other independent variables fixed at their means. The graph on the far left shows the predicted probability of failure for the large-scale dairy cooperative for varying levels of starting equity with the other variables fixed at a value that is one standard deviation away

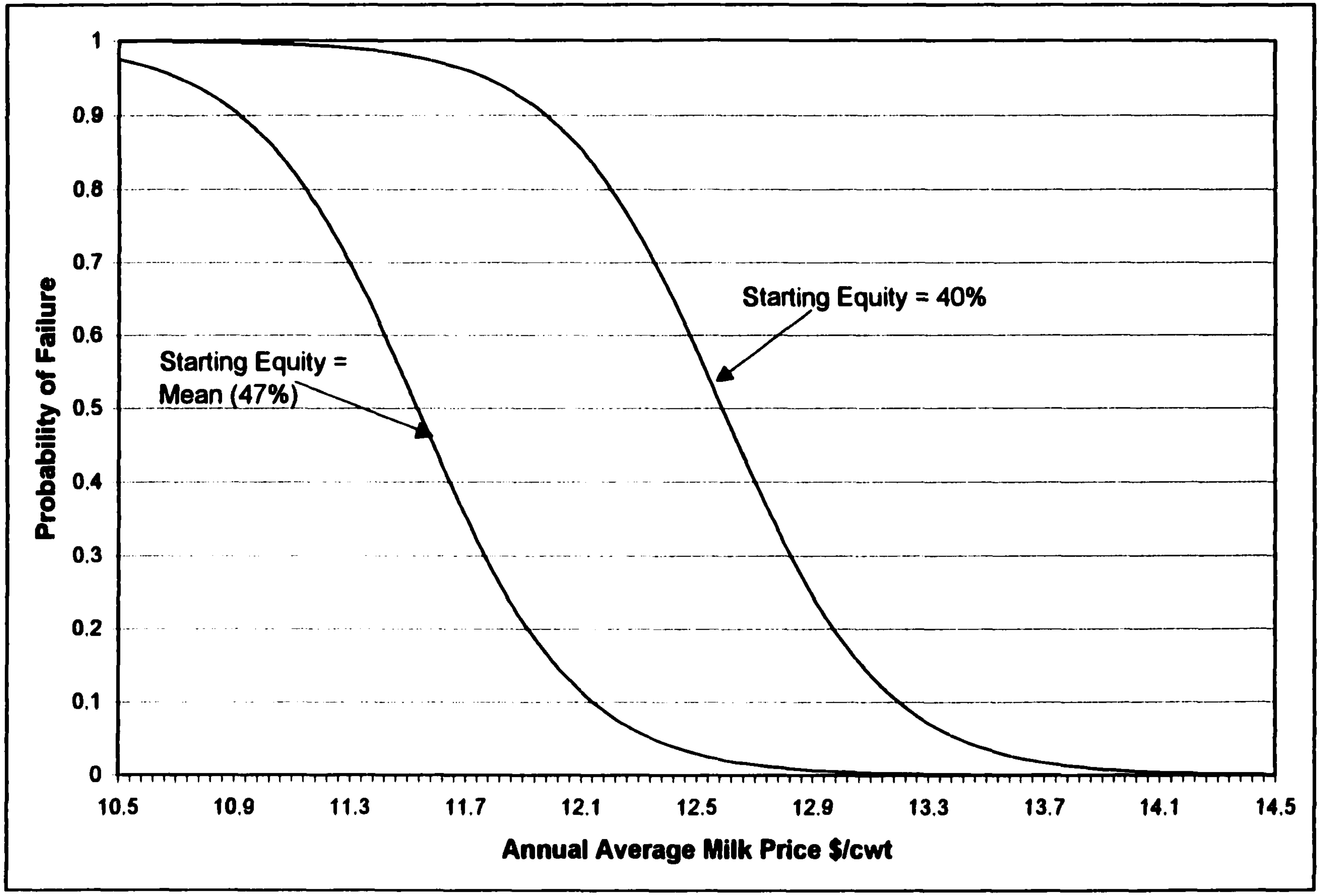


Figure 5.3. Projected Probability of Failure with Varying Levels of Milk Price ($/cwt) All Other Variables at Their Means (SEQU = 0.4)

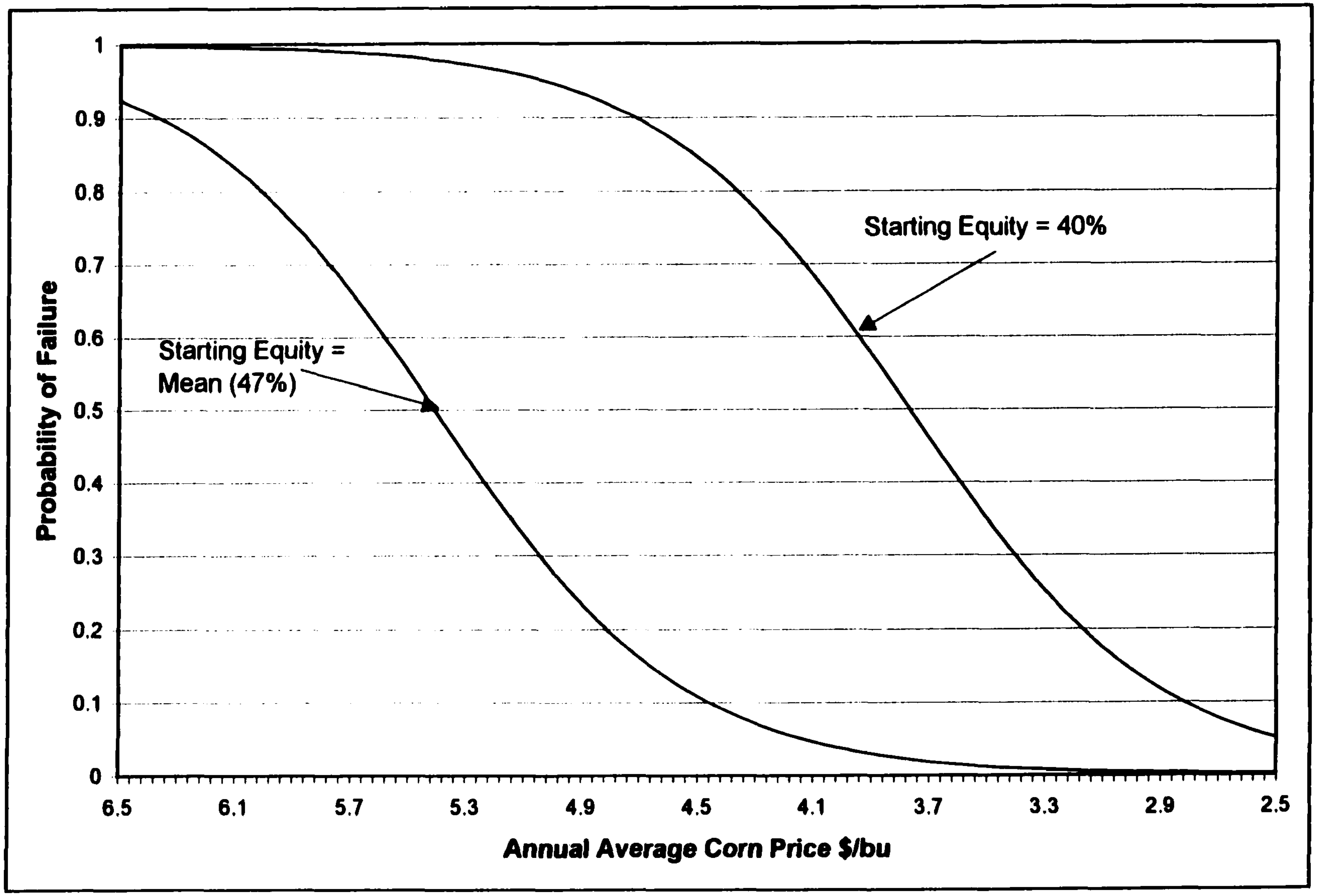


Figure 5.4. Projected Probability of Failure with Varying Levels of Corn Price ($/bu)
All Other Variables at Their Means (SEQU = 0.4)

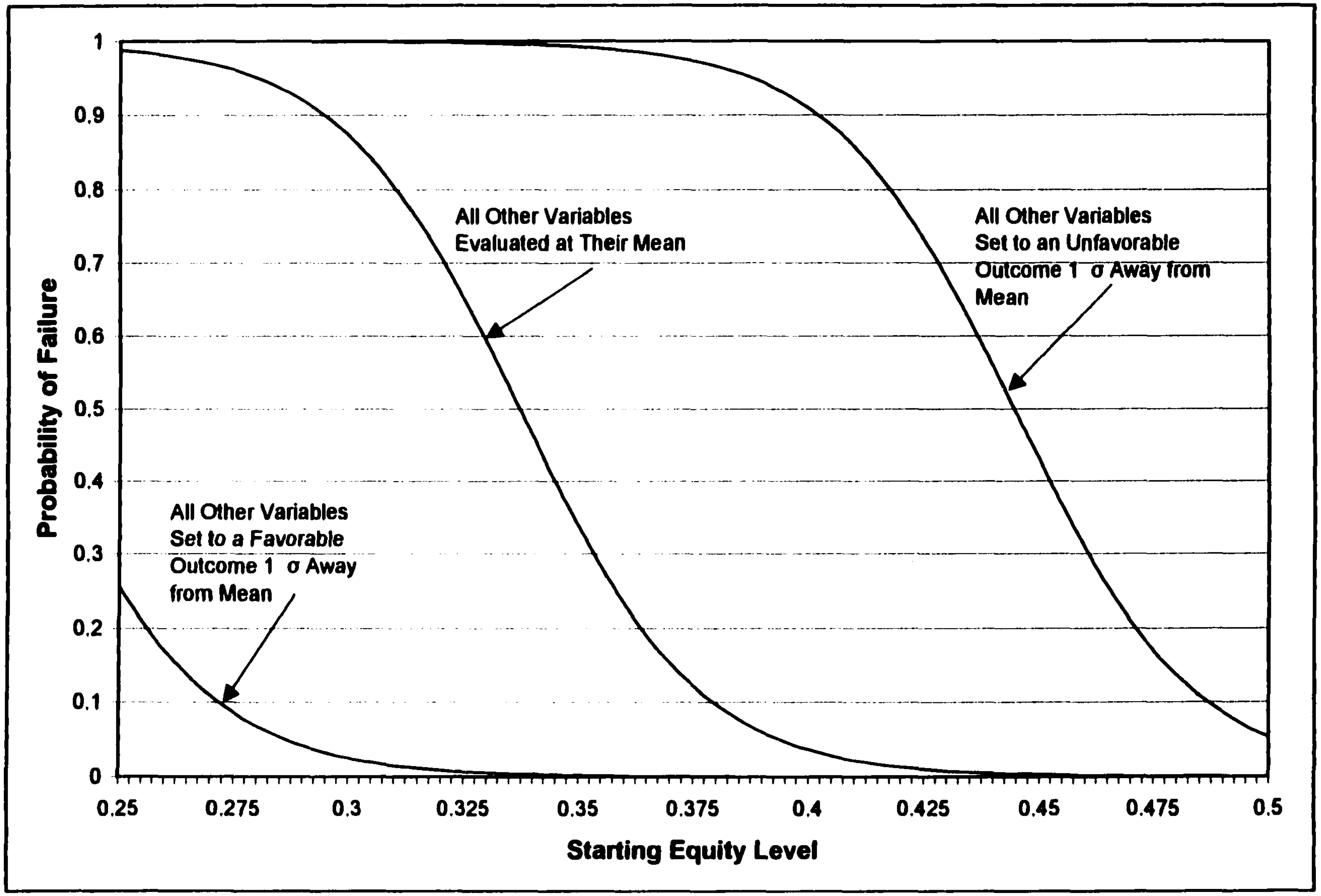


Figure 5.5. Projected Probability of Failure with Varying Levels of Starting Equity

from their mean such that the movement from the mean provides a favorable outcome for the cooperative. For example, milk production is set one standard deviation above its mean and culling rate is set one standard deviation below its mean. The graph on the far right shows the probability of failure for the large-scale dairy cooperative for varying levels of starting equity with the other variables fixed at a value that is one standard deviation away from their mean such that the movement from the mean provides an unfavorable outcome for the cooperative. The three graphs provide a means to evaluate the impact of starting equity on the predicted probability of failure. When all other variables are at their means, even with a low starting equity of 40% there is less than a 5% probability of failure. When an unfavorable outcome for all the other variables that is equal to a one standard deviation movement from their means is realized, the probability of failure for the large-scale dairy cooperative increases to 90% with a starting equity of 40%.

This illustrates the extreme risk associated with starting up a large-scale dairy cooperative with low levels of equity, if production performance should fall below the medium production path used in this analysis. As long as the other variables take a value that is equal to a one standard deviation unfavorable movement from their mean, a 49% starting equity level is required to reduce the predicted probability of failure to a level below 10%. When all of the independent variables take on a value that is equal to a one standard deviation favorable movement from their mean, the probability of failure falls to approximately 0 for any level of starting equity that would reasonably be allowed by lenders.

Figure 5.5 also strengthens the case for performing a full simulation analysis, as was performed in this paper, when evaluating potential value added ventures rather than using the simple budgeting approaches typically undertaken. As seen in Figure 5.5, with all independent variables at their mean, as would be the case in a simple budgeting approach, a 40% starting equity level shows less than a 5% probability of failure. In a simple budgeting approach a 40% starting equity level may very well appear to be a reasonable starting equity level to use when forming a large-scale closed dairy cooperative. As reported in Chapter 4, a 40% starting equity level and medium production level had a 23% chance of failure during the first 5 years. By undertaking a full simulation analysis a much better representation of the risk associated with starting a large-scale closed dairy cooperative can be obtained.

Equation (20) developed in this section can be used by managers of large-scale dairy operations as a decision making tool. While Equation (20) does not provide the impact on profit for evaluating management decisions, the change in predicted probability for different decisions can be determined from Equation (20). This may be very useful for many management decisions. For example, the decision to hedge corn or milk prices could be examined using the predicted probability of failure equation to determine the impact the hedging decision would have on the predicted probability of failure. Equation (20) provides a way to quantify the benefit of a hedging decision in terms of avoiding catastrophic losses.

Conclusions

The main objective of this research was to answer the question, does investing in a large-scale closed dairy cooperative in the upper Midwest make economic sense? Three key pieces of information are provided by this research to answer this question. First, the returns from forming a large-scale closed dairy cooperative are reported in Chapter 4. The returns calculated in this research indicate that a large-scale closed dairy cooperative may provide reasonable returns provided that a low production growth path can be avoided.

Second the risk associated with the returns is provided in two ways. The standard deviation of the returns is reported along with the expected returns for all of the cases. In addition, a graph of the distributions is provided for all the cases. This allows those interested in forming a large-scale closed dairy cooperative to compare the projected risks calculated in this research with their own willingness to undertake an investment with the distribution of returns shown.

A final piece of information provided by this research is to quantify the probability of catastrophic failure of the cooperative. In the case where the cooperative failures those who invested in the cooperative will likely lose a majority of their initial investment in the cooperative. The probability of failure for different time periods was reported in Chapter 4. The results show that in order to face a reasonable probability of failure the cooperative must achieve a high production level or invest a high level of starting equity. In addition, Chapter 5 provides additional information about the probability of failure. Investors can use the figures and predictive equation reported in Chapter 5, to determine the predicted probability of failure associated with any combination of key independent variables that they are concerned about.

Having the three types of information described above permits potential investors to have considerably more information than has typically been available when evaluating value added ventures. The three types of information should be used together in evaluation a project of this type. Only looking at the reported returns in Chapter 4 is somewhat misleading because the impact of catastrophic failures, which lead to large losses to the investors, is not capture in the reported returns. Looking only at the predicted probability of failures only provides information about the survival of the operation and not the returns that investors expect.

All of the information provided indicates that a large-scale closed dairy cooperative would be feasible in the upper Midwest. The closed dairy cooperative would have to be viewed as a long-term investment as the expected returns are low for the first several years of operation while startup issues and the biological production nature of dairy production are expected to depress returns. Once the operation reaches a steady state level of production a large-scale closed dairy cooperative provides adequate returns that merit consideration as an investment for farmers looking to add value to their crop enterprises.

In addition to evaluating a large-scale closed dairy cooperative, this research has provided an improved methodology for evaluating other types of value added activities. The methodology used in this research can be summarized as: 1) modeling the production process 2) using a simulation to develop a reasonable range of outcomes and summarizing the results and 3) isolating the impacts of key independent variables on the probability of failure. This methodology represents a more comprehensive approach to evaluating value added activities than previously used. Such an approach provides both potential investors and managers of the operations additional information to evaluate their investments and managerial decisions.

Future Considerations

While progress was made in determining the expected returns for starting up a large scale closed dairy cooperative, the results imply additional questions for future research. More research is needed to investigate the impact of different levels of equity contributions in the cooperative under the price and biological uncertainties investigated in this paper. One approach to investigating the impact of different equity levels would be to look at the returns from the dairy operation, not the returns provided to the members. In this way finance theory described in Chapter 2 could be more directly applied to the return on assets and returns on equity of the dairy operation.

The farm level financial model developed for this research that incorporates a model of the cow flows through the dairy operation has the potential to be useful as an Extension tool in helping farmers look at expanding or staring large-scale dairy operations. Some additional work may be required on the model to make the interface more user friendly, however there appears to be a number of potential applications for the model developed. In addition to using the financial model as a tool for evaluating potential dairy operations. the model may be useful in working with lenders to secure debt for a new or expansion dairy operation. Because the financial model is developed as a true monthly model, variations in cash flow can be examined before the operation has started. This allows both the lender and members to have a better understanding of the projected cash flows. Understanding the impact of the biological nature of dairy production on cash flows can help avoid situations where normal operation conditions are confused with poor management or financial performance.

As large-scale dairy operations continue to increase throughout the Midwest, the opportunity to fine tune the assumptions used in this research may be possible. This research relied on at most three years of production data by large producers. In addition the some of the herds used were considerably smaller than proposed in this research. By tracking the production of only large-scale dairy operations for a longer period of time, the accuracy of the results may possibly be improved.

APPENDIX A

DATA INPUT SHEET FROM DAIRY MODEL

Dairy Model - Cash Flow Modeling

Name of Operation:	**1200 Commercial Dairy Cow Unit**
Type of Operation:	***No Raised Replacements Commercial Production***

Start-up Month (Jan = 1, Feb = 2, etc)	9
Start-up Year (four digits: 1999, 2000, etc.)	2002

Cow Numbers

Designed Capacity	1200
Number Females Purchased	1200
Cost of Females FOB Farm	$ 1,800.00

	September	October	November	December	January	February
Delivery Schedule (% by Month)	25%	25%	25%	25%	0%	0%

Machinery and Equipment

Vehicles	$ 120,000
Cattle Handling Equipment	107,000
Misc. Milking Equipment	-
TMR Mixer	35,000
Other Equipment	53,800

Facilities

Building Site Preparation	$ 55,000
Roads and Driveways	82,000
Manure Management System	518,000
Water Supply System	8,400
Electric Lines/Generator	50,000
L.P. Tanks	7,200
Managers Home and Alarm	-
Other (overwrite this)	-
Other (overwrite this)	-

Land Purchased Acres	80
Purchase Price per Acre	$ 1,800

	No. Spaces	*Cost / Space*	*Total Cost*
Free Stall Barn	1020	$ 1,200.00	$ **1,224,000**
Calving/Special Needs Barn	1	360,000.00	**360,000**
Milking Center (Parlor, Office, etc.)	1	492,000.00	**492,000**
Milking Equipment and Bulk Tank	1	492,000.00	**492,000**
Dry Cow Barn	180	1,200.00	**216,000**
Bunker Silo		139,000.00	**139,000**
Other Feed Facility and Storage		90,000.00	**90,000**
Isolation and Biosecurity Facility	0	-	-
Misc. Equipment and Hardware	1	100,000.00	**100,000**
Other		-	-
Other (overwrite this)		-	-
Other (overwrite this)		-	-

Construction Schedule	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
Percent per Month	25%	25%	25%	25%	0%	0%
Dollars per Month	***$ 994,400***	***$ 994,400***	***$ 994,400***	***$ 994,400***	***$ -***	***$ -***

Equity Contribution

Total Facility and Land Cost	***$ 3,977,600***	
Long-Term Equity Contribution (% of Total)	35.0%	
Dollars of L-T Facility Equity Contribution	***$ 1,392,160***	
Total Machinery and Equipment Costs	***$ 315,800***	
Intermediate Term Equity Contribution (% of Total)	80.0%	
Dollars of Machinery and Equiq. Contribution	***$ 252,640***	
Total Cow Herd Cost	***$ 2,160,000***	
Intermediate Term Equity Contribution (% of Total)	80.0%	
Dollars of Cow Herd Equity Contribution	***$ 1,728,000***	$ 3,922,800
		$ 7,003,400
Operating Capital	***$ 550,000***	56.0%
Operating Capital Equity Contribution	100.0%	

Loan Data

	Interest Rate	Loan Term in Years	Repayment Schedule	LOC Commitment
Long-Term Interest Rate	9.75%	20	Monthly	
IT Machinery and Equipment Rate	9.00%	5	Monthly	
IT Breeding Stock Interest Rate	8.50%	7	Monthly	
Line of Credit Interest Rate	11.00%		Monthly	
General Inflation Rate	1.25%			
Inflation Rate for Labor Expense	2.50%			

Price Data

	Long-Term Prices *Price per Ton*	*Price/lbs. (DM)*	*% Dry Matter*
Shell Corn	$ 132.16	$ 0.075	88%
Corn Gluten Feed	120.00	$ 0.067	90%
Corn Silage	23.67	$ 0.030	40%
Soybean Meal, 48%	189.99	$ 0.106	90%
Whole Cotton Seed	207.00	$ 0.113	92%
Alfalfa Hay, Early B loom	71.23	$ 0.040	90%
SoyPlus	240.00	$ 0.136	89%
Calcium Carbonate	149.00	$ 0.075	100%
Fat	600.00	$ 0.306	98%
Sodium Bicarbinate	380.00	$ 0.190	100%
Salt	128.00	$ 0.064	100%
Urea	400.00	$ 0.200	100%
Dairy Micro Premix	2,000.00	$ 1.000	100%
Dicalcium Phosphate 18.5	346.00	$ 0.173	100%
Magnesium Oxide	318.00	$ 0.159	100%
Dry Cow Supreme PX	1,460.00	$ 0.793	92%
Soybean Hulls	120.00	$ 0.067	90%
Magnesium Sulf.	520.00	$ 0.260	100%
		$ -	100%
		$ -	100%

	Long-Term	*Year 1*	*Year 2*	*Year 3*
Milk Price/cwt	$ 13.51	$ 13.51	$ 13.51	$ 13.51
Heifer Calf Sale Price/Head	$ 90.00	90.00	90.00	90.00
Cull Cow Sale Price/cwt	$ 41.89	41.89	41.89	41.89
Bull Calf Sale Price/Hd	$ 90.00	90.00	90.00	90.00

Ration Analysis

Compute Dry Matter Basis for Each Diet - Rations computed for mature cows weighing 1,350lbs with average milk production - DMI [illegible]

RATION INGREDIENT	Transition Day 1-40 *lbs.*	Early Lactation Day 41-199 *lbs.*	Late Lactation Day 200 + *lbs.*	Dry Cows *lbs.*
Shell Corn	1.76	6.88	4.40	-
Corn Gluten Feed	4.50	6.30	6.30	
Corn Silage	22.40	21.92	22.96	21.90
Soybean Meal, 48%	4.50	4.05	4.54	1.56
Whole Cotton Seed	2.76	3.68	1.84	-
Alfalfa Hay, Early B loom	3.60	3.60	3.60	3.60
SoyPlus	2.58	2.48	-	-
Calcium Carbonate	0.70	0.78	0.61	0.05
Fat	0.36	0.46	-	-
Sodium Bicarbinate	0.40	0.35	0.35	-
Salt	0.18	0.20	0.19	0.04
Urea	0.15	0.20	0.20	-
Dairy Micro Premix	0.10	0.11	0.10	-
Dicalcium Phosphate 18.5	0.10	0.09	0.10	-
Magnesium Oxide	0.02	0.02	-	0.04
Dry Cow Supreme PX	-	-	-	0.12
Soybean Hulls	0.94	-	1.82	0.09
Magnesium Sulf.	-	-		0.10
0	-	-	-	-
0				-
	2.83	3.35	2.66	1.09
DMI	**46.06**	**51.12**	**47.01**	**27.50**
COST/LB. Of DMI	$ **0.063**	$ **0.066**	$ **0.057**	$ **0.040**

Body Weight (lbs. /cow)	Transition 1st Lactation	Early Lactation 1st Lactation	Late Lactation 1st Lactation	Transition Mature Cows	Early Lactation Mature Cows	Late Lactation Mature Cows	Dry Cows
Average Weight during stage	990	1,100	1,210	1,215	1,350	1,418	[illegible]
Days in Milk Cycle	1-40	41-199	200-345	1-40	41-199	200-345	345-405

Start-up Herd Information

% of Herd Purchased as Heifers	100.0%
% of Herd Purchased from Existing Herd	0.0%

Production Data Input

Herd Size (Head)	1200
Calf Mortality	12.5%

Months in Milk	11.5
Months Dry	2
Total Months in Cycle	*13.5*

Daily Average Milk Production During Lactation

	Average	
First Lactation, Transition	62.8	Day 1-40
First Lactation, High	76.9	Day 41-199
First Lactation, Average	66.3	Day 200-345
Second+ Lactation, Transition	87.9	Day 1-40
Second+ Lactation, High	91.0	Day 41-199
Second+ Lactation, Average	63.7	Day 200-345

	Year 1	Year 2	Year 3
Annual Milk Sales/Cow	**20,558**	**21,596**	**21,974**
Daily Milk Sales/Cow	**56.32**	**59.17**	**60.20**
	Year 4	**Year 5**	**Year 6**
Annual Milk Sales/Cow	**23,940**	**24,490**	**25,092**
Daily Milk Sales/Cow	**65.59**	**67.10**	**68.75**
	Year 7	**Year 8**	**Year 9**
Annual Milk Sales/Cow	**25,697**	**26,317**	**26,817**
Daily Milk Sales/Cow	**70.40**	**72.10**	**73.47**
	Year 10		
Annual Milk Sales/Cow	**27,294**		
Daily Milk Sales/Cow	**74.78**		

Cull Rate Data	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Annual Culling Rate	38.0%	29.5%	29.5%	29.5%	29.5%	29.5%	29.5%
Average Weight	1,200	1,200	1,200	1,200	1,200	1,200	1,200
Death Loss/Herd/Year	6.0%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
Total Percent Leaving Herd	*44.0%*	*34.0%*	*34.0%*	*34.0%*	*34.0%*	*34.0%*	*34.0%*

Milk Loss Due to Mastitis

Percent of Cow Herd Infected/yr	12.0%
Average Days Treated	4

Milk Loss Due to Other Disease

Percent of Cow Herd Infected/yr	2.0%
Average Days Treated	7

AVERAGE ANNUAL NON-FEED VARIABLE COSTS

Repair and Maintenance for Buildings		$ 78,672.00
Repair and Maintenance for Equipment		6,316.00
Utility Costs		61,200.00
Fuel and Oil		39,200.00
Parlor Supplies		65,304.00
Bedding Supplies		33,000.00
BST and Other Expenses		242,400.00
Veterinary & Medicines		145,200.00
Breeding and AI Costs		43,200.00
Marketing/Transportation		84,000.00
Labor (including benefits)		516,000.00
Labor hours / Cow / Year	40	
Total Employees	24	
Manger's Salary		70,000.00
Truck and Auto Expenses		9,800.00
Property Taxes and Insurance		59,664.00
DHIA Testing		16,326.00
Livestock Leases		-
Rental and Lease Expenses		-
Professional Fees (non veterinary)		22,000.00
Record-Keeping System		5,000.00
Manure Management		98,550.00
Gal. of waste/cow/day (inc. milk house)	30	

Labor Worksheet

Total Hours:		*48000*
Labor Hours / Employee:		*2000*
Total F.T.E.'s:		*24*
Labor Cost per Hour:	*$*	*10.75*
Average Salary / Employee:	*$*	*21,500.00*

Manure Management Worksheet

Gallons of Manure Nutrients Produced:		*13,140,000*
Manure Nutrient Cost per Gallon:	*$*	*0.0075*

APPENDIX B-1

SUMMARY STATISTICS FOR PRICE AND BIOLOGICAL VARIABLES

Table B-1.1. Summary Statistics for Price Variables Used in Simulation

	Average	Std. Deviation	Min	Max
Sept. Cull Cow Price	41.86	7.54	32.40	52.40
Oct. Cull Cow Price	40.36	7.34	31.10	52.40
Nov. Cull Cow Price	38.65	7.20	29.70	49.40
Dec. Cull Cow Price	39.65	7.71	29.70	47.20
Jan. Cull Cow Price	41.22	6.87	32.10	50.00
Feb. Cull Cow Price	42.75	7.31	33.30	50.40
Mar. Cull Cow Price	42.84	6.91	33.10	51.90
Apr. Cull Cow Price	42.85	6.93	31.90	51.50
May Cull Cow Price	43.65	7.27	33.40	51.30
June Cull Cow Price	43.51	7.23	32.60	53.70
July Cull Cow Price	42.95	6.84	33.40	53.10
Aug. Cull Cow Price	42.35	6.95	33.90	53.30
Sept. Milk Price	14.34	1.56	13.00	16.77
Oct. Milk Price	14.38	1.57	12.24	18.07
Nov. Milk Price	14.27	1.81	11.85	18.49
Dec. Milk Price	13.96	2.14	11.26	18.68
Jan. Milk Price	13.57	1.70	11.22	16.89
Feb. Milk Price	13.04	1.17	11.15	14.81
Mar. Milk Price	13.06	1.15	11.04	14.38
Apr. Milk Price	12.87	1.02	11.00	14.29
May Milk Price	12.74	1.12	11.10	14.85
June Milk Price	12.94	1.25	11.28	15.05
July Milk Price	13.23	1.41	11.74	15.58
Aug. Milk Price	13.74	1.71	11.90	16.55
Sept. Corn Price	2.36	0.64	1.72	4.14
Oct. Corn Price	2.23	0.37	1.56	2.92
Nov. Corn Price	2.21	0.32	1.65	2.70
Dec. Corn Price	2.25	0.33	1.73	2.90
Jan. Corn Price	2.27	0.31	1.87	2.85
Feb. Corn Price	2.34	0.40	1.87	3.23
Mar. Corn Price	2.43	0.40	1.95	3.38
Apr. Corn Price	2.48	0.51	1.96	3.83
May Corn Price	2.47	0.51	1.96	3.80
June Corn Price	2.49	0.66	1.96	4.35
July Corn Price	2.43	0.73	1.60	4.45
Aug. Corn Price	2.34	0.69	1.60	4.19
Sept. Soy Meal Price	187.34	44.87	126.90	265.70
Oct. Soy Meal Price	179.60	30.54	129.40	238.00
Nov. Soy Meal Price	182.06	33.02	139.30	242.70
Dec. Soy Meal Price	180.99	32.37	139.60	240.90
Jan. Soy Meal Price	177.02	32.26	131.00	240.70
Feb. Soy Meal Price	176.50	34.25	124.40	253.60
Mar. Soy Meal Price	177.33	37.74	127.20	270.40
Apr. Soy Meal Price	180.02	41.95	128.60	277.70
May Soy Meal Price	184.16	45.62	127.00	296.00
June Soy Meal Price	181.70	39.43	131.70	275.90
July Soy Meal Price	183.64	40.10	125.71	261.50
Aug. Soy Meal Price	180.88	42.39	135.70	261.60

Table B-1.2. Summary Statistics for Biological Variables Used in Simulation

	Average	Std. Deviation	Min	Max
Daily Milk Production (lbs.)				
Jan. Heifer Transition	64.30	7.51	45.00	86.00
Feb. Heifer Transition	63.32	8.82	40.00	93.00
Mar. Heifer Transition	63.96	7.43	40.00	85.00
Apr. Heifer Transition	65.07	8.41	43.00	90.00
May Heifer Transition	65.18	7.60	48.00	87.00
June Heifer Transition	64.73	7.78	50.00	85.00
July Heifer Transition	63.99	8.24	45.00	86.00
Aug. Heifer Transition	63.33	6.71	44.00	78.00
Sept. Heifer Transition	63.32	6.67	49.00	82.00
Oct. Heifer Transition	64.34	7.04	47.00	84.00
Nov. Heifer Transition	65.74	7.03	45.00	90.00
Dec. Heifer Transition	65.07	7.27	46.00	83.00
Jan. Heifer Early	78.68	6.26	60.44	93.21
Feb. Heifer Early	79.73	6.75	59.81	97.88
Mar. Heifer Early	80.46	6.72	58.64	96.48
Apr. Heifer Early	80.82	6.30	66.18	99.13
May Heifer Early	81.31	6.50	65.33	96.46
June Heifer Early	80.25	6.73	63.00	97.92
July Heifer Early	78.68	6.62	60.51	94.61
Aug. Heifer Early	77.57	6.11	64.66	91.62
Sept. Heifer Early	76.40	6.54	62.54	91.90
Oct. Heifer Early	76.96	6.70	62.13	94.51
Nov. Heifer Early	77.75	6.75	62.00	96.59
Dec. Heifer Early	78.73	6.66	64.56	95.60
Jan. Heifer Late	67.53	6.85	42.63	87.18
Feb. Heifer Late	68.35	6.73	48.80	83.39
Mar. Heifer Late	68.93	6.38	50.28	84.25
Apr. Heifer Late	69.85	6.77	51.92	87.93
May Heifer Late	70.33	6.63	51.12	91.01
June Heifer Late	69.75	6.44	48.76	90.40
July Heifer Late	68.21	6.97	48.25	85.87
Aug. Heifer Late	66.91	6.87	48.22	86.43
Sept. Heifer Late	65.90	7.14	50.25	82.10
Oct. Heifer Late	66.61	6.35	53.26	82.82
Nov. Heifer Late	66.81	6.72	52.00	83.65
Dec. Heifer Late	67.26	6.34	54.00	84.36
Jan. Mature Transition	91.62	7.87	73.46	108.00
Feb. Mature Transition	92.85	8.28	74.47	116.85
Mar. Mature Transition	93.17	8.72	67.73	118.88
Apr. Mature Transition	94.80	10.72	46.44	118.50
May Mature Transition	91.78	11.37	29.14	116.20
June Mature Transition	88.61	9.35	56.67	112.72
July Mature Transition	87.50	9.11	66.67	117.50
Aug. Mature Transition	86.61	8.70	60.23	107.15
Sept. Mature Transition	85.73	8.34	65.15	114.91
Oct. Mature Transition	88.37	8.71	67.74	116.00
Nov. Mature Transition	90.13	8.08	63.33	107.19
Dec. Mature Transition	91.65	8.51	68.75	112.66
Jan. Mature Early	91.89	7.57	74.55	118.92
Feb. Mature Early	93.65	7.18	76.62	118.35
Mar. Mature Early	95.32	7.40	77.77	113.05

Table B-1.2. (continued)

	Average	Std. Deviation	Min	Max
Apr. Mature Early	97.14	7.36	80.97	119.41
May Mature Early	97.73	7.74	83.23	122.08
June Mature Early	95.84	7.12	78.54	117.60
July Mature Early	92.77	8.12	67.23	109.24
Aug. Mature Early	91.64	7.48	75.49	112.28
Sept. Mature Early	90.44	7.32	74.35	113.07
Oct. Mature Early	90.80	7.14	74.02	114.65
Nov. Mature Early	91.04	7.60	73.31	117.32
Dec. Mature Early	92.04	7.21	75.14	110.45
Jan. Mature Late	64.63	6.65	46.81	85.51
Feb. Mature Late	65.84	6.75	48.27	82.92
Mar. Mature Late	66.24	6.70	48.51	85.41
Apr. Mature Late	67.00	6.31	52.63	90.33
May Mature Late	67.75	6.26	54.34	85.71
June Mature Late	68.21	6.27	49.22	81.21
July Mature Late	66.68	6.67	48.73	82.51
Aug. Mature Late	65.41	6.70	45.69	83.88
Sept. Mature Late	63.57	6.85	47.55	87.00
Oct. Mature Late	63.08	6.65	48.25	88.01
Nov. Mature Late	62.61	6.82	46.39	87.72
Dec. Mature Late	63.59	6.54	49.73	82.89
Jan. Culling Rate	0.33	0.07	0.02	0.51
Feb. Culling Rate	0.33	0.06	0.04	0.46
Mar. Culling Rate	0.33	0.06	0.07	0.46
Apr. Culling Rate	0.33	0.06	0.09	0.50
May Culling Rate	0.33	0.06	0.12	0.45
June Culling Rate	0.33	0.06	0.13	0.51
July Culling Rate	0.34	0.06	0.15	0.49
Aug. Culling Rate	0.34	0.06	0.14	0.49
Sept. Culling Rate	0.34	0.06	0.17	0.51
Oct. Culling Rate	0.34	0.06	0.19	0.49
Nov. Culling Rate	0.34	0.06	0.20	0.48
Dec. Culling Rate	0.34	0.05	0.20	0.45

APPENDIX B-2

CORRELATION MATRICIES FOR PRICE VARIABLES

Cull Cow Price

Cull Cow Price

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Sep	1.0000	0.9900	0.9796	0.9735	0.9802	0.9815	0.9467	0.9049	0.9032	0.8940	0.8537	0.8840
Oct		1.0000	0.9941	0.9887	0.9860	0.9872	0.9652	0.9360	0.9302	0.9116	0.8840	0.9109
Nov			1.0000	0.9923	0.9896	0.9885	0.9656	0.9389	0.9295	0.9171	0.8943	0.9237
Dec				1.0000	0.9938	0.9878	0.9666	0.9417	0.9477	0.9397	0.9221	0.9505
Jan					1.0000	0.9936	0.9573	0.9255	0.9318	0.9307	0.9086	0.9389
Feb						1.0000	0.9726	0.9466	0.9444	0.9470	0.9156	0.9356
Mar							1.0000	0.9918	0.9848	0.9688	0.9576	0.9565
Apr								1.0000	0.9883	0.9677	0.9623	0.9476
May									1.0000	0.9805	0.9839	0.9725
Jun										1.0000	0.9841	0.9753
Jul											1.0000	0.9903
Aug												1.0000

Milk Price

Cull Cow Price

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Sep	-0.6035	-0.5549	-0.3558	-0.2965	-0.3411	-0.3682	-0.4727	-0.1360	0.0329	-0.1045	-0.3102	-0.4935
Oct	-0.5705	-0.5593	-0.3748	-0.3178	-0.3538	-0.3682	-0.4689	-0.1360	0.0485	-0.0866	-0.3089	-0.5221
Nov	-0.5259	-0.5204	-0.3395	-0.2873	-0.3293	-0.3492	-0.4776	-0.1182	0.0341	-0.1031	-0.3168	-0.5345
Dec	-0.4914	-0.4765	-0.2880	-0.2343	-0.2842	-0.3643	-0.4753	-0.1173	0.0616	-0.0575	-0.2521	-0.4710
Jan	-0.5227	-0.4522	-0.2532	-0.1985	-0.2528	-0.3623	-0.4388	-0.0858	0.0931	-0.0469	-0.2532	-0.4600
Feb	-0.5011	-0.4721	-0.3080	-0.2560	-0.3054	-0.3413	-0.4703	-0.1422	0.0230	-0.1139	-0.3285	-0.5209
Mar	-0.3667	-0.4155	-0.3278	-0.2861	-0.3256	-0.3642	-0.4877	-0.1862	-0.0395	-0.2003	-0.3987	-0.5612
Apr	-0.2790	-0.3854	-0.3379	-0.3033	-0.3370	-0.3801	-0.4910	-0.2103	-0.0949	-0.2504	-0.4411	-0.5929
May	-0.2784	-0.3403	-0.2712	-0.2350	-0.2828	-0.3827	-0.4838	-0.1881	-0.0283	-0.1755	-0.3480	-0.4980
Jun	-0.2346	-0.3228	-0.2659	-0.2320	-0.2982	-0.3869	-0.5485	-0.2749	-0.0571	-0.1991	-0.3670	-0.5229
Jul	-0.1820	-0.2244	-0.1726	-0.1430	-0.2060	-0.4539	-0.4683	-0.1759	0.0333	-0.1294	-0.2924	-0.4500
Aug	-0.2688	-0.2591	-0.1530	-0.1154	-0.1809	-0.3857	-0.4541	-0.1261	0.0166	-0.0426	-0.2136	-0.4066

Corn Price

Cull Cow Price

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Sep	-0.2963	-0.1806	-0.1730	-0.1835	-0.1905	-0.1530	-0.1958	-0.1985	-0.1606	-0.1971	-0.0787	-0.0911
Oct	-0.2761	-0.1682	-0.1493	-0.1706	-0.1661	-0.1484	-0.1912	-0.2115	-0.1706	-0.2156	-0.0971	-0.1284
Nov	-0.3337	-0.2472	-0.2213	-0.2391	-0.2314	-0.2147	-0.2601	-0.2786	-0.2311	-0.2685	-0.1591	-0.1957
Dec	-0.3476	-0.2496	-0.2263	-0.2485	-0.2479	-0.2328	-0.2734	-0.2813	-0.2357	-0.2661	-0.1533	-0.1895
Jan	-0.3564	-0.2503	-0.2265	-0.2501	-0.2603	-0.2413	-0.2826	-0.2797	-0.2361	-0.2594	-0.1449	-0.1667
Feb	-0.2926	-0.2229	-0.2276	-0.2699	-0.2769	-0.2717	-0.3108	-0.3184	-0.2775	-0.3127	-0.1928	-0.2048
Mar	-0.1546	-0.1478	-0.1650	-0.2224	-0.2385	-0.2445	-0.2826	-0.3074	-0.2667	-0.3353	-0.2321	-0.2466
Apr	-0.1108	-0.1397	-0.1641	-0.2410	-0.2539	-0.2795	-0.3154	-0.3539	-0.3187	-0.3971	-0.2974	-0.3153
May	-0.1451	-0.1396	-0.1576	-0.2315	-0.2588	-0.2772	-0.3115	-0.3363	-0.3065	-0.3724	-0.2689	-0.2812
Jun	-0.1967	-0.2370	-0.2812	-0.3600	-0.3885	-0.4021	-0.4226	-0.4141	-0.3757	-0.4177	-0.3053	-0.2977
Jul	-0.1708	-0.1970	-0.2125	-0.2882	-0.3276	-0.3469	-0.3727	-0.3719	-0.3318	-0.3809	-0.2864	-0.2924
Aug	-0.2519	-0.2312	-0.2268	-0.2781	-0.3082	-0.3138	-0.3430	-0.3351	-0.2848	-0.3196	-0.2238	-0.2434

Soybean Price

Cull Cow Price

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Sep	-0.1433	-0.0836	-0.2524	-0.2717	-0.3225	-0.3260	-0.3050	-0.3106	-0.2785	-0.2746	-0.2238	-0.1656
Oct	-0.0826	-0.0235	-0.1870	-0.2130	-0.2605	-0.2710	-0.2518	-0.2729	-0.2287	-0.2275	-0.1809	-0.1466
Nov	-0.1295	-0.0771	-0.2375	-0.2746	-0.3171	-0.3267	-0.3014	-0.3263	-0.2721	-0.2773	-0.2441	-0.2074
Dec	-0.1236	-0.0831	-0.2451	-0.2744	-0.3242	-0.3465	-0.3175	-0.3377	-0.2843	-0.2907	-0.2434	-0.2038
Jan	-0.1508	-0.1174	-0.2757	-0.3019	-0.3528	-0.3809	-0.3497	-0.3638	-0.3152	-0.3191	-0.2537	-0.2071
Feb	-0.1014	-0.0716	-0.2444	-0.2847	-0.3392	-0.3511	-0.3158	-0.3379	-0.2837	-0.2902	-0.2318	-0.1947
Mar	-0.0273	0.0343	-0.1493	-0.1869	-0.2323	-0.2183	-0.1613	-0.1957	-0.1247	-0.1385	-0.1469	-0.0948
Apr	0.0310	0.0748	-0.1006	-0.1486	-0.1953	-0.1767	-0.1139	-0.1630	-0.0809	-0.0992	-0.1208	-0.0853
May	-0.0050	0.0439	-0.1280	-0.1572	-0.2104	-0.2098	-0.1446	-0.1819	-0.1073	-0.1209	-0.1151	-0.0703
Jun	-0.0697	-0.0478	-0.2440	-0.2782	-0.3184	-0.3092	-0.2305	-0.2518	-0.1735	-0.2002	-0.1719	-0.1171
Jul	-0.0544	-0.0076	-0.1585	-0.2075	-0.2445	-0.2513	-0.1667	-0.1941	-0.1091	-0.1340	-0.1254	-0.0649
Aug	-0.1045	-0.0465	-0.2252	-0.2434	-0.2794	-0.3002	-0.2296	-0.2486	-0.1713	-0.1928	-0.1698	-0.1073

Milk Price

Milk Price

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Sep	1.0000	0.6581	0.3061	0.2244	0.1982	-0.1174	-0.0046	-0.3482	-0.3955	-0.3909	-0.1518	0.0620
Oct		1.0000	0.8872	0.8445	0.8297	0.4526	0.6007	0.2694	0.1622	0.1803	0.3819	0.6069
Nov			1.0000	0.9949	0.9759	0.5823	0.7009	0.4724	0.3773	0.4668	0.6513	0.7897
Dec				1.0000	0.9851	0.6150	0.7158	0.5098	0.4170	0.5202	0.6886	0.8052
Jan					1.0000	0.7336	0.8117	0.5905	0.4259	0.5526	0.7045	0.8175
Feb						1.0000	0.9598	0.8339	0.5096	0.6629	0.6341	0.6536
Mar							1.0000	0.8281	0.5064	0.5944	0.6143	0.7025
Apr								1.0000	0.8396	0.7967	0.6445	0.5293
May									1.0000	0.8686	0.6826	0.4746
Jun										1.0000	0.9136	0.7079
Jul											1.0000	0.9076
Aug												1.0000

Corn Price

Milk Price

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Sep	0.1875	-0.1997	-0.2697	-0.3374	-0.3829	-0.4283	-0.3859	-0.3507	-0.3616	-0.3655	-0.4700	-0.4274
Oct	0.1324	0.0330	0.0243	-0.0138	-0.1091	-0.1625	-0.1578	-0.1158	-0.1146	-0.0985	-0.2261	-0.1885
Nov	-0.1515	-0.0318	0.0218	0.0401	-0.0346	-0.0592	-0.0794	-0.0352	-0.0203	0.0292	-0.0788	-0.0859
Dec	-0.1633	-0.0053	0.0495	0.0714	0.0019	-0.0229	-0.0456	-0.0037	0.0150	0.0635	-0.0348	-0.0493
Jan	-0.0577	0.1165	0.1694	0.1851	0.1319	0.0856	0.0605	0.0731	0.0909	0.1184	0.0146	-0.0173
Feb	0.3652	0.6090	0.6478	0.6327	0.6530	0.5386	0.5203	0.4373	0.4438	0.4062	0.3426	0.2677
Mar	0.3180	0.5363	0.6007	0.5975	0.5774	0.4935	0.4745	0.4238	0.4134	0.3944	0.3052	0.2637
Apr	0.1976	0.5376	0.6994	0.7231	0.7076	0.6534	0.6302	0.5918	0.5965	0.5909	0.5612	0.4851
May	0.0476	0.3630	0.5264	0.5811	0.5322	0.5464	0.5514	0.6131	0.6407	0.6895	0.7006	0.6624
Jun	-0.0320	0.3560	0.4644	0.5168	0.5339	0.4993	0.4997	0.5080	0.5350	0.5929	0.6019	0.5173
Jul	-0.1420	0.2161	0.3112	0.3908	0.4014	0.3907	0.3892	0.4055	0.4255	0.4999	0.4616	0.3789
Aug	-0.0361	0.2496	0.3007	0.3645	0.3336	0.3295	0.3235	0.3424	0.3293	0.3865	0.3073	0.2754

Soybean Price

		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Milk Price	**Sep**	-0.0115	-0.1066	-0.0595	-0.0790	-0.0203	0.0578	0.1714	0.1545	0.2242	0.1582	-0.0245	0.0224
	Oct	0.0365	-0.0484	0.0503	0.0371	-0.0008	-0.0621	0.0037	-0.0097	0.0196	-0.0017	-0.0985	-0.0384
	Nov	-0.0477	-0.1462	-0.0296	-0.0458	-0.1362	-0.2720	-0.2641	-0.2700	-0.2714	-0.2674	-0.2911	-0.2425
	Dec	-0.0203	-0.1194	-0.0114	-0.0299	-0.1328	-0.2802	-0.2833	-0.2898	-0.2960	-0.2878	-0.2973	-0.2537
	Jan	0.1191	0.01965	0.1389	0.1073	-0.0069	-0.1581	-0.1808	-0.2060	-0.2141	-0.2003	-0.2259	-0.2113
	Feb	0.6168	0.5595	0.6761	0.6297	0.5171	0.3678	0.2652	0.1960	0.1665	0.2073	0.2207	0.1029
	Mar	0.4541	0.3929	0.5529	0.5387	0.4471	0.3024	0.2257	0.1780	0.1402	0.1820	0.1887	0.1159
	Apr	0.3615	0.4045	0.5267	0.5823	0.5425	0.3591	0.2767	0.2525	0.2142	0.2676	0.3719	0.2973
	May	0.0569	0.1879	0.2163	0.3525	0.3874	0.2198	0.1870	0.2419	0.2011	0.2365	0.4109	0.4218
	Jun	0.2309	0.2759	0.3242	0.3789	0.3276	0.1293	0.0287	0.0460	-0.0071	0.0372	0.2264	0.1451
	Jul	0.1135	0.11353	0.2069	0.2499	0.1773	-0.0064	-0.1030	-0.0800	-0.1417	-0.1023	0.0203	-0.0297
	Aug	0.0873	0.0561	0.1899	0.2256	0.1297	-0.0193	-0.0919	-0.0701	-0.1410	-0.0984	-0.0409	-0.0511

Corn Price

		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Corn Price	**Sep**	1.0000	0.8610	0.7397	0.6195	0.5870	0.4787	0.5155	0.4463	0.4154	0.2825	0.2742	0.3235
	Oct		1.0000	0.9547	0.8818	0.8617	0.7672	0.7783	0.6865	0.6471	0.5316	0.5427	0.5452
	Nov			1.0000	0.9708	0.9459	0.8833	0.8840	0.8014	0.7640	0.6650	0.6612	0.6346
	Dec				1.0000	0.9801	0.9655	0.9608	0.8977	0.8711	0.7911	0.7697	0.7267
	Jan					1.0000	0.9692	0.9624	0.8721	0.8531	0.7719	0.7554	0.6829
	Feb						1.0000	0.9936	0.9441	0.9285	0.8672	0.8438	0.7819
	Mar							1.0000	0.9672	0.9512	0.8970	0.8781	0.8256
	Apr								1.0000	0.9905	0.9696	0.9526	0.9280
	May									1.0000	0.9808	0.9598	0.9239
	Jun										1.0000	0.9819	0.9519
	Jul											1.0000	0.9771
	Aug												1.0000

Soybean Meal Price

		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Corn Price	**Sep**	0.7270	0.8194	0.7766	0.8040	0.8178	0.8716	0.8921	0.8552	0.8597	0.8664	0.7931	0.7500
	Oct	0.7673	0.8746	0.8812	0.9321	0.8846	0.8435	0.7889	0.7543	0.7106	0.7622	0.7865	0.7062
	Nov	0.6555	0.7909	0.8454	0.9358	0.9140	0.8429	0.7794	0.7558	0.7032	0.7635	0.7934	0.7281
	Dec	0.5076	0.6791	0.7484	0.8645	0.8630	0.7933	0.7181	0.7184	0.6487	0.7128	0.7226	0.6917
	Jan	0.5681	0.7259	0.7946	0.8789	0.8690	0.7992	0.6966	0.6796	0.6121	0.6760	0.6845	0.6112
	Feb	0.3679	0.5614	0.6300	0.7563	0.7793	0.7267	0.6347	0.6553	0.5712	0.6351	0.6311	0.6186
	Mar	0.3787	0.5663	0.6269	0.7647	0.8035	0.7563	0.6712	0.7021	0.6169	0.6750	0.6830	0.6722
	Apr	0.2243	0.4105	0.4573	0.6364	0.7120	0.6692	0.6105	0.6835	0.5907	0.6375	0.6674	0.7110
	May	0.2047	0.4030	0.4286	0.5996	0.6818	0.6410	0.5852	0.6594	0.5754	0.6144	0.6253	0.6799
	Jun	0.0818	0.2599	0.2974	0.4822	0.5784	0.5233	0.4659	0.5620	0.4684	0.5051	0.5587	0.6196
	Jul	0.1106	0.2810	0.2912	0.4773	0.5673	0.5065	0.4450	0.5434	0.4479	0.4873	0.5948	0.6375
	Aug	0.0556	0.2234	0.2205	0.4233	0.5250	0.4827	0.4459	0.5637	0.4634	0.5002	0.6259	0.6963

Soybean Price

Soybean Price

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Sep	1.0000	0.9272	0.9184	0.8250	0.7082	0.6551	0.5826	0.4621	0.4802	0.4994	0.5088	0.3068
Oct		1.0000	0.9578	0.9141	0.8423	0.8145	0.7534	0.6560	0.6688	0.6955	0.6659	0.5120
Nov			1.0000	0.9641	0.8848	0.8293	0.7470	0.6412	0.6383	0.6786	0.6558	0.4787
Dec				1.0000	0.96528	0.9085	0.8416	0.7750	0.7535	0.7982	0.7979	0.6653
Jan					1.0000	0.9716	0.9296	0.8932	0.8731	0.9056	0.8941	0.7973
Feb						1.0000	0.9801	0.9508	0.9386	0.9594	0.8927	0.8252
Mar							1.0000	0.9825	0.9856	0.9926	0.9023	0.8763
Apr								1.0000	0.9891	0.9943	0.9216	0.9353
May									1.0000	0.9944	0.8976	0.9093
Jun										1.0000	0.9194	0.9210
Jul											1.0000	0.9506
Aug												1.0000

APPENDIX B-3

CORRELATION MATRICIES FOR BIOLOGICAL VARIABLES

Heifer Transition lbs of Milk/ Day

Heifer Transition lbs Milk/day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	1.0000	0.4589	0.4406	0.4382	0.4597	0.3934	0.2880	0.4029	0.3533	0.3724	0.2469	0.1908
Feb		1.0000	0.5363	0.4918	0.4561	0.4360	0.4704	0.3839	0.4066	0.3490	0.3129	0.3742
Mar			1.0000	0.2746	0.3859	0.4935	0.3817	0.4162	0.3479	0.3318	0.2395	0.2782
Apr				1.0000	0.5534	0.4894	0.4567	0.3609	0.4714	0.4297	0.3400	0.3361
May					1.0000	0.5981	0.4719	0.5187	0.5718	0.4483	0.3554	0.3047
Jun						1.0000	0.4746	0.5558	0.5984	0.4337	0.3170	0.3206
Jul							1.0000	.3368	0.4810	0.4141	0.3081	0.3551
Aug								1.0000	0.6337	0.4794	0.3246	0.3163
Sep									1.0000	0.4945	0.4891	0.4064
Oct										1.0000	0.5304	0.4268
Nov											1.0000	0.4913
Dec												1.0000

Heifer Early lbs Milk/Day

Heifer Transition lbs Milk/day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	0.4314	0.4524	0.4141	0.4304	0.4420	0.4032	0.3429	0.2822	0.2910	0.2679	0.2062	0.2430
Feb	0.3349	0.4893	0.4186	0.4423	0.4551	0.3534	0.3504	0.3429	0.3649	0.3681	0.3238	0.3757
Mar	0.2854	0.3358	0.3495	0.3556	0.4171	0.3497	0.3251	0.3219	0.2901	0.2947	0.2564	0.2667
Apr	0.2437	0.2807	0.2531	0.4075	0.4066	0.3023	0.1667	0.1924	0.3109	0.2416	0.2404	0.2719
May	0.3326	0.3084	0.3605	0.4996	0.5198	0.4997	0.3760	0.4051	0.4538	0.4282	0.3578	0.4307
Jun	0.2754	0.2517	0.2287	0.3261	0.4196	0.4860	0.3616	0.3310	0.3924	0.3663	0.3808	0.3988
Jul	0.1839	0.2102	0.1496	0.3243	0.3278	0.2120	0.3846	0.2771	0.3547	0.1798	0.2303	0.3270
Aug	0.1908	0.2130	0.1682	0.1971	0.2497	0.2831	0.2286	0.3463	0.4180	0.3753	0.3796	0.3007
Sep	0.2153	0.2403	0.1961	0.3130	0.3158	0.3534	0.2659	0.3145	0.4923	0.4068	0.3544	0.3743
Oct	0.2195	0.2537	0.1796	0.2494	0.3455	0.2732	0.2012	0.3097	0.3488	0.4522	0.4521	0.4692
Nov	0.2309	0.2555	0.2600	0.3151	0.3554	0.3317	0.2820	0.3452	0.4468	0.4900	0.5550	0.5235
Dec	-0.0087	0.1346	0.0636	0.0299	0.1691	0.1138	0.0100	0.1157	0.2037	0.2289	0.2839	0.4560

Heifer Late lbs Milk/day

Heifer Transition lbs Milk/day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	0.3448	0.3621	0.3177	0.3513	0.3532	0.2865	0.2702	0.2550	0.2690	0.3063	0.2383	0.2983
Feb	0.2994	0.3929	0.3317	0.3103	0.3654	0.2733	0.2853	0.2664	0.3248	0.3951	0.3506	0.3626
Mar	0.3099	0.3155	0.2706	0.2488	0.2378	0.1955	0.2052	0.2314	0.2922	0.3439	0.3151	0.3329
Apr	0.1707	0.2476	0.2699	0.2965	0.2792	0.2152	0.2113	0.0767	0.1258	0.2198	0.1648	0.2157
May	0.3352	0.3376	0.3009	0.3378	0.3902	0.3623	0.3024	0.2449	0.3035	0.3520	0.2625	0.3472
Jun	0.2375	0.2620	0.2068	0.2641	0.2789	0.3048	0.2206	0.1980	0.2488	0.3371	0.2473	0.3582
Jul	0.1694	0.2224	0.1713	0.2030	0.2762	0.2552	0.3476	0.2883	0.3199	0.2589	0.2319	0.1793
Aug	0.1306	0.2241	0.1178	0.1380	0.1618	0.2296	0.1831	0.1994	0.2596	0.3358	0.2542	0.2775
Sep	0.1784	0.2389	0.2006	0.2531	0.2196	0.2970	0.2225	0.1900	0.2660	0.3233	0.2327	0.2644
Oct	0.1483	0.2338	0.1720	0.1869	0.2533	0.2366	0.1969	0.1946	0.2656	0.3885	0.2612	0.3049
Nov	0.1880	0.2484	0.1487	0.1149	0.2105	0.2451	0.2254	0.2644	0.3326	0.4446	0.3886	0.3978
Dec	-0.0185	0.0503	-0.0361	-0.0606	0.691	-0.0186	-0.0455	0.0272	0.0473	0.1802	0.1230	0.2668

Mature Transition lbs of Milk/ Day

Heifer Transition lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	0.5024	0.3870	0.2949	0.3397	0.2088	0.1927	0.3144	0.3723	0.2658	0.2502	0.2360	0.2362
Feb	0.3546	0.5387	0.4810	0.2965	0.3260	0.2647	0.3142	0.3673	0.2888	0.3336	0.3096	0.3611
Mar	0.3095	0.4042	0.4206	0.2329	0.2519	0.2158	0.2894	0.2975	0.3193	0.3136	0.2540	0.2452
Apr	0.2229	0.2925	0.2164	0.4989	0.3157	0.3073	0.3608	0.4562	0.3266	0.3444	0.2871	0.2069
May	0.3598	0.4980	0.3434	0.5142	0.3783	0.5119	0.4412	0.4780	0.4848	0.3852	0.4451	0.3796
Jun	0.3587	0.3863	0.2458	0.3806	0.3477	0.3831	0.3992	0.3426	0.3636	0.3160	0.3323	0.3370
Jul	0.3299	0.2765	0.3429	0.2505	0.3408	0.4503	0.6017	0.3786	0.3252	0.3816	0.2290	0.3272
Aug	0.3401	0.2717	0.2157	0.3474	0.2723	0.3040	0.3316	0.4664	0.3445	0.3147	0.2893	0.2545
Sep	0.2691	0.3425	0.2100	0.4371	0.2041	0.3693	0.3797	0.3823	0.3725	0.4061	0.3554	0.3565
Oct	0.3062	0.3240	0.1242	0.4700	0.2199	0.3539	0.3019	0.4597	0.3872	0.4911	0.4296	0.4210
Nov	0.2211	0.3165	0.2797	0.4452	0.1968	0.3746	0.2967	0.4230	0.4135	0.5672	0.5856	0.4783
Dec	0.0457	0.1695	0.1853	0.2477	0.2007	0.3293	0.2143	0.2567	0.2792	0.3109	0.3529	0.5251

Mature Early lbs Milk/Day

Heifer Transition lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	0.3267	0.3734	0.2807	0.3493	0.3150	0.2849	0.2448	0.3404	0.3074	0.2964	0.2450	0.2202
Feb	0.2030	0.3765	0.3096	0.3536	0.4062	0.3122	0.2171	0.3160	0.3174	0.3251	0.2989	0.3195
Mar	0.1628	0.2518	0.2068	0.2087	0.2263	0.2112	0.1861	0.2249	0.2534	0.2269	0.1494	0.1802
Apr	0.1619	0.2068	0.1491	0.2963	0.3079	0.2324	0.1555	0.2746	0.2691	0.2259	0.2306	0.2661
May	0.3004	0.3353	0.3322	0.4209	0.4457	0.3900	0.2873	0.3309	0.3230	0.3486	0.2582	0.3370
Jun	0.2028	0.2677	0.1900	0.2812	0.3368	0.4082	0.2035	0.2806	0.2840	0.2389	0.2007	0.2697
Jul	0.0847	0.1990	0.1435	0.2859	0.3078	0.2777	0.3562	0.3855	0.2737	0.2038	0.1967	0.3177
Aug	0.0884	0.1450	0.0728	0.1142	0.1295	0.1780	0.1407	0.2342	0.2424	0.1809	0.1089	0.1189
Sep	0.1329	0.2028	0.1280	0.2187	0.1850	0.2545	0.1313	0.1874	0.2959	0.2171	0.1794	0.2185
Oct	0.0721	0.1938	0.0960	0.2046	0.2482	0.1963	0.1021	0.2526	0.1929	0.2876	0.2294	0.3654
Nov	0.1859	0.2663	0.1921	0.2943	0.2327	0.2629	0.2025	0.2821	0.3475	0.3999	0.4472	0.4447
Dec	-0.1510	0.0360	-0.0177	0.0823	0.1483	0.0185	-0.0636	0.0704	0.0005	0.0285	0.1329	0.2741

Mature Late lbs Milk/day

Heifer Transition lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	0.3183	0.3455	0.3052	0.3223	0.3189	0.3003	0.2938	0.3006	0.2655	0.3162	0.2727	0.2916
Feb	0.2051	0.3788	0.3282	0.2739	0.3593	0.3009	0.2627	0.2940	0.3123	0.3233	0.3576	0.3245
Mar	0.2474	0.2569	0.2526	0.1917	0.2424	0.2037	0.2446	0.2658	0.1980	0.2802	0.3015	0.2557
Apr	0.2121	0.2603	0.2162	0.2765	0.3112	0.2671	0.2057	0.2347	0.1944	0.1910	0.2194	0.3086
May	0.3713	0.4020	0.2983	0.3013	0.3939	0.3399	0.2896	0.3651	0.3333	0.3180	0.2933	0.3848
Jun	0.2524	0.3053	0.2140	0.1995	0.2978	0.3221	0.2614	0.3608	0.3452	0.3371	0.3166	0.3915
Jul	0.1674	0.1931	0.0836	0.1582	0.2233	0.1803	0.2813	0.3303	0.2937	0.1935	0.3043	0.2874
Aug	0.0964	0.1504	0.0495	0.0161	0.0881	0.1399	0.1446	0.2081	0.1758	0.2074	0.1901	0.2041
Sep	0.1383	0.2251	0.1155	0.0965	0.0898	0.2306	0.1630	0.1672	0.1915	0.1875	0.1788	0.1936
Oct	0.0718	0.1860	0.0909	0.0202	0.0827	0.0992	0.0771	0.2039	0.2268	0.2885	0.2158	0.2783
Nov	0.1831	0.2903	0.1699	0.0529	0.0667	0.1652	0.1502	0.2518	0.2692	0.3343	0.3041	0.2944
Dec	-0.0561	0.0780	0.0002	-0.0877	-0.0020	-0.0826	-0.1208	0.0454	0.0432	0.0682	0.1167	0.1930

Monthly Culling Rate

Heifer Transition lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	-0.3501	-0.3039	-0.2943	-0.2893	-0.3174	-0.2944	-0.2871	-0.2617	-0.2017	-0.2077	-0.2118	-0.2268
Feb	-0.1933	-0.1432	-0.1360	-0.1480	-0.1348	-0.1091	-0.1135	-0.0965	-0.0586	-0.0798	-0.1297	-0.1651
Mar	-0.3057	-0.3057	-0.2739	-0.2752	-0.2758	-0.2213	-0.2451	-0.2545	-0.2100	-0.2241	-0.2408	-0.2057
Apr	-0.1589	-0.1037	-0.1156	-0.1137	-0.1549	-0.1361	-0.1443	-0.1232	-0.0646	-0.0784	-0.1602	-0.1388
May	-0.2376	-0.1882	-0.1557	-0.1403	-0.1721	-0.1122	-0.0832	-0.1033	-0.0569	-0.0361	-0.0679	-0.0431
Jun	-0.2611	-0.2521	-0.2113	-0.2004	-0.2457	-0.1900	-0.1775	-0.2125	-0.2092	-0.1974	-0.1942	-0.1454
Jul	-0.0344	-0.0202	0.0073	-0.0152	-0.0381	-0.0219	-0.0525	-0.0813	-0.1049	-0.1652	-0.2157	-0.2029
Aug	-0.2289	-0.1807	-0.1764	-0.1547	-0.1515	-0.0876	-0.1008	-0.1002	-0.1028	-0.0706	-0.1066	-0.1021
Sep	-0.2690	-0.2357	-0.2340	-0.2361	-0.2335	-0.1714	-0.1874	-0.2014	-0.1819	-0.1711	-0.2074	-0.1606
Oct	-0.2099	-0.2039	-0.1977	0.1926	-0.2134	-0.1326	-0.1766	-0.1877	-0.1181	-0.1520	-0.1249	-0.0922
Nov	-0.1667	-0.1065	-0.1061	-0.163	-0.1055	-0.0944	-0.1096	-0.1196	-0.0639	-0.0726	-0.0767	-0.0304
Dec	-0.1839	-0.1553	-0.1694	-0.1170	-0.0939	-0.1137	-0.1214	-0.1011	-0.1043	-0.1078	-0.1321	-0.1420

Heifer Early lbs Milk/Day

Heifer Early lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	1.0000	0.8318	0.8082	0.7430	0.7216	0.6678	0.6082	0.6499	0.5757	0.5618	0.5552	0.5214
Feb		1.0000	0.8748	0.7723	0.7439	0.6660	0.5644	0.6419	0.5862	0.6205	0.5880	0.5657
Mar			1.0000	0.8370	0.7832	0.7325	0.6154	0.6875	0.6186	0.6517	0.6245	0.5849
Apr				1.0000	0.8328	0.7552	0.6283	0.6512	0.6610	0.5825	0.5690	0.5433
May					1.0000	0.8157	0.6984	0.7179	0.6766	0.6892	0.6520	0.6404
Jun						1.0000	0.7319	0.7290	0.6943	0.7077	0.6432	0.6353
Jul							1.0000	0.7800	0.6825	0.5974	0.5606	0.5309
Aug								1.0000	0.8264	0.7736	0.7120	0.6586
Sep									1.0000	0.7857	0.6836	0.6244
Oct										1.0000	0.8610	0.7852
Nov											1.0000	0.8242
Dec												1.0000

Heifer Late lbs Milk/day

Heifer Early lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	0.8098	0.7776	0.7300	0.7432	0.7243	0.6604	0.6295	0.6369	0.5882	0.6366	0.5725	0.5238
Feb	0.7239	0.8209	0.7435	0.7058	0.7073	0.6248	0.5435	0.5779	0.5515	0.6295	0.5722	0.5195
Mar	0.7489	0.7565	0.7986	0.7265	0.6996	0.6617	0.5548	0.5997	0.5747	0.6388	0.6212	0.5591
Apr	0.6985	0.7186	0.7425	0.7480	0.6751	0.6759	0.6263	0.5996	0.6276	0.6266	0.5990	0.5075
May	0.6581	0.7124	0.7064	0.6777	0.7618	0.6638	0.6447	0.6018	0.5932	0.6291	0.5774	0.5344
Jun	0.6373	0.6234	0.6097	0.6486	0.6232	0.7724	0.5905	0.5482	0.5755	0.6274	0.5897	0.5884
Jul	0.6104	0.5875	0.5645	0.5466	0.6058	0.6717	0.7849	0.6202	0.6570	0.6163	0.5957	0.5266
Aug	0.5981	0.6456	0.5929	0.5607	0.6005	0.6736	0.6619	0.7973	0.7333	0.7374	0.7038	0.6548
Sep	0.5600	0.5710	0.5592	0.5399	0.5654	0.6177	0.6341	0.6607	0.8055	0.7325	0.6209	0.5106
Oct	0.5692	0.5975	0.5564	0.5028	0.5260	0.5591	0.4667	0.5312	0.5854	0.7592	0.6505	0.6167
Nov	0.5500	0.5754	0.5540	0.4847	0.5342	0.5627	0.4930	0.5385	0.5458	0.7355	0.7404	0.6643
Dec	0.358	0.5677	0.5233	0.4495	0.5144	0.5217	0.4455	0.5095	0.4757	0.6508	0.6422	0.7303

Mature Transition lbs Milk/Day

Heifer Early lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	0.4184	0.4594	0.3729	0.2744	0.2048	0.1709	0.2578	0.3630	0.2473	0.3013	0.1502	0.2249
Feb	0.2717	0.5628	0.3739	0.2809	0.1760	0.1707	0.1804	0.3414	0.2967	0.2909	0.1562	0.2877
Mar	0.2780	0.5041	0.4504	0.2748	0.1317	0.2175	0.1936	0.3437	0.2767	0.2462	0.1980	0.2972
Apr	0.3111	0.5558	0.4644	0.4768	0.2803	0.3536	0.3878	0.4262	0.4228	0.3473	0.2487	0.2675
May	0.3261	0.5759	0.4459	0.4864	0.3909	0.3912	0.3880	0.4504	0.4166	0.3555	0.2994	0.2891
Jun	0.2603	0.4944	0.4007	0.3886	0.3133	0.4221	0.3787	0.3957	0.3858	0.3211	0.2449	0.3056
Jul	0.3648	0.4696	0.3908	0.3080	0.2912	0.3390	0.5068	0.4383	0.3786	0.3204	0.2735	0.2649
Aug	0.2991	0.4515	0.3912	0.4078	0.2427	0.3548	0.3298	0.5450	0.4253	0.3981	0.3020	0.3759
Sep	0.2636	0.4991	0.3302	0.4503	0.2600	0.3925	0.3155	0.4603	0.5124	0.4551	0.2441	0.3622
Oct	0.2351	0.4658	0.3291	0.4023	0.2138	0.3550	0.2003	0.4113	0.4255	0.3608	0.3299	0.3537
Nov	0.2230	0.3929	0.3336	0.3977	0.2151	0.3722	0.2685	0.4260	0.3981	0.3515	0.4201	0.4362
Dec	0.1641	0.4045	0.3973	0.3735	0.2661	0.4214	0.2542	0.4251	0.4089	0.3139	0.5044	0.5346

Mature Early lbs Milk/Day

Heifer Early lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	0.8150	0.7576	0.7281	0.6494	0.5795	0.5951	0.4958	0.5813	0.5928	0.6109	0.5662	0.5498
Feb	0.6123	0.8072	0.7005	0.6426	0.5996	0.5770	0.4065	0.4890	0.5219	0.5701	0.5522	0.5352
Mar	0.6556	0.7472	0.8070	0.6811	0.6186	0.6167	0.4547	0.5226	0.6173	0.6577	0.6268	0.5994
Apr	0.6552	0.7031	0.7391	0.7759	0.6681	0.6442	0.5273	0.5750	0.6934	0.6341	0.6011	0.5876
May	0.6199	0.6911	0.7020	0.6999	0.7790	0.6998	0.5601	0.6149	0.6242	0.6268	0.6010	0.6042
Jun	0.5531	0.5870	0.6136	0.6367	0.6174	0.8100	0.5334	0.5491	0.6000	0.6147	0.5384	0.5074
Jul	0.5188	0.5768	0.5577	0.5730	0.5697	0.6984	0.7932	0.6587	0.6132	0.5914	0.5131	0.4702
Aug	0.5306	0.6315	0.6046	0.5618	0.5291	0.6025	0.5601	0.7407	0.6767	0.6834	0.6075	0.5751
Sep	0.4760	0.5255	0.5239	0.5357	0.4985	0.5916	0.5261	0.6599	0.7476	0.6543	0.5475	0.4978
Oct	0.4294	0.5460	0.5192	0.4985	0.4819	0.5728	0.3692	0.4871	0.5445	0.7342	0.6448	0.6078
Nov	0.4472	0.5378	0.5165	0.5231	0.5009	0.5410	0.3818	0.4730	0.5113	0.6699	0.7124	0.6825
Dec	0.3682	0.4739	0.4943	0.5033	0.4899	0.5062	0.3412	0.4557	0.4320	0.5637	0.6210	0.7318

Mature Late lbs Milk/day

Heifer Early lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	0.6803	0.6563	0.6231	0.5827	0.5826	0.5496	0.5522	0.5511	0.5080	0.5437	0.4390	0.4940
Feb	0.5418	0.6479	0.5799	0.5237	0.5261	0.4517	0.4170	0.4607	0.4637	0.4931	0.3999	0.3904
Mar	0.5971	0.6267	0.6439	0.5620	0.5549	0.5069	0.4818	0.5155	0.4946	0.5284	0.4796	0.4960
Apr	0.5920	0.6028	0.6164	0.6046	0.5405	0.5333	0.5340	0.5540	0.5730	0.5271	0.4785	0.5035
May	0.5423	0.5835	0.5705	0.5257	0.6089	0.5190	0.5388	0.5960	0.5353	0.5396	0.4747	0.5184
Jun	0.5579	0.5286	0.5023	0.4897	0.5133	0.6277	0.5118	0.5279	0.5128	0.5256	0.4674	0.5106
Jul	0.5064	0.4852	0.4749	0.4368	0.4530	0.5067	0.7263	0.5926	0.5594	0.5201	0.5185	0.4743
Aug	0.4435	0.4949	0.4359	0.3798	0.4166	0.4819	0.5672	0.6724	0.6009	0.5492	0.5242	0.4929
Sep	0.4119	0.4062	0.3744	0.3361	0.3505	0.4361	0.5182	0.5999	0.7102	0.5715	0.4822	0.4209
Oct	0.4241	0.4583	0.4017	0.3040	0.3321	0.3583	0.3520	0.4696	0.4859	0.5712	0.4888	0.4545
Nov	0.4220	0.4736	0.3901	0.3002	0.3377	0.3592	0.3490	0.4633	0.4359	0.5307	0.5652	0.5238
Dec	0.4274	0.4864	0.4048	0.2853	0.2582	0.2983	0.2920	0.4306	0.4117	0.4397	0.4972	0.5519

Culling Rate

Heifer Early lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	-0.1587	-0.1012	-0.0976	-0.1205	-0.1457	-0.1414	-0.1451	-0.1545	-0.1148	-0.0972	-0.1009	-0.0926
Feb	-0.2393	-0.1721	-0.1770	-0.1662	-0.1837	-0.1881	-0.1829	-0.1833	-0.1630	-0.1441	-0.1195	-0.1180
Mar	-0.1660	-0.1119	-0.1116	-0.1182	-0.1241	-0.1061	-0.1126	-0.1143	-0.0795	-0.0795	-0.0605	-0.0596
Apr	-0.1572	-0.1074	-0.0905	-0.1198	-0.1594	-0.1159	-0.1267	-0.1386	-0.0933	-0.1065	-0.0966	-0.0736
May	-0.1471	-0.1058	-0.1059	-0.1230	-0.1463	-0.1086	-0.1261	-0.1173	-0.0842	-0.0925	-0.0867	-0.0600
Jun	-0.1879	-0.1626	-0.1246	-0.1244	-0.1439	-0.0989	-0.1064	-0.0973	-0.0780	-0.0623	-0.0231	-0.0045
Jul	-0.1473	-0.1350	-0.1022	-0.1494	-0.1609	-0.1477	-0.1617	-0.1706	-0.1901	-0.2090	-0.2044	-0.1715
Aug	-0.1250	-0.0869	-0.0543	-0.0723	-0.0665	-0.0508	-0.0952	-0.0924	-0.0725	-0.0786	-0.0586	-0.0336
Sep	-0.1617	-0.1258	-0.1246	-0.1319	-0.1143	-0.0916	-0.1138	-0.0960	-0.0662	-0.0838	-0.0742	-0.0479
Oct	-0.2008	-0.1493	-0.1469	-0.1338	-0.1377	-0.1059	-0.1144	-0.0918	-0.0486	-0.0319	-0.0145	0.0345
Nov	-0.1083	-0.0593	-0.0679	-0.0658	-0.0806	-0.0539	-0.0545	-0.0782	-0.0537	-0.0291	-0.0283	0.0114
Dec	-0.0571	-0.0028	0.0047	0.0241	0.0033	0.0225	0.0259	0.0129	0.0305	0.0329	0.0436	0.0728

Heifer Late lbs Milk/Day

Heifer Late lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	1.0000	0.8702	0.8240	0.8017	0.7420	0.6984	0.6262	0.6179	0.5950	0.665	0.6158	0.5611
Feb		1.0000	0.8512	0.8017	0.7769	0.7046	0.6282	0.6821	0.6304	0.6976	0.6319	0.6106
Mar			1.0000	0.8884	0.8184	0.7249	0.6611	0.6432	0.6166	0.6636	0.6404	0.5666
Apr				1.0000	0.8430	0.7960	0.6705	0.6553	0.6209	0.6401	0.6094	0.5069
May					1.0000	0.7893	0.7549	0.6963	0.6684	0.6652	0.6501	0.5255
Jun						1.0000	0.8008	0.7525	0.7159	0.6945	0.6859	0.5701
Jul							1.0000	0.7693	0.7550	0.6639	0.6447	0.5050
Aug								1.0000	0.8406	0.7219	0.6993	0.5916
Sep									1.0000	0.8074	0.7502	0.5356
Oct										1.0000	0.8567	0.6479
Nov											1.0000	0.7543
Dec												1.0000

Mature Transition lbs Milk/day

Heifer Late lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	0.2739	0.3875	0.3392	0.1744	0.1626	0.2278	0.2489	0.2234	0.1889	0.1872	0.1256	0.2286
Feb	0.2303	0.4151	0.3125	0.2481	0.1593	0.1842	0.2094	0.2760	0.1955	0.1825	0.1821	0.2678
Mar	0.1841	0.3915	0.3484	0.2620	0.1654	0.1772	0.2121	0.2628	0.2553	0.1721	0.1435	0.2126
Apr	0.2312	0.3928	0.2983	0.2628	0.2172	0.2275	0.3009	0.2609	0.2776	0.2305	0.1408	0.1821
May	0.2472	0.4756	0.3236	0.2497	0.3263	0.2709	0.3247	0.3385	0.3236	0.2857	0.2511	0.2313
Jun	0.2238	0.3774	0.2528	0.2271	0.1573	0.3003	0.3666	0.3237	0.3023	0.2954	0.1828	0.2409
Jul	0.2808	0.3644	0.2704	0.2500	0.2744	0.2623	0.4692	0.3888	0.3217	0.3055	0.2261	0.1790
Aug	0.3083	0.3536	0.3191	0.2516	0.1811	0.3191	0.3540	0.4565	0.3443	0.3500	0.2936	0.3680
Sep	0.2542	0.4365	0.2595	0.2836	0.1674	0.3019	0.2917	0.4003	0.4084	0.4057	0.2549	0.3389
Oct	0.2844	0.5053	0.3362	0.3106	0.2402	0.2957	0.2893	0.4247	0.3716	0.4104	0.3209	0.3335
Nov	0.1752	0.4187	0.3592	0.2199	0.2507	0.2406	0.2546	0.3692	0.3613	0.3217	0.3470	0.3368
Dec	0.1372	0.3612	0.4408	0.2792	0.2333	0.2904	0.2014	0.3929	0.3481	0.2764	0.4412	0.4587

Mature Early lbs Milk/day

Heifer Late lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	0.7093	0.6541	0.6605	0.5625	0.5029	0.5660	0.5040	0.5241	0.5337	0.5468	0.4772	0.5313
Feb	0.6259	0.7088	0.6453	0.5597	0.5401	0.5475	0.4538	0.5216	0.5030	0.5438	0.4827	0.5213
Mar	0.5944	0.6314	0.7225	0.6108	0.5805	0.5624	0.4884	0.5238	0.5976	0.5957	0.5525	0.5748
Apr	0.5922	0.6087	0.6416	0.6274	0.5763	0.5875	0.4473	0.4782	0.5568	0.5246	0.4938	0.4953
May	0.5771	0.6545	0.6769	0.6387	0.7280	0.6388	0.5427	0.5941	0.5834	0.5316	0.5300	0.5488
Jun	0.5468	0.5609	0.6038	0.5525	0.5418	0.7284	0.5570	0.5571	0.5792	0.5472	0.4785	0.4974
Jul	0.5520	0.5391	0.5717	0.5205	0.5639	0.6198	0.7710	0.6822	0.6348	0.5470	0.4653	0.4472
Aug	0.5440	0.5893	0.6122	0.5151	0.4940	0.5248	0.5437	0.7437	0.6459	0.5927	05381	0.5380
Sep	0.5156	0.5458	0.5551	0.5290	0.5038	0.5794	0.5752	0.6777	0.7338	0.6033	0.5088	0.4636
Oct	0.5426	0.6379	0.6013	0.5998	0.5507	0.5862	0.4809	0.6217	0.6328	0.7145	0.6275	0.6022
Nov	0.4933	0.5675	0.5866	0.5582	0.5112	0.5647	0.4847	0.5540	0.5757	0.6291	0.6690	0.6129
Dec	0.3893	0.4499	0.5022	0.4218	0.4169	0.4560	0.3689	0.4494	0.4490	0.5035	0.5327	0.6403

Mature Late lbs Milk/Day

Heifer Late lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	0.7842	0.7097	0.7209	0.6354	0.6108	0.5757	0.5646	0.5284	0.5019	0.5540	0.5000	0.5564
Feb	0.6845	0.7778	0.6622	0.6013	0.5908	0.5341	0.5186	0.5388	0.4952	0.5541	0.4980	0.5494
Mar	0.6904	0.6910	0.7551	0.6838	0.6463	0.5904	0.5861	0.5535	0.5636	0.5857	0.5232	0.5703
Apr	0.6948	0.6467	0.6611	0.7252	0.6520	0.6276	0.5629	0.5192	0.5182	0.5302	0.4702	0.4935
May	0.6223	0.6365	0.6196	0.6155	0.7413	0.6007	0.6010	0.5938	0.5831	0.5933	0.5197	0.5163
Jun	0.6187	0.6102	0.5608	0.5608	0.5853	0.7606	0.6539	0.6070	0.5832	0.5802	0.5178	0.5340
Jul	0.5727	0.5538	0.5463	0.5153	0.5580	0.6211	0.8317	0.6848	0.6454	0.5994	0.5440	0.5042
Aug	0.4973	0.5342	0.4745	0.4107	0.4555	0.5373	0.6332	0.7778	0.6707	0.5710	0.5248	0.4786
Sep	0.4690	0.4777	0.4572	0.4188	0.4691	0.5440	0.6462	0.7271	0.8250	0.6748	0.5879	0.4551
Oct	0.5580	0.6192	0.5568	0.4640	0.5050	0.5344	0.5344	0.6564	0.6876	0.8084	0.6789	0.5701
Nov	0.5317	0.5885	0.5502	0.5074	0.5192	0.5539	0.5554	0.6248	0.6053	0.6717	0.7542	0.6029
Dec	0.5165	0.5921	0.5070	0.4235	0.4338	0.4442	0.4369	0.5237	0.4636	0.5185	0.6102	0.7314

Culling Rate

Heifer Late lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	-0.1155	-0.0523	-0.0509	-0.0836	-0.0980	-0.1068	-0.1010	-0.1048	-0.1009	-0.0880	-0.0873	-0.0599
Feb	-0.1321	-0.0751	-0.0793	-0.0995	-0.0987	-0.1028	-0.1150	-0.1037	-0.0795	-0.0865	-0.0851	-0.0801
Mar	-0.0147	0.0244	0.0201	-0.0025	-0.0115	-0.0132	-0.0298	-0.0449	-0.0387	-0.0515	-0.0694	-0.0775
Apr	-0.0463	-0.0054	-0.0107	-0.0415	-0.0668	-0.0639	-0.0908	-0.0934	-0.0921	-0.0860	-0.0792	-0.0783
May	-0.0521	-0.0034	-0.0160	-0.0334	-0.0318	-0.0357	-0.0576	-0.0695	-0.0558	-0.0764	-0.0990	-0.1114
Jun	-0.0774	-0.0511	-0.0342	-0.0484	-0.0516	-0.0330	-0.0732	-0.0576	-0.0655	-0.0697	-0.0576	-0.0840
Jul	-0.0216	-0.0103	-0.0118	-0.0558	-0.0629	-0.0563	-0.0908	-0.0967	-0.1304	-0.1617	-0.1721	-0.1789
Aug	-0.0065	0.0386	0.0559	0.0141	0.0416	0.0429	-0.0090	-0.0008	-0.0202	-0.0555	-0.0542	-0.0794
Sep	-0.0628	-0.0340	-0.0249	-0.0635	-0.0283	0.0033	-0.0272	-0.0139	-0.0025	-0.0604	-0.0678	-0.0801
Oct	-0.1653	-0.1135	-0.1151	-0.1262	-0.1154	-0.0965	-0.1196	-0.1053	-0.0766	-0.1045	-0.1151	-0.0863
Nov	-0.0326	0.0120	0.0056	-0.0140	-0.0323	-0.0152	-0.0411	-0.0622	-0.0279	-0.0663	-0.0791	-0.0773
Dec	-0.0501	-0.0090	0.0093	0.0208	0.0075	0.0363	0.0472	0.0351	0.0776	0.0415	0.0511	0.0177

Mature Transition lbs Milk/day

Mature Transition lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	1.0000	0.4291	0.4110	0.3291	0.2639	0.2809	0.4477	0.4642	0.3091	0.3405	0.2941	0.1994
Feb		1.0000	0.5243	0.5397	0.3694	0.3547	0.2882	0.4142	0.4969	0.4418	0.3482	0.2677
Mar			1.0000	0.3619	0.4711	0.3193	0.3975	0.4180	0.3215	0.3740	0.3132	0.3348
Apr				1.0000	0.4052	0.4697	0.3845	0.5261	0.5406	0.4846	0.4576	0.3396
May					1.0000	0.4927	0.5814	0.5266	0.5699	0.4036	0.3344	0.1580
Jun						1.0000	0.5578	0.5008	0.5429	0.4583	0.4412	0.4156
Jul							1.0000	0.5726	0.5150	0.4729	0.3759	0.2928
Aug								1.0000	06202	0.5538	0.5179	0.3938
Sep									1.0000	0.6376	0.4819	0.3939
Oct										1.0000	0.5369	0.5282
Nov											1.0000	0.5681
Dec												1.0000

Mature Early lbs Milk/Day

Mature Transition lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	0.4772	0.4394	0.3629	0.3915	0.3466	0.3193	0.3038	0.4344	0.3345	0.3895	0.2824	0.2977
Feb	0.4337	0.6081	0.5702	0.6334	0.6664	0.5506	0.3756	0.4366	0.5198	0.5102	0.4601	0.4361
Mar	0.4056	0.4763	0.5663	0.5590	0.4954	0.4856	0.4300	0.5251	0.4644	0.4413	0.4182	0.4631
Apr	0.3047	0.3930	0.2904	0.4977	0.4860	0.3936	0.3022	0.4061	0.4405	0.3919	0.3476	0.3427
May	0.2485	0.2483	0.2357	0.3709	0.5084	0.4147	0.4381	0.4573	0.3533	0.2988	0.2937	0.3021
Jun	0.1975	0.2392	0.2489	0.3739	0.3923	0.4344	0.3541	0.4257	0.3410	0.3395	0.3259	0.4207
Jul	0.2457	0.2638	0.25089	0.4078	0.3928	0.4637	0.6013	0.5400	0.4224	0.3367	0.2864	0.3244
Aug	0.3711	0.4079	0.3709	0.4933	0.4316	0.4062	0.4559	0.6498	0.5253	0.4934	0.4300	0.4802
Sep	0.2660	0.3091	0.3167	0.4675	0.4743	0.4385	0.4275	0.4770	0.5447	0.5483	0.5039	0.5025
Oct	0.3212	0.3840	0.2981	0.4176	0.3699	0.3789	0.3405	0.4725	0.5142	0.5084	0.4689	0.4912
Nov	0.1919	0.2615	0.1926	0.2957	0.3462	0.2576	0.2216	0.2935	0.3171	0.3715	0.5023	0.5302
Dec	0.1261	0.2596	0.2703	0.3145	0.3027	0.3062	0.1989	0.3166	0.3093	0.3642	0.4118	0.5620

Mature Late lbs Milk/Day

Mature Transition lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	0.2987	0.3260	0.2382	0.2064	0.2071	0.2072	0.2914	0.3286	0.2308	0.2358	0.2145	0.2421
Feb	0.3485	0.4558	0.4106	0.3170	0.3798	0.2883	0.2969	0.4003	0.4852	0.4773	0.3628	0.3145
Mar	0.3744	0.3661	0.3926	0.3454	0.3379	0.2969	0.3210	0.3746	0.3197	0.3479	0.4401	0.4248
Apr	0.1249	0.2204	0.1559	0.1541	0.1740	0.1743	0.1831	0.2687	0.3123	0.2843	0.2260	0.2907
May	0.2008	0.1688	0.1768	0.2834	0.3418	0.2378	0.2455	0.3018	0.2700	0.2406	0.2761	0.2806
Jun	0.2155	0.1671	0.1263	0.1065	0.1419	0.1967	0.1734	0.3228	0.2701	0.2082	0.2657	0.3324
Jul	0.2520	0.2254	0.1709	0.2258	0.2100	0.2605	0.3996	0.3505	0.2490	0.2219	0.2647	0.2764
Aug	0.1778	0.2249	0.1750	0.1592	0.2128	0.2535	0.3096	0.4518	0.3478	0.2936	0.2790	0.3110
Sep	0.2376	0.2167	0.2002	0.2181	0.1915	0.1881	0.2731	0.3619	0.4405	0.3159	0.3227	0.2718
Oct	0.1459	0.1952	0.1568	0.1977	0.2172	0.2841	0.2522	0.3615	0.4145	0.4013	0.3586	0.2928
Nov	0.1552	0.2577	0.1244	0.0873	0.1891	0.1487	0.1716	0.2534	0.2064	0.2892	0.3358	0.3670
Dec	0.1114	0.2168	0.1235	0.0603	0.1267	0.1362	0.1035	0.2486	0.2839	0.2648	0.3178	0.3255

Culling Rate

Mature Transition lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	-0.2364	-0.2395	-0.2412	-0.2588	-0.2525	-0.2524	-0.2612	-0.2558	-0.2155	-0.2133	-0.2071	-0.1854
Feb	-0.3213	-0.2737	-0.2680	-0.2417	-0.2310	-0.2241	-0.2068	-0.2325	-0.1703	-0.1740	-0.1414	-0.1366
Mar	-0.1269	-0.1092	-0.0792	-0.0871	-0.0845	-0.0519	-0.0567	-0.0836	-0.0295	-0.0322	-0.0379	-0.0559
Apr	-0.1860	-0.1614	-0.1452	-0.1300	-0.1562	-0.1005	-0.1421	-0.1301	-0.0691	-0.0737	-0.0645	-0.0420
May	0.0684	0.0786	0.0529	0.0427	0.0171	0.0465	0.0191	-0.0245	0.0071	-0.0019	-0.0550	-0.0157
Jun	0.0829	0.1006	0.1339	0.1344	0.1351	0.1718	0.1733	0.1687	0.1622	0.1635	0.1615	0.1973
Jul	-0.0618	-0.0660	-0.0562	-0.0919	-0.1118	-0.0926	-0.1289	-0.1567	-0.1689	-0.1820	-0.2220	-0.1875
Aug	-0.0933	-0.0799	-0.0856	-0.1074	-0.1015	-0.0627	-0.0932	-0.1136	-0.0601	-0.0788	-0.1225	-0.1300
Sep	-0.0864	-0.0741	-0.0664	-0.0522	-0.0836	-0.0581	-0.0663	-0.1080	-0.0608	-0.0806	-0.0743	-0.0613
Oct	-0.1347	-0.1292	-0.1239	-0.1147	-0.1059	-0.0840	-0.1263	-0.1519	-0.1386	-0.1535	-0.1385	-0.1185
Nov	-0.1729	-0.1503	-0.1285	-0.1444	-0.1280	-0.0938	-0.0727	-0.1319	-0.0714	-0.0835	-0.1003	-0.0743
Dec	-0.1182	-0.0851	-0.0683	-0.0706	-0.0442	-0.0246	-0.0319	-0.0757	-0.0634	-0.0958	-0.0812	-0.0715

Mature Early lbs Milk/Day

Mature Eary lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	1.0000	0.8139	0.7741	0.6903	0.6109	0.6087	0.5576	0.6251	0.6294	0.6328	0.5671	0.5356
Feb		1.0000	0.8244	0.7991	0.7027	0.6616	0.5093	0.6241	0.5853	0.6611	0.6463	0.6053
Mar			1.0000	0.8451	0.7605	0.7146	0.6007	0.6572	0.6955	0.6957	0.6656	0.6646
Apr				1.0000	0.8199	0.7500	0.5900	0.6548	0.6778	0.6628	0.6855	0.6544
May					1.0000	0.7714	0.6452	0.6251	0.6524	0.6054	0.6276	0.6278
Jun						1.0000	0.7317	0.6640	0.6944	0.6572	0.6056	0.5829
Jul							1.0000	0.7429	0.6943	0.5654	0.4621	0.4321
Aug								1.0000	0.8051	0.7041	0.6041	0.5872
Sep									1.0000	0.7950	0.6973	0.6226
Oct										1.0000	0.8628	0.7677
Nov											1.0000	0.8582
Dec												1.0000

Mature Late lbs Milk/Day

Mature Early lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	0.6986	0.6442	0.6434	0.6181	0.6212	0.6172	0.5951	0.5968	0.4995	0.4975	0.4283	0.4664
Feb	0.5758	0.7171	0.6181	0.5929	0.6167	0.5467	0.5217	0.5954	0.5286	0.5555	0.4992	0.4502
Mar	0.6159	0.6553	0.7547	0.6296	0.6364	0.5555	0.5763	0.6498	0.5926	0.5754	0.5304	0.5241
Apr	0.5155	0.5599	0.5939	0.6172	0.6018	0.4943	0.4931	0.5895	0.5904	0.5612	0.5351	0.4849
May	0.4738	0.5015	0.5381	0.5081	0.6643	0.4340	0.4878	0.5525	0.5615	0.5503	0.4974	0.4956
Jun	0.5243	0.5080	0.5119	0.5109	0.5717	0.6493	0.5890	0.5823	0.6070	0.5789	0.5486	0.5256
Jul	0.4677	0.3880	0.4885	0.4189	0.4431	0.4564	0.7410	0.5730	0.5482	0.4727	0.4655	0.4161
Aug	0.4541	0.4307	0.4391	0.3906	0.4760	0.4913	0.6336	0.7803	0.6802	0.5830	0.5481	0.5119
Sep	0.4633	0.4179	0.4973	0.4571	0.4689	0.4916	0.5975	0.6500	0.7663	0.6055	0.5169	0.4747
Oct	0.5376	0.5244	0.5546	0.4803	0.4890	0.4977	0.5311	0.6370	0.6611	0.7015	0.5985	0.5344
Nov	0.4556	0.5131	0.5085	0.4826	0.4670	0.4158	0.4295	0.5642	0.5795	0.6047	0.6490	0.5536
Dec	0.4983	0.5447	0.5258	0.4467	0.4518	0.4093	0.3984	0.5449	0.5504	0.5651	0.6124	0.6828

Culling Rate

Mature Early lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	-0.0473	-0.0052	-0.0063	-0.0412	-0.0725	-0.0448	-0.0439	-0.0611	-0.0246	0.0064	-0.0037	-0.0165
Feb	-0.1911	-0.1494	-0.1475	-0.1468	-0.1580	-0.1559	-0.1538	-0.1731	-0.1481	-0.1299	-0.1072	-0.1165
Mar	-0.0588	-0.0293	-0.0371	-0.0481	-0.0686	-0.0586	-0.0710	-0.0935	-0.0668	-0.0712	-0.0620	-0.0839
Apr	-0.1241	-0.1153	-0.1074	-0.1230	-0.1510	-0.1489	-0.1594	-0.2044	-0.1626	-0.1711	-0.1743	-0.1746
May	-0.1118	-0.0886	-0.0968	-0.1134	-0.1248	-0.1116	-0.1206	-0.1544	-0.1287	-0.1509	-0.1540	-0.1473
Jun	-0.1000	-0.1043	-0.0793	-0.0821	-0.1159	-0.0893	-0.0941	-0.1019	-0.0858	-0.1110	-0.0825	-0.0959
Jul	0.0133	0.0056	0.0215	-0.0390	-0.0625	-0.0508	-0.0793	-0.1116	-0.1425	-0.1931	-0.2083	-0.2151
Aug	-0.0129	0.0026	0.0329	-0.0091	-0.0068	-0.0068	-0.0419	-0.0463	-0.0255	-0.0671	-0.0810	-0.0916
Sep	-0.0423	-0.0114	0.0027	-0.0258	-0.0197	-0.0039	-0.0316	-0.0506	-0.0189	-0.0737	-0.0765	-0.0855
Oct	-0.0763	-0.0461	-0.0365	-0.0531	-0.0730	-0.0693	-0.0826	-0.0882	-0.0505	-0.0698	-0.0702	-0.0567
Nov	-0.0701	-0.0251	-0.0134	-0.0274	-0.0711	-0.0758	-0.0693	-0.1118	-0.0583	-0.0660	-0.0555	-0.0431
Dec	-0.0360	0.0080	0.0194	0.0180	-0.0175	-0.0142	-0.0003	-0.0392	0.0016	-0.0357	-0.0287	-0.0248

Mature Late lbs Milk/Day

Mature Late lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	1.0000	0.8435	0.8142	0.7411	0.6763	0.6397	0.6173	0.5722	0.4854	0.5951	0.5865	0.6212
Feb		1.0000	0.8281	0.7446	0.6822	0.6312	0.5831	0.6075	0.5151	0.6311	0.6275	0.6431
Mar			1.0000	0.8299	0.7211	0.6510	0.6547	0.6212	0.5699	0.6442	0.6146	0.6440
Apr				1.0000	0.8304	0.7323	0.6608	0.5841	0.5459	0.5495	0.5762	0.5638
May					1.0000	0.7709	0.6608	0.6520	0.5838	0.6334	0.6098	0.6096
Jun						1.0000	0.7551	0.6843	0.6162	0.6269	0.6022	0.6047
Jul							1.0000	0.7957	0.6951	0.6163	0.6023	0.5493
Aug								1.0000	0.8265	0.7183	0.6693	0.6118
Sep									1.0000	0.7862	0.6688	0.5813
Oct										1.0000	0.8084	0.6869
Nov											1.0000	0.8067
Dec												1.0000

Culling Rate

Mature Late lbs Milk/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	-0.0840	-0.0213	-0.0069	-0.0262	-0.0715	-0.0623	-0.0367	-0.0586	-0.0220	0.0026	-0.0056	0.0109
Feb	-0.1388	-0.0882	-0.0905	-0.0767	-0.1127	-0.1220	-0.1071	-0.0979	-0.0495	-0.0462	-0.0454	-0.0611
Mar	-0.0525	0.0003	-0.0115	-0.0223	-0.0857	-0.1009	-0.1050	-0.1145	-0.0771	-0.0820	-0.0808	-0.0869
Apr	-0.0295	-0.0019	-0.0163	-0.0238	-0.0920	-0.0960	-0.0990	-0.1173	-0.0808	-0.0750	-0.0769	-0.0827
May	-0.0510	-0.0292	-0.0381	-0.0515	-0.0939	-0.0755	-0.0701	-0.0812	-0.0492	-0.0456	-0.0836	-0.1196
Jun	-0.0174	-0.0175	-0.0067	-0.0248	-0.0646	-0.0324	-0.0492	-0.0386	-0.0333	-0.0227	-0.0337	-0.0736
Jul	-0.0092	-0.0165	-0.0088	-0.0525	-0.0780	-0.0829	-0.1021	-0.1101	-0.1343	-0.1526	-0.1740	-0.1963
Aug	0.0047	0.0297	0.0464	0.0262	0.0177	0.0127	-0.0076	0.0005	-0.0011	-0.0322	-0.0400	-0.0683
Sep	-0.0604	-0.0395	-0.0189	-0.0283	-0.0372	-0.0201	-0.0209	-0.0236	-0.0014	-0.0588	-0.0465	-0.0551
Oct	-0.1616	-0.1559	-0.1480	-0.1491	-0.1747	-0.1590	-0.1664	-0.1650	-0.1224	-0.1567	-0.1670	-0.1546
Nov	-0.0293	-0.0308	-0.0144	-0.0307	-0.0758	-0.0598	-0.0537	-0.0896	-0.0539	-0.0928	0.0896	-0.1124
Dec	-0.0437	-0.0353	-0.0068	-0.0148	-0.0648	-0.0490	-0.0241	-0.0443	-0.0017	-0.0412	-0.0484	-0.0860

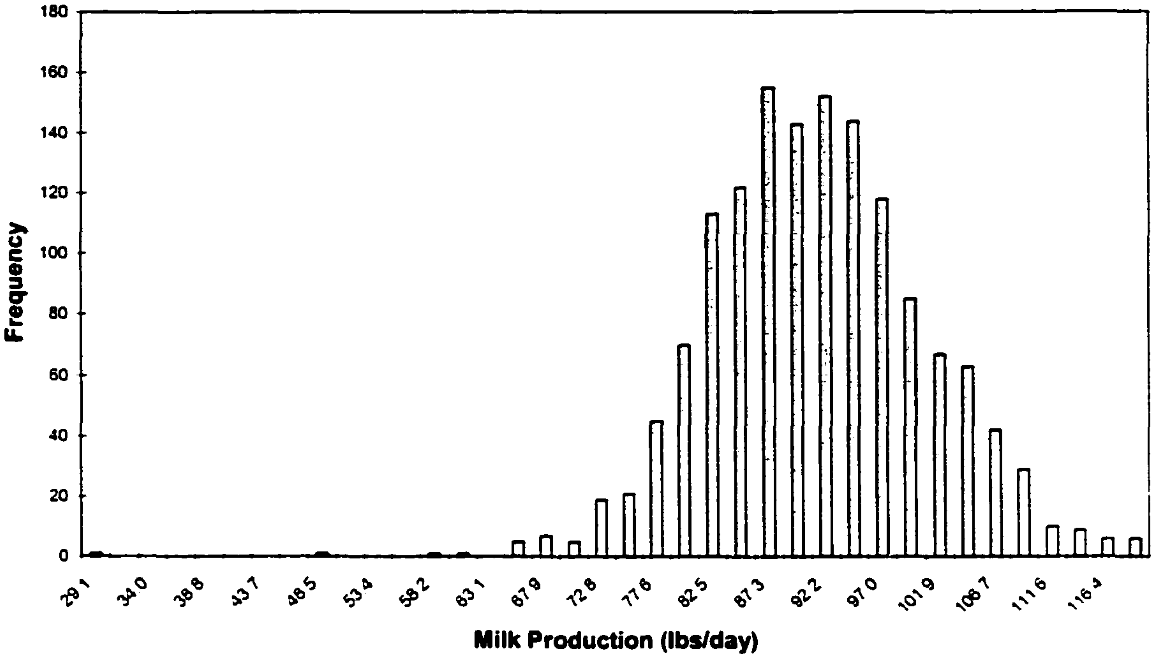
Culling Rate

Culling Rate

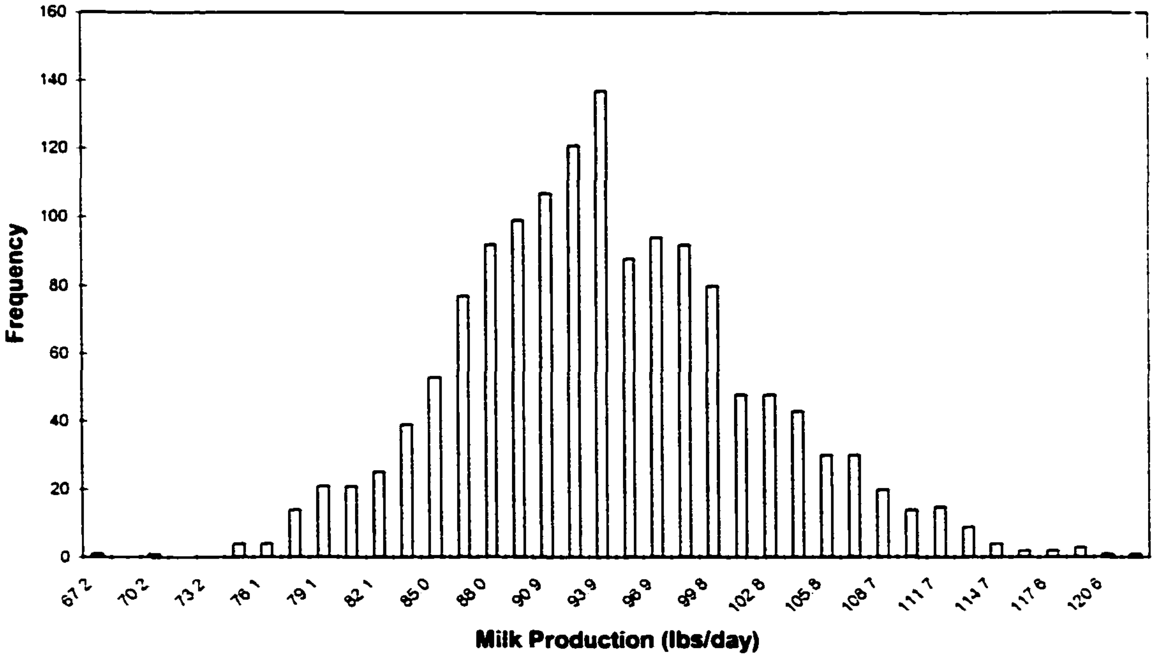
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jan	1.0000	0.9539	0.9271	0.9020	0.8651	0.8238	0.7533	0.7184	0.6286	0.5788	0.5149	0.4225
Feb		1.0000	0.9744	0.9505	0.9052	0.8672	0.8136	0.7796	0.6919	0.6459	0.5719	0.4860
Mar			1.0000	0.9704	0.9188	0.8982	0.8527	0.8058	0.7201	0.6747	0.6141	0.5243
Apr				1.0000	0.9502	0.9226	0.8828	0.8455	0.7642	0.7271	0.6821	0.5884
May					1.0000	0.9500	0.9164	0.8851	0.8031	0.7646	0.7142	0.6166
Jun						1.0000	0.9671	0.9283	0.8645	0.8345	0.7749	0.6890
Jul							1.0000	0.9500	0.8966	0.8770	0.8185	0.7350
Aug								1.0000	0.9379	0.9052	0.8483	0.7508
Sep									1.0000	0.9545	0.9047	0.8134
Oct										1.0000	0.9492	0.8843
Nov											1.0000	0.9430
Dec												1.0000

APPENDIX B-4

MILK PRODUCITION DISTRIBUTIONS FOR EACH STAGE OF LACTATION

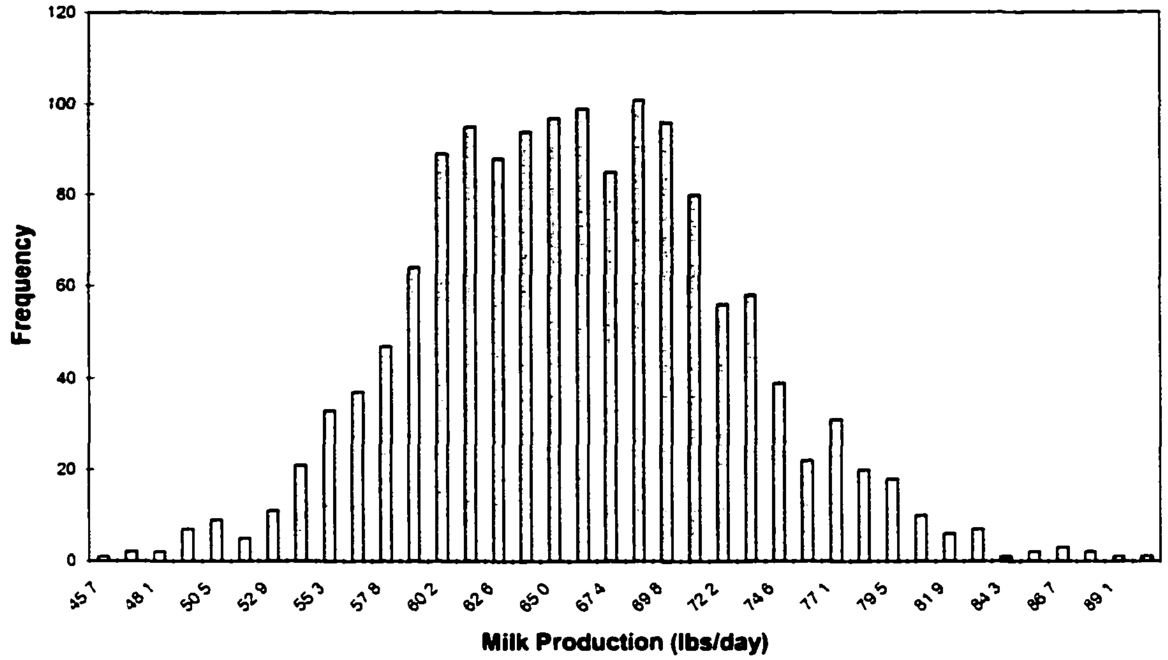


Mature Transition

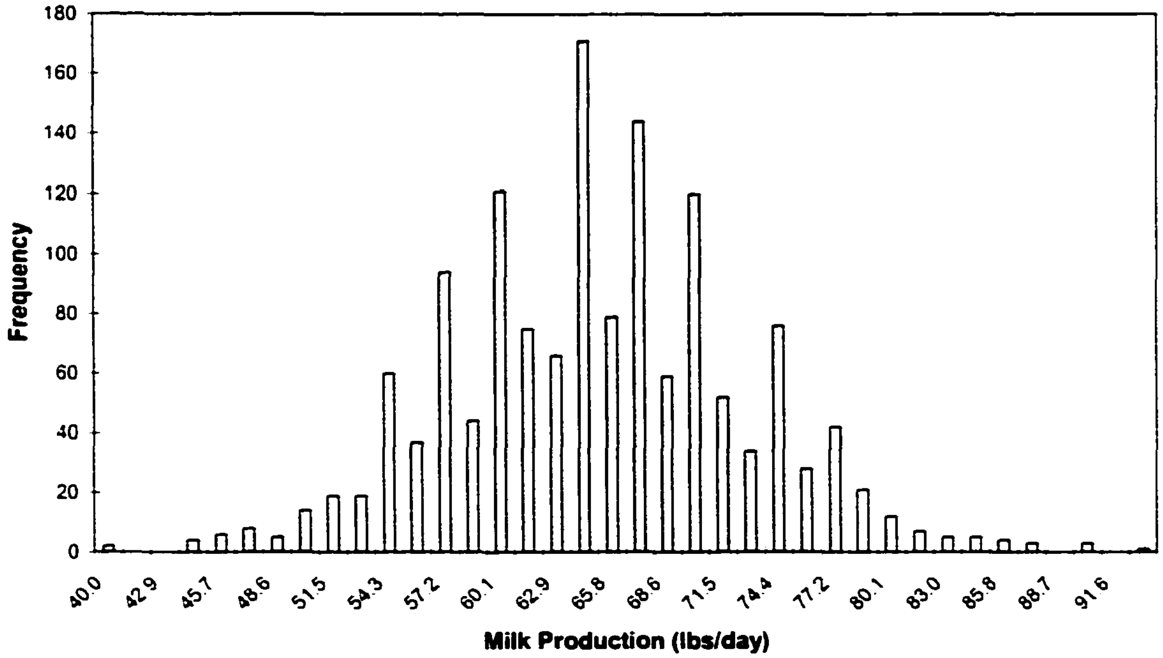


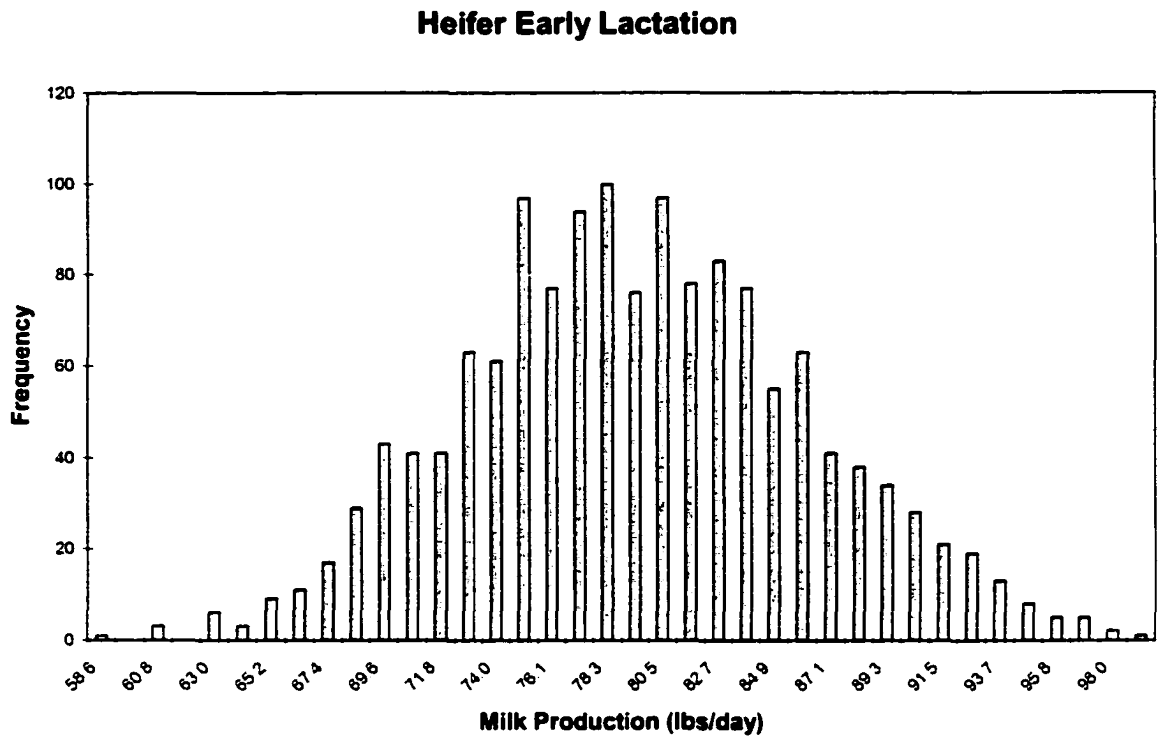
Mature Early Lactaion

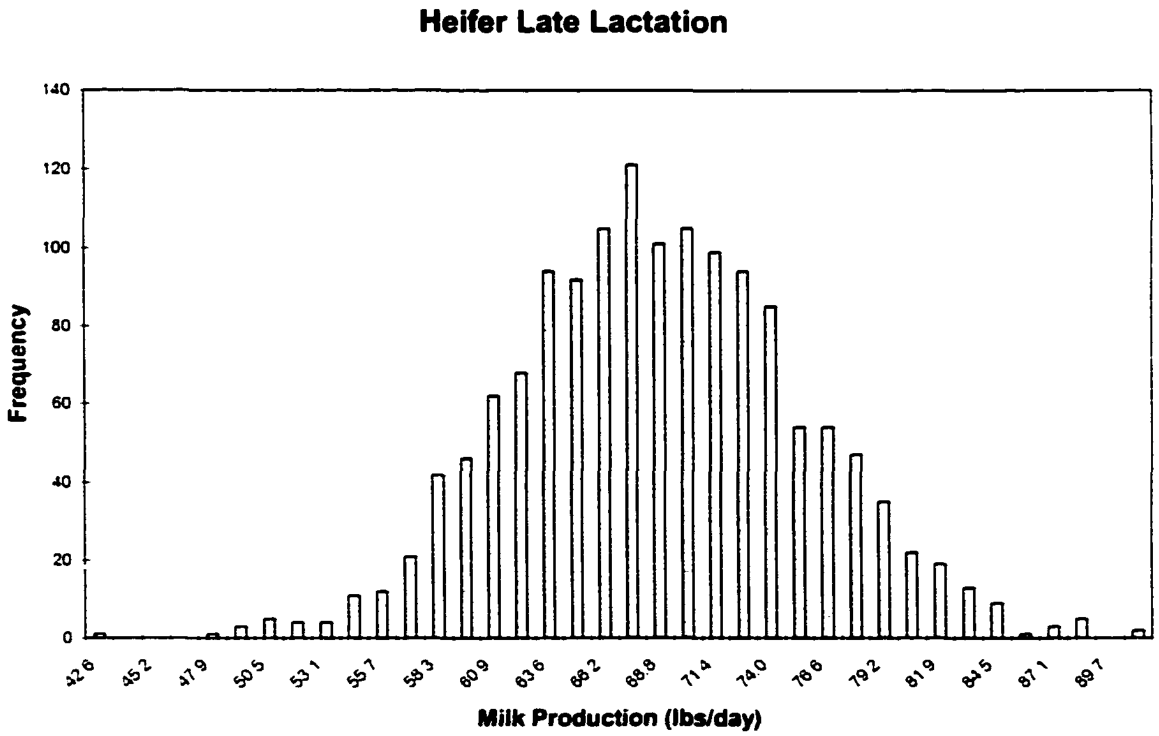
Mature Late Lactation



Heifer Transistion Stage




Heifer Early Lactation
Frequency
0
20
40
60
80
100
120
58.6
60.8
63.0
65.2
67.4
69.6
71.8
74.0
76.1
78.3
80.5
82.7
84.9
87.1
89.3
91.5
93.7
95.8
98.0
Milk Production (lbs/day)


Heifer Late Lactation
Frequency
0
20
40
60
80
100
120
140
42.6
45.2
47.9
50.5
53.1
55.7
58.3
60.9
63.6
66.2
68.8
71.4
74.0
76.6
79.2
81.9
84.5
87.1
89.7
Milk Production (lbs/day)

APPENDIX C-1

ANNUAL DISCOUNTED NET CASH FLOWS

Table C-1.1. Discounted Annual Net Cash Flows – Low Production Level – 56% Equity Level

Year	Average	St. Dev.	Min	Max	# Failing
1	($249,445)	269,761	($929,928)	$695,314	0
2	($166,455)	282,400	($886,794)	$660,333	0
3	($62,798)	283,151	($813,119)	$979,334	0
4	$54,726	287,756	($707,645)	$971,759	1
5	$169,296	274,778	($516,495)	$1,080,460	7
6	$196,955	273,547	($536,917)	$1,115,874	3
7	$204,152	258,145	($461,890)	$964,868	2
8	$265,227	242,191	($417,275)	$1,042,565	3
9	$257,781	233,213	($414,912)	$1,098,123	3
10	$244,003	220,138	($287,495)	$950,125	2
Total	$892,948	1,107,676	($2,384,616)	$3,789,607	21

Table C-1.2. Discounted Annual Net Cash Flows – High Production Level – 56% Equity Level

Year	Average	St. Dev.	Min	Max	# Failing
1	$187,363	316,526	($591,046)	$1,303,635	0
2	$317,117	320,634	($466,223)	$1,264,546	0
3	$331,038	307,149	($429,189)	$1,494,479	0
4	$362,325	305,296	($425,513)	$1,338,164	0
5	$392,877	287,394	($339,297)	$1,347,456	0
6	$448,995	288,594	($243,689)	$1,430,002	0
7	$479,906	278,196	($238,232)	$1,300,868	0
8	$564,428	267,737	($122,930)	$1,427,444	0
9	$576,716	264,370	($134,280)	$1,513,405	0
10	$581,368	250,821	($37,088)	$1,392,714	0
Total	$4,242,132	1,038,045	$1,243,706	$7,339,156	0

Table C-1.3. Discounted Annual Net Cash Flows – Medium Production Level – 46% Equity Level

Year	Average	St. Dev.	Min	Max	# Failing
1	($200,368)	285,308	($914,708)	$801,570	0
2	($138,982)	296,952	($892,263)	$760,590	0
3	($33,358)	294,864	($758,901)	$1,060,883	4
4	$92,226	295,364	($706,492)	$1,037,609	30
5	$120,678	276,714	($576,905)	$1,039,609	14
6	$191,321	278,029	($494,856)	$1,125,646	19
7	$224,039	264,017	($471,585)	$1,002,147	13
8	$390,815	251,652	($331,914)	$1,197,630	3
9	$399,504	244,839	($292,416)	$1,276,138	1
10	$399,108	233,775	($175,072)	$1,148,829	1
Total	$1,305,525	1,245,175	($1,829,256)	$4,380,814	85

Table C-1.4. Discounted Annual Net Cash Flows – Low Production Level – 46% Equity Level

Year	Average	St. Dev.	Min	Max	#Failing
1	($346,151)	270,063	($1,028,954)	$598,796	0
2	($307,861)	285,957	($1,034,266)	$523,953	0
3	($190,083)	277,934	($844,197)	$837,391	55
4	($58,604)	280,916	($745,595)	$834,157	103
5	$60,670	272,488	($688,743)	$970,456	74
6	$110,342	275,309	($474,803)	$1,023,853	53
7	$122,584	255,720	($490,098)	$878,056	39
8	$265,650	239,943	($322,102)	$1,042,565	17
9	$263,248	229,519	($289,544)	$1,047,088	3
10	$253,668	219,633	($287,4950	$950,125	2
Total	($160,976)	1,202,994	($1,885,962)	$3,033,030	346

Table C-1.5. Discounted Annual Net Cash Flows – High Production Level – 46% Equity Level

Year	Average	St. Dev.	Min	Max	# Failing
1	$90,844	316,527	($688,092)	$1,207,117	0
2	$184,774	321,625	($609,523)	$1,133,529	0
3	$205,431	308,590	($583,912)	$1,370,879	0
4	$243,766	306,689	($545,176)	$1,221,559	0
5	$281,113	288,517	($449,301)	$1,237,451	1
6	$355,870	288,955	($335,802)	$1,337,982	0
7	$392,473	278,568	($325,135)	$1,214,056	0
8	$564,168	267,996	($122,930)	$1,427,444	0
9	$576,936	264,394	($134,280)	$1,513,405	0
10	$581,579	250,848	($37,088)	$1,392,714	0
Total	$3,474,202	1,059,040	($1,531,144)	$6,582,579	1

Table C-1.6. Discounted Annual Net Cash Flows – Medium Production Level – 40% Equity Level

Year	Average	St. Dev.	Min	Max	# Failing
1	($242,872)	285,391	($958,247)	$759,113	0
2	($198,700)	295,934	($959,696)	$668,557	8
3	($72,628)	286,329	($761,029)	$998,469	85
4	$46,344	292,512	($659,762)	$979,328	82
5	$81,878	272,081	($634,383)	$989,459	54
6	$155,282	275,896	($418,184)	$1,078,057	39
7	$179,904	261,316	($507,032)	$957,251	16
8	$374,894	251,928	($247,260)	$1,182,575	16
9	$388,739	240,407	($153,869)	$1,207,749	0
10	$389,982	235,886	($198,681)	$1,135,430	1
Total	$645,124	1,378,618	($1,451,771)	$3,982,541	301

Table C-1.7. Discounted Annual Net Cash Flows – Low Production Level – 40% Equity Level

Year	Average	St. Dev.	Min	Max	# Failing
1	($388,740)	270,255	($1,072,493)	$556,339	0
2	($353,512)	276,175	($1,026,219)	$460,464	46
3	($194,933)	258,627	($906,672)	$768,955	263
4	($71,277)	265,411	($772,839)	$673,398	175
5	$34,344	268,680	($601,172)	$920,011	81
6	$112,460	268,156	($456,309)	$976,264	56
7	$98,955	260,448	($479,141)	$823,598	18
8	$245,618	250,030	($341,938)	$1,027,510	17
9	$260,774	222,234	($276,175)	$938,097	6
10	$235,293	214,478	($300,893)	$861,987	1
Total	($552,254)	930,649	($1,491,098)	$2,634,574	663

Table C-1.8. Discounted Annual Net Cash Flows – High Production Level – 40% Equity Level

Year	Average	St. Dev.	Min	Max	# Failing
1	$48,385	316,531	($731,105)	$1,164,660	0
2	$123,694	322,332	($676,400)	$1,076,449	0
3	$148,104	308,764	($587,711)	$1,314,199	2
4	$190,149	307,294	($604,055)	$1,168,088	3
5	$233,390	287,059	($500,375)	$1,187,007	9
6	$306,774	289,706	($392,299)	$1,290,392	0
7	$348,904	277,752	($370,030)	$1,169,160	1
8	$549,309	267,912	($138,551)	$1,412,389	0
9	$562,071	262,262	($148,482)	$1,499,202	0
10	$567,088	251,832	($50,487)	$1,379,315	0
Total	$3,038,647	1,143,629	($1,389,188)	$6,184,305	15

APPENDIX C-2

VALUE ADDED CORN PAYMENTS

Table C-2.1. Discounted Expected Corn Payments from Cooperative – Medium Production Case – 46% Equity Level (St. Dev. in Parentheses)

Year	Value Added Payment		Corn Price from Cooperative		Market Corn Price		Premium	
1	$0.28	(0.693)	$2.59	(0.755)	$2.36	(0.382)	$0.23	(0.706)
2	$0.22	(0.624)	$2.40	(0.691)	$2.22	(0.366)	$0.18	(0.633)
3	$0.26	(0.723)	$2.32	(0.766)	$2.10	(0.342)	$0.22	(0.746)
4	$0.43	(0.933)	$2.37	(0.967)	$1.98	(0.322)	$0.39	(0.941)
5	$0.56	(1.064)	$2.39	(1.094)	$1.87	(0.300)	$0.52	(1.068)
6	$0.86	(1.306)	$2.59	(1.309)	$1.76	(0.288)	$0.83	(1.315)
7	$1.08	(1.364)	$2.71	(1.380)	$1.66	(0.272)	$1.05	(1.369)
8	$1.91	(1.588)	$3.45	(1.613)	$1.57	(0.258)	$1.88	(1.585)
9	$2.31	(1.539)	$3.76	(1.549)	$1.48	(0.233)	$2.28	(1.540)
10	$2.41	(1.474)	$3.77	(1.488)	$1.39	(0.226)	$2.38	(1.476)
Average	$0.96	(0.589)	$2.79	(0.556)	$1.86	(0.140)	$0.92	(0.593)

Table C-2.2. Discounted Expected Corn Payments from Cooperative – Medium Production Case – 40% Equity Level (St. Dev. in Parentheses)

Year	Value Added Payment		Corn Price from Cooperative		Market Corn Price		Premium	
1	$0.23	(0.611)	$2.54	(0.679)	$2.36	(0.382)	$0.18	(0.627)
2	$0.14	(0.490)	$2.32	(0.568)	$2.22	(0.366)	$0.10	(0.502)
3	$0.18	(0.599)	$2.23	(0.641)	$2.09	(0.331)	$0.15	(0.613)
4	$0.29	(0.754)	$2.22	(0.798)	$1.97	(0.320)	$0.25	(0.764)
5	$0.42	(0.923)	$2.25	(0.954)	$1.87	(0.301)	$0.38	(0.928)
6	$0.71	(1.201)	$2.43	(1.210)	$1.75	(0.281)	$0.68	(1.209)
7	$0.87	(1.251)	$2.50	(1.281)	$1.65	(0.269)	$0.84	(1.256)
8	$1.78	(1.582)	$3.32	(1.606)	$1.57	(0.259)	$1.74	(1.580)
9	$2.23	(1.533)	$3.68	(1.534)	$1.48	(0.232)	$2.20	(1.538)
10	$2.38	(1.471)	$3.74	(1.482)	$1.39	(0.223)	$2.35	(1.473)
Average	$0.67	(0.590)	$2.58	(0.496)	$1.95	(0.225)	$0.64	(0.596)

Table C-2.3. Discounted Expected Corn Payments from Cooperative – Low Production Case – 56% Equity Level (St. Dev. in Parentheses)

Year	Value Added Payment		Corn Price from Cooperative		Market Corn Price		Premium	
1	$0.19	(0.540)	$2.50	(0.614)	$2.36	(0.382)	$0.15	(0.558)
2	$0.15	(0.489)	$2.33	(0.567)	$2.22	(0.366)	$0.10	(0.500)
3	$0.19	(0.603)	$2.24	(0.645)	$2.10	(0.343)	$0.14	(0.619)
4	$0.30	(0.759)	$2.24	(0.800)	$1.98	(0.324)	$0.26	(0.770)
5	$0.57	(1.097)	$2.40	(1.125)	$1.87	(0.301)	$0.54	(1.101)
6	$0.85	(1.302)	$2.57	(1.304)	$1.76	(0.288)	$0.81	(1.310)
7	$0.96	(1.292)	$2.59	(1.309)	$1.66	(0.273)	$0.93	(1.298)
8	$1.26	(1.354)	$2.79	(1.379)	$1.57	(0.257)	$1.23	(1.352)
9	$1.38	(1.353)	$2.83	(1.361)	$1.48	(0.234)	$1.35	(1.356)
10	$1.41	(1.299)	$2.78	(1.310)	$1.39	(0.226)	$1.38	(1.302)
Average	$0.72	(0.516)	$2.52	(0.512)	$1.84	(0.107)	$0.68	(0.520)

Table C-2.4. Discounted Expected Corn Payments from Cooperative – Low Production Case – 46% Equity Level (St. Dev. in Parentheses)

Year	Value Added Payment		Corn Price from Cooperative		Market Corn Price		Premium	
1	$0.10	(0.378)	$2.42	(0.473)	$2.36	(0.382)	$0.06	(0.403)
2	$0.05	(0.243)	$2.23	(0.365)	$2.22	(0.366)	$0.01	(0.271)
3	$0.06	(0.314)	$2.11	(0.402)	$2.09	(0.338)	$0.02	(0.335)
4	$0.08	(0.317)	$2.02	(0.451)	$1.98	(0.319)	$0.04	(0.389)
5	$0.18	(0.624)	$2.01	(0.659)	$1.87	(0.300)	$0.15	(0.638)
6	$0.39	(0.933)	$2.11	(0.948)	$1.75	(0.281)	$0.35	(0.941)
7	$0.49	(1.007)	$2.11	(1.036)	$1.65	(0.265)	$0.46	(1.011)
8	$0.92	(1.299)	$2.46	(1.316)	$1.57	(0.257)	$0.89	(1.299)
9	$1.24	(1.334)	$2.68	(1.335)	$1.48	(0.228)	$1.21	(1.339)
10	$1.35	(1.308)	$2.72	(1.321)	$1.39	(0.224)	$1.33	(1.310)
Average	$0.33	(0.409)	$2.25	(0.360)	$1.95	(0.219)	$0.30	(0.417)

Table C-2.5. Discounted Expected Corn Payments from Cooperative – Low Production Case – 40% Equity Level (St. Dev. in Parentheses)

Year	Value Added Payment		Corn Price from Cooperative		Market Corn Price		Premium	
1	$0.08	(0.316)	$2.39	(0.425)	$2.36	(0.382)	$0.03	(0.346)
2	$0.03	(0.163)	$2.21	(0.319)	$2.22	(0.368)	($0.02)	(0.204)
3	$0.04	(0.266)	$2.09	(0.368)	$2.08	(0.332)	$0.00	(0.288)
4	$0.05	(0.259)	$1.98	(0.362)	$1.96	(0.312)	$0.02	(0.281)
5	$0.14	(0.556)	$1.97	(0.591)	$1.86	(0.295)	$0.11	(0.569)
6	$0.34	(0.825)	$2.05	(0.845)	$1.74	(0.294)	$0.31	(0.839)
7	$0.47	(0.941)	$2.11	(0.958)	$1.67	(0.265)	$0.44	(0.946)
8	$0.93	(1.289)	$2.47	(1.299)	$1.57	(0.253)	$0.90	(1.289)
9	$1.28	(1.305)	$2.71	(1.311)	$1.46	(0.208)	$1.26	(1.304)
10	$1.35	(1.241)	$2.71	(1.221)	$1.40	(0.222)	$1.32	(1.221)
Average	$0.18	(0.319)	$2.23	(0.276)	$2.09	(0.277)	$0.14	(0.330)

Table C-2.6. Discounted Expected Corn Payments from Cooperative – High Production Case – 56% Equity Level (St. Dev. in Parentheses)

Year	Value Added Payment		Corn Price from Cooperative		Market Corn Price		Premium	
1	$1.48	(1.592)	$3.79	(1.634)	$2.36	(0.382)	$1.43	(1.592)
2	$1.93	(1.804)	$4.10	(1.847)	$2.22	(0.366)	$1.88	(1.802)
3	$2.02	(1.762)	$4.07	(1.776)	$2.10	(0.343)	$1.98	(1.770)
4	$2.21	(1.783)	$4.15	(1.799)	$1.98	(0.324)	$2.17	(1.788)
5	$2.38	(1.733)	$4.21	(1.755)	$1.87	(0.303)	$2.34	(1.734)
6	$2.74	(1.780)	$4.47	(1.785)	$1.76	(0.288)	$2.71	(1.788)
7	$2.97	(1.711)	$4.60	(1.729)	$1.66	(0.273)	$2.93	(1.714)
8	$3.49	(1.666)	$5.03	(1.690)	$1.57	(0.257)	$3.46	(1.665)
9	$3.58	(1.638)	$5.03	(1.654)	$1.48	(0.232)	$3.55	(1.637)
10	$3.61	(1.559)	$4.98	(1.573)	$1.40	(0.227)	$3.58	(1.559)
Average	$2.64	(0.640)	$4.44	(0.641)	$1.84	(0.096)	$2.60	(0.643)

Table C-2.7. Discounted Expected Corn Payments from Cooperative – High Production Case – 46% Equity Level (St. Dev. in Parentheses)

Year	Value Added Payment		Corn Price from Cooperative		Market Corn Price		Premium	
1	$1.09	(1.413)	$3.40	(1.456)	$2.36	(0.382)	$1.04	(1.416)
2	$1.26	(1.557)	$3.44	(1.602)	$2.22	(0.366)	$1.22	(1.557)
3	$1.29	(1.525)	$3.35	(1.538)	$2.10	(0.343)	$1.25	(1.535)
4	$1.45	(1.587)	$3.39	(1.608)	$1.98	(0.324)	$1.41	(1.592)
5	$1.63	(1.598)	$3.46	(1.619)	$1.87	(0.303)	$1.59	(1.601)
6	$2.07	(1.744)	$3.80	(1.748)	$1.76	(0.288)	$2.04	(1.753)
7	$2.36	(1.699)	$3.98	(1.718)	$1.66	(0.273)	$2.32	(1.702)
8	$3.43	(1.679)	$4.97	(1.702)	$1.57	(0.256)	$3.40	(1.677)
9	$3.57	(1.646)	$5.02	(1.662)	$1.48	(0.232)	$3.54	(1.645)
10	$3.61	(1.557)	$4.98	(1.572)	$1.40	(0.227)	$3.58	(1.557)
Average	$2.17	(0.640)	$3.98	(0.640)	$1.84	(0.098)	$2.41	(0.644)

Table C-2.8. Discounted Expected Corn Payments from Cooperative – High Production Case – 40% Equity Level (St. Dev. in Parentheses)

Year	Value Added Payment		Corn Price from Cooperative		Market Corn Price		Premium	
1	$0.94	(1.329)	$3.25	(1.372)	$2.36	(0.382)	$0.89	(1.333)
2	$1.01	(1.418)	$3.19	(1.464)	$2.22	(0.366)	$0.96	(1.419)
3	$1.00	(1.383)	$3.06	(1.398)	$2.10	(0.343)	$0.96	(1.394)
4	$1.14	(1.453)	$3.08	(1.476)	$1.98	(0.324)	$1.10	(1.459)
5	$1.30	(1.503)	$3.13	(1.526)	$1.87	(0.301)	$1.26	(1.505)
6	$1.74	(1.687)	$3.47	(1.690)	$1.76	(0.288)	$1.71	(1.696)
7	$2.03	(1.669)	$3.66	(1.686)	$1.66	(0.273)	$2.00	(1.672)
8	$3.28	(1.692)	$4.81	(1.716)	$1.57	(0.256)	$3.24	(1.689)
9	$3.47	(1.627)	$4.93	(1.643)	$1.48	(0.233)	$3.44	(1.626)
10	$3.52	(1.568)	$4.89	(1.582)	$1.39	(0.225)	$3.49	(1.568)
Average	$1.92	(0.659)	$3.73	(0.647)	$1.85	(0.111)	$1.88	(0.664)

APPENDIX C-3

RATE OF RETURN ON INVESTMENT

Table C-3.1. Annual Discounted Rate of Return on Investment – Medium Production Case – 46% Equity

Year	Expected Rate of Return	Standard Deviation	Minimum	Maximum
1	1.17%	3.54%	-3.08%	24.97%
2	0.88%	3.17%	-2.90%	21.47%
3	1.11%	3.74%	-2.74%	30.56%
4	1.97%	4.72%	-2.59%	27.63%
5	2.63%	5.35%	-2.44%	32.46%
6	4.16%	6.59%	-2.30%	35.05%
7	5.27%	6.86%	-2.17%	31.20%
8	9.43%	7.95%	-2.05%	37.29%
9	11.42%	7.72%	-1.73%	39.63%
10	11.95%	7.40%	-0.64%	35.77%
Average	4.62%	2.97%	-1.03%	13.65%

Table C-3.2. Annual Discounted Rate of Return on Investment – Medium Production Case – 40% Equity

Year	Expected Rate of Return	Standard Deviation	Minimum	Maximum
1	1.04%	3.61%	-3.54%	27.15%
2	0.58%	2.89%	-3.34%	21.07%
3	0.84%	3.53%	-3.15%	33.07%
4	1.44%	4.40%	-2.97%	29.81%
5	2.18%	5.34%	-2.80%	35.47%
6	3.89%	6.96%	-2.64%	38.55%
7	4.85%	7.23%	-2.49%	34.23%
8	10.04%	9.09%	-2.22%	42.28%
9	12.66%	8.85%	-1.85%	43.13%
10	13.54%	8.48%	-0.92%	40.60%
Average	3.66%	3.43%	-2.15%	14.26%

Table C-3.3. Annual Discounted Rate of Return on Investment – Low Production Case – 56% Equity

Year	Expected Rate of Return	Standard Deviation	Minimum	Maximum
1	0.60%	2.29%	-2.52%	17.73%
2	0.42%	2.05%	-2.38%	14.34%
3	0.59%	2.54%	-2.24%	23.21%
4	1.05%	3.16%	-2.12%	21.08%
5	2.20%	4.52%	-2.00%	27.61%
6	3.33%	5.38%	-1.88%	28.45%
7	3.81%	5.33%	-1.78%	24.60%
8	5.03%	5.55%	-1.68%	26.58%
9	5.55%	5.57%	-1.42%	27.91%
10	5.68%	5.34%	-1.49%	24.22%
Average	2.78%	2.14%	-0.70%	9.67%

Table C-3.4. Annual Discounted Rate of Return on Investment Low Production Case – 46% Equity

Year	Expected Rate of Return	Standard Deviation	Minimum	Maximum
1	0.29%	2.02%	-3.08%	18.65%
2	0.02%	1.36%	-2.90%	10.58%
3	0.09%	1.68%	-2.74%	24.50%
4	0.21%	1.95%	-2.59%	20.42%
5	0.73%	3.20%	-2.44%	30.30%
6	1.78%	4.72%	-2.03%	31.88%
7	2.32%	5.07%	-2.17%	25.98%
8	4.47%	6.51%	-2.05%	32.46%
9	6.06%	6.71%	-1.75%	31.33%
10	6.65%	6.57%	-1.67%	29.58%
Average	1.48%	2.09%	-1.88%	9.49%

Table C-3.5. Annual Discounted Rate of Return on Investment – Low Production Case – 40% Equity

Year	Expected Rate of Return	Standard Deviation	Minimum	Maximum
1	0.17%	1.99%	-3.54%	19.90%
2	-0.10%	1.17%	-3.34%	8.91%
3	0.03%	1.66%	-3.15%	26.11%
4	0.11%	1.62%	-2.97%	16.47%
5	0.60%	3.28%	-2.80%	31.53%
6	1.76%	4.83%	-2.64%	32.02%
7	2.51%	5.45%	-2.49%	25.87%
8	5.18%	7.42%	-2.35%	36.74%
9	7.23%	7.51%	-1.71%	33.66%
10	7.59%	7.03%	-1.92%	30.82%
Average	0.80%	1.90%	-2.93%	9.50%

Table C-3.6. Annual Discounted Rate of Return on Investment – High Production Case – 56% Equity

Year	Expected Rate of Return	Standard Deviation	Minimum	Maximum
1	5.87%	6.54%	-2.52%	33.24%
2	7.72%	7.40%	-2.36%	32.24%
3	8.11%	7.27%	-2.24%	38.10%
4	8.92%	7.34%	-2.12%	34.13%
5	9.62%	7.12%	-1.97%	34.42%
6	11.12%	7.34%	-1.88%	36.54%
7	12.04%	7.04%	-1.49%	33.16%
8	14.21%	6.83%	-1.42%	36.39%
9	14.57%	6.72%	-0.37%	38.50%
10	14.70%	6.40%	-0.13%	35.50%
Average	10.69%	2.64%	3.31%	18.71%

Table C-3.7. Annual Discounted Rate of Return on Investment – High Production Case – 46% Equity

Year	Expected Rate of Return	Standard Deviation	Minimum	Maximum
1	5.22%	7.10%	-3.08%	37.59%
2	6.10%	7.80%	-2.90%	35.10%
3	6.28%	7.70%	-2.74%	41.20%
4	7.09%	7.98%	-2.59%	38.06%
5	7.96%	8.03%	-2.44%	38.61%
6	10.22%	8.79%	-2.30%	41.66%
7	11.65%	8.53%	-1.83%	37.80%
8	17.06%	8.41%	-1.73%	44.45%
9	17.75%	8.25%	-0.45%	47.02%
10	17.95%	7.81%	-0.16%	43.36%
Average	10.72%	3.23%	-0.64%	20.49%

Table C-3.8. Annual Discounted Rate of Return on Investment – High Production Case – 40% Equity

Year	Expected Rate of Return	Standard Deviation	Minimum	Maximum
1	5.13%	7.67%	-3.54%	41.65%
2	5.54%	8.17%	-3.34%	38.15%
3	5.54%	8.02%	-3.15%	43.51%
4	6.34%	8.40%	-2.97%	41.80%
5	7.28%	8.66%	-2.80%	42.54%
6	9.82%	9.76%	-2.64%	46.14%
7	11.51%	9.63%	-2.49%	41.80%
8	18.68%	9.72%	-1.99%	50.50%
9	19.82%	9.36%	-1.02%	53.49%
10	20.10%	9.03%	-0.18%	49.32%
Average	10.85%	3.82%	-1.09%	22.11%

APPENDIX C-4

DISTRIBUTION OF 10-YEAR AVERAGE OF DISCOUNTED ANNUAL ROI

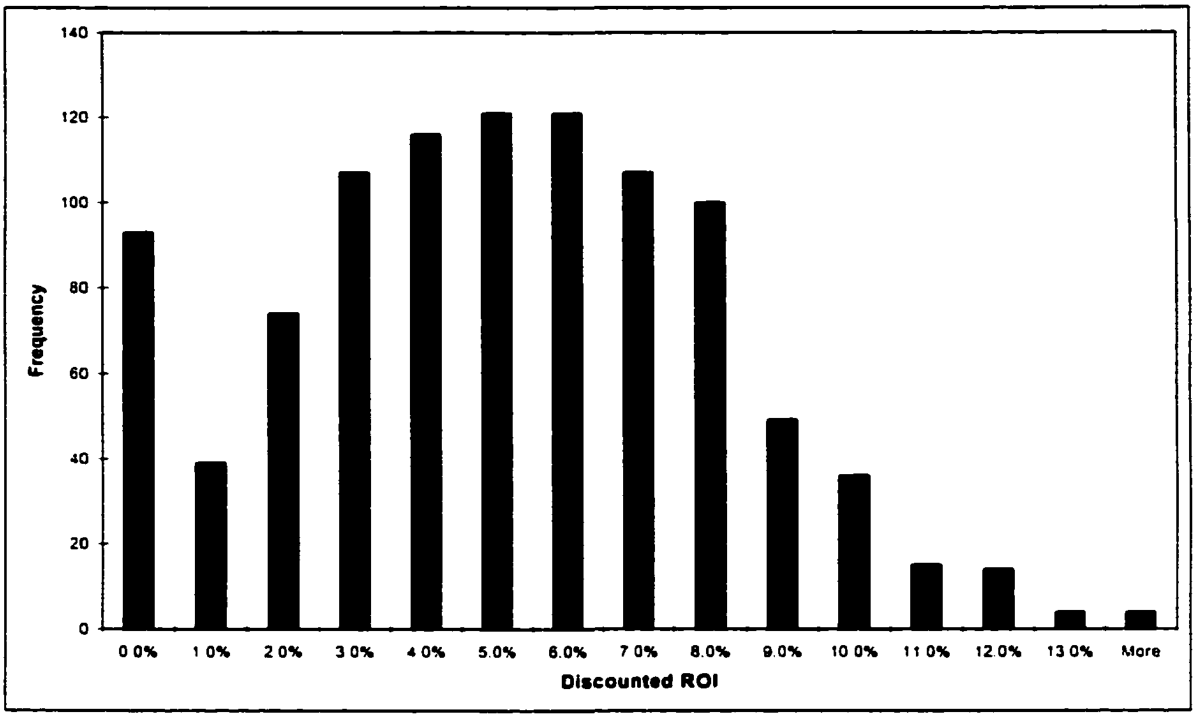


Figure C-4.1. 10-Year Average of Discounted Annual ROI – Medium Production 46% Equity

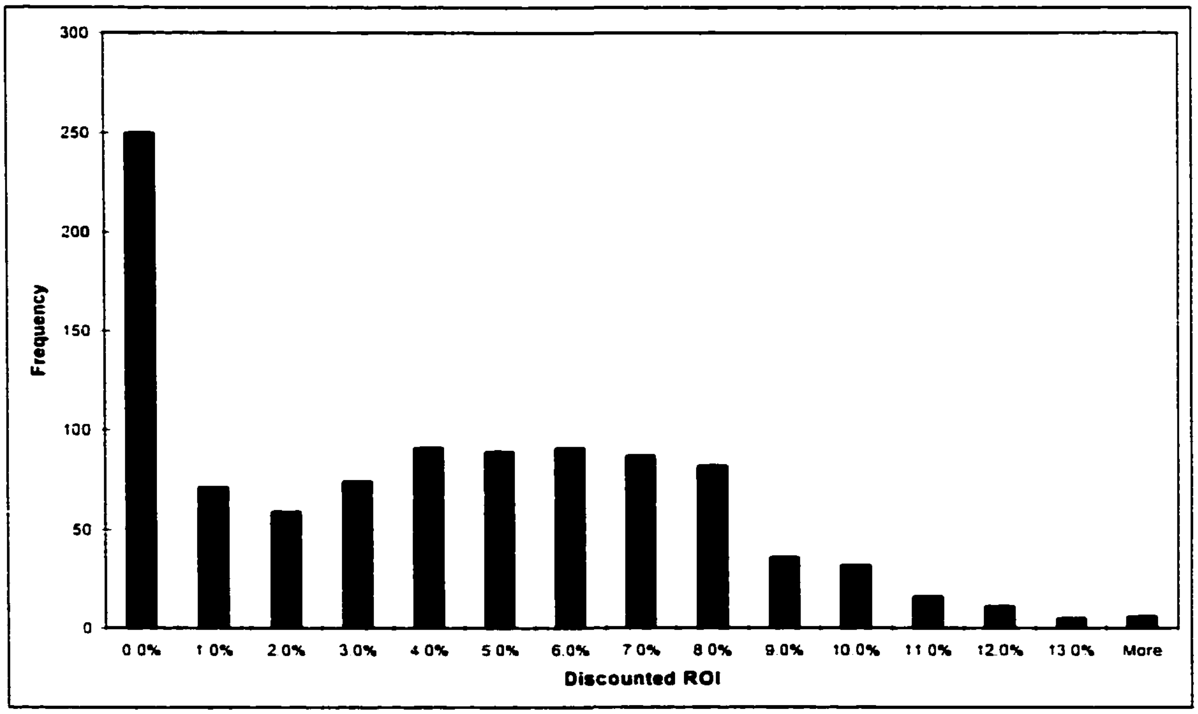


Figure C-4.2. 10-Year Average of Discounted Annual ROI – Medium Production 40% Equity

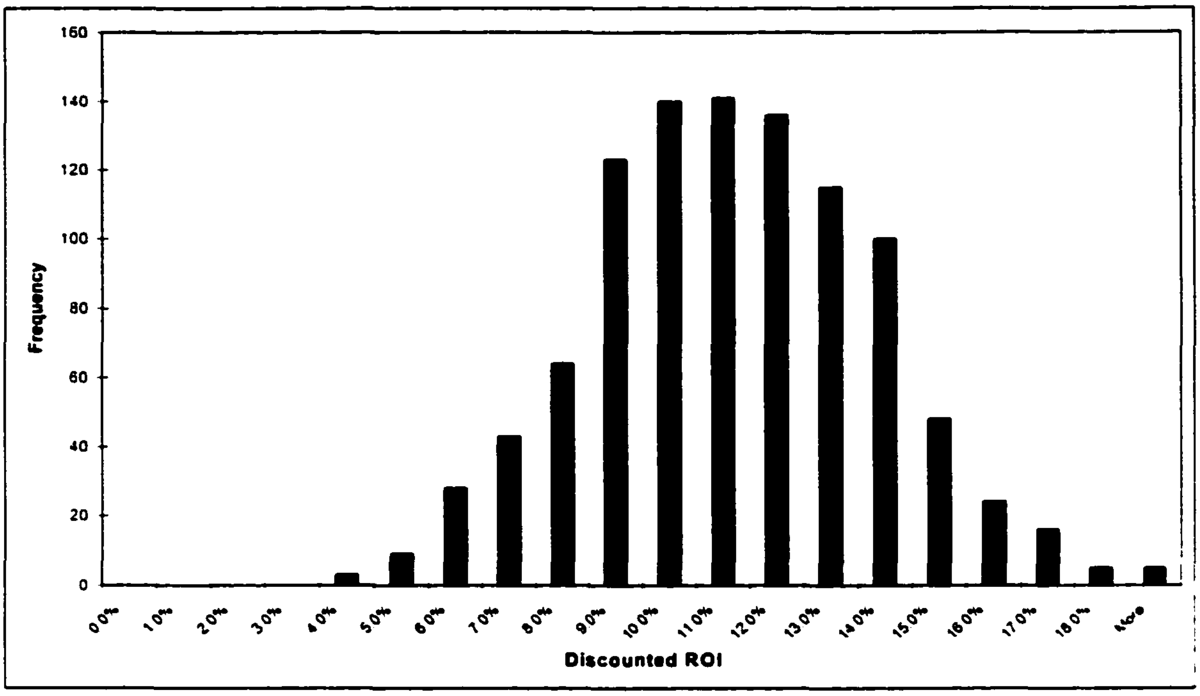


Figure C-4.3. 10-Year Average of Discounted Annual ROI – High Production 56% Equity

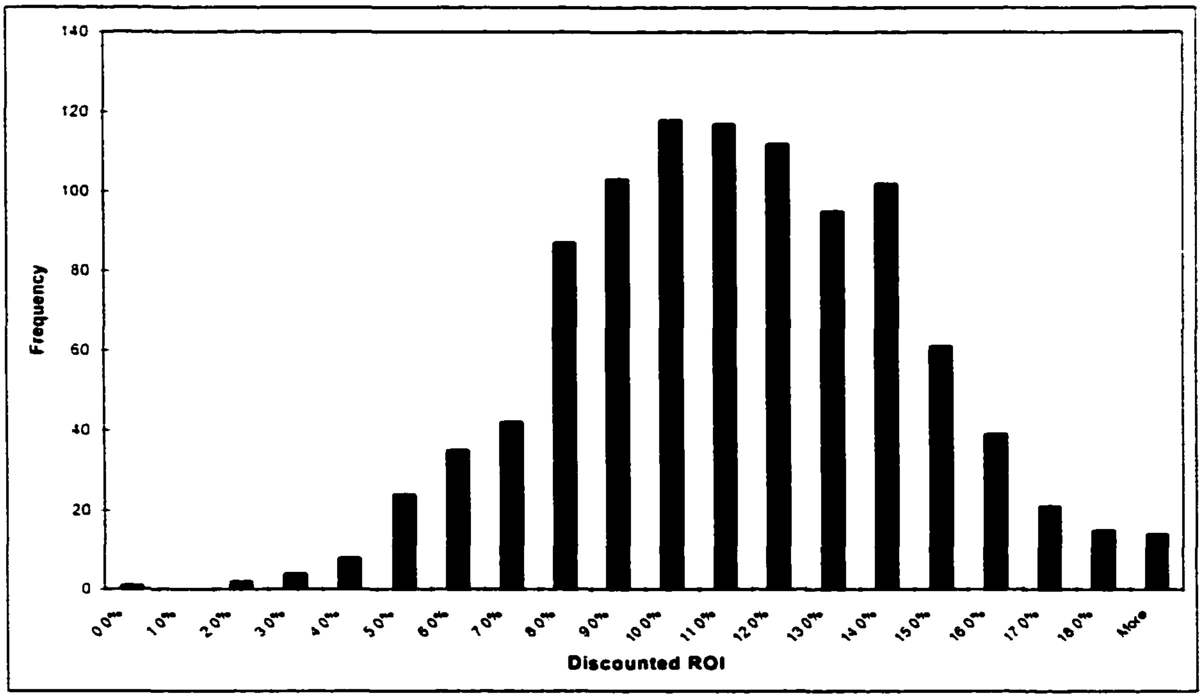


Figure C-4.4. 10-Year Average of Discounted Annual ROI – High Production 46% Equity

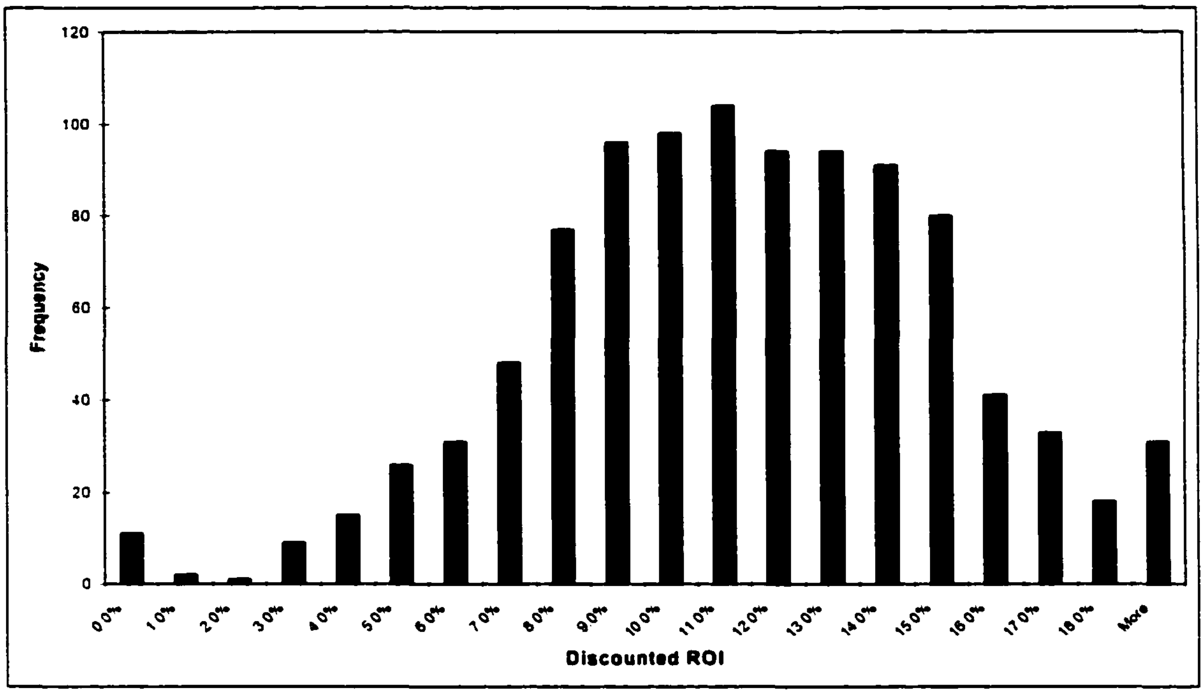


Figure C-4.5. 10-Year Average of Discounted Annual ROI – High Production 40% Equity

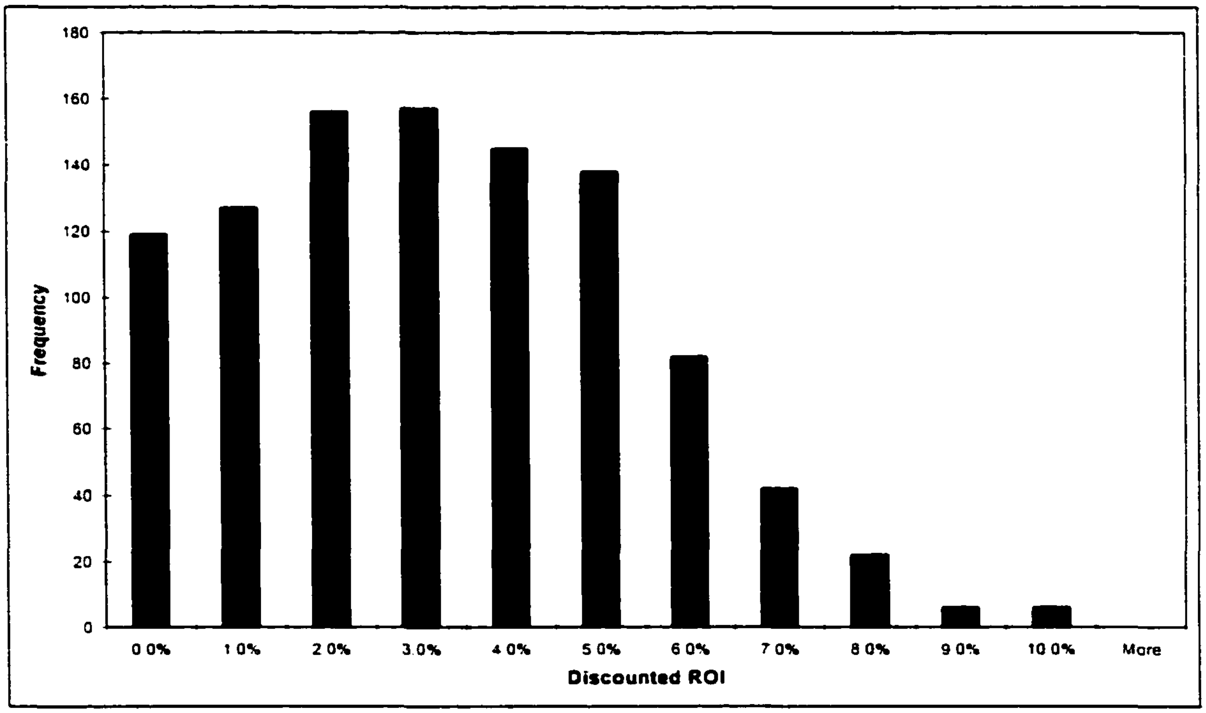


Figure C-4.6. 10-Year Average of Discounted Annual ROI – Low Production 56% Equity

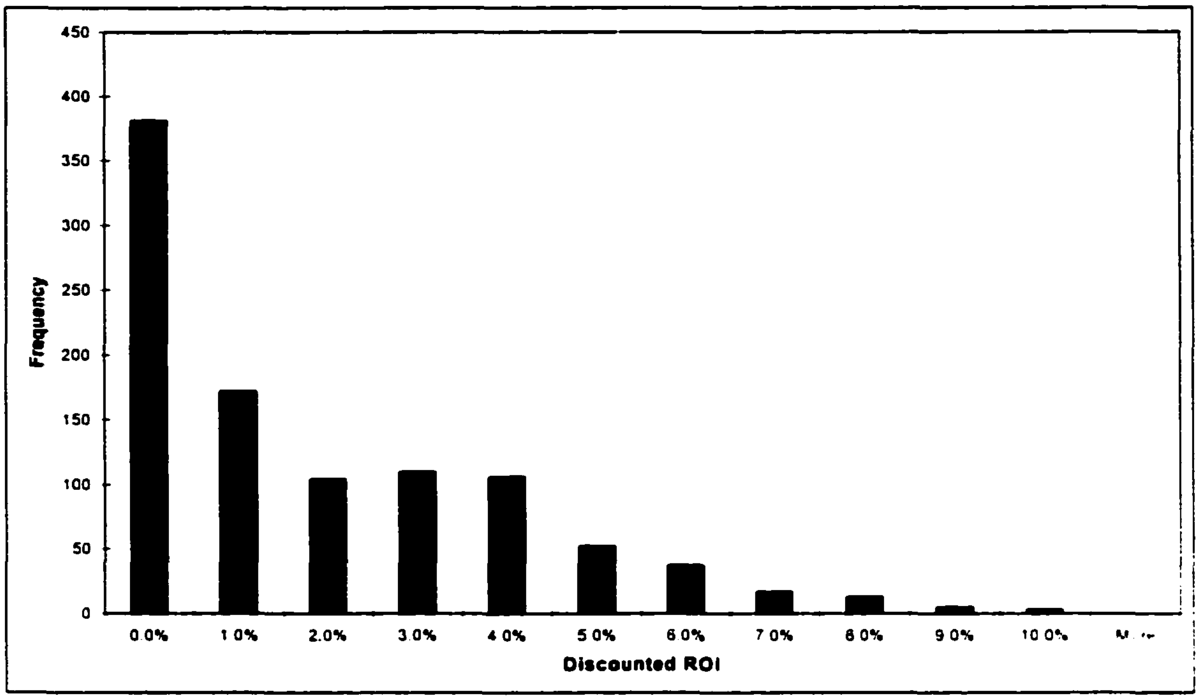


Figure C-4.7. 10-Year Average of Discounted Annual ROI – Low Production 46% Equity

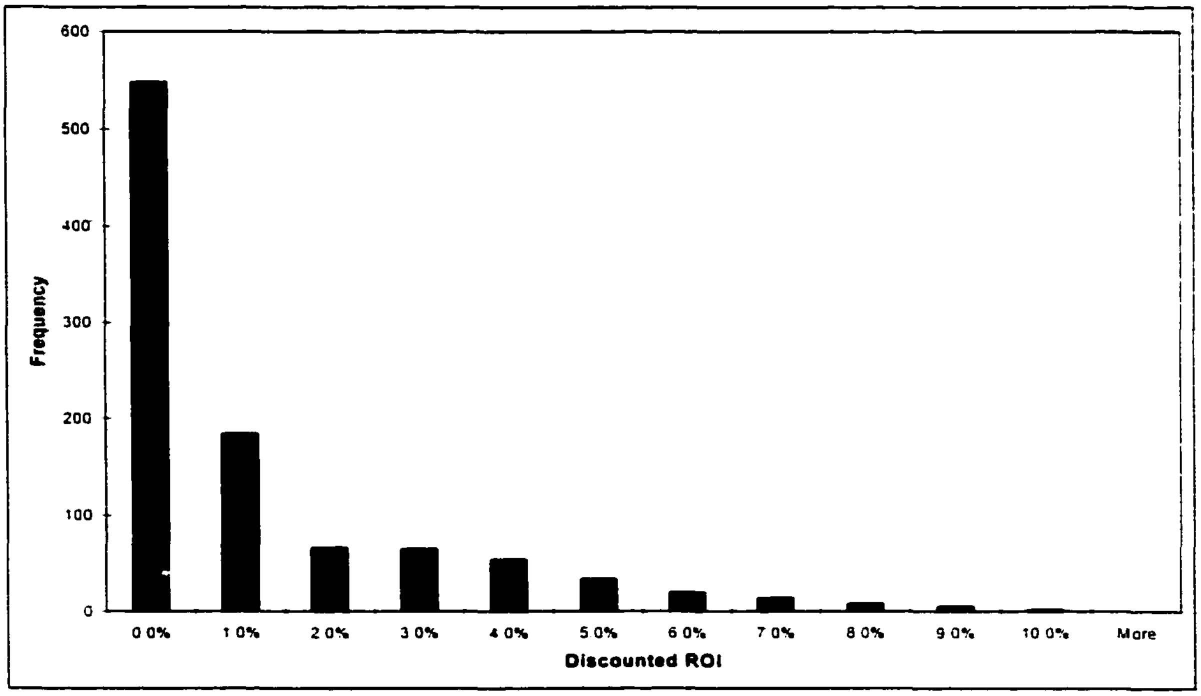


Figure C-4.8. 10-Year Average of Discounted Annual ROI – Low Production 40% Equity

REFERENCES

Bailey, K., et al. "An Economic Simulation Study of Large Scale Dairy Units in the Midwest." *Journal of Dairy Science* 80(1997):205-214.

Barton, D.G., Parcell, J.L., and A.M. Featherstone. "Optimal Capital Structure in Centralized Agricultural Cooperatives." Paper Submitted for Contributed Paper Submission WAEA Meetings, March 17, 1996.

Cobia, D. *Cooperatives in Agriculture.* New Jersey: Prentice-Hall, Inc. 1989.

Collins, R.A. "Expected Utility, Debt-Equity Structure, and Risk Balancing." *American Journal of Agricultural Economics* 67(1985):627-29.

Collins, R.A. and R.D. Green. "Statistical Methods for Bankruptcy Forecasting." *Journal of Economics and Business.* 34(1982):349-354.

Cropp, R. *New Generation Cooperatives Defined.* University of Wisconsin, Center for Cooperatives. Presentation to the New Generation Cooperative Conference. Stevens Point, Wisconsin, April 1, 1996.

Dairy Records Management Systems. *DHI-202 Herd Summary.* Fact Sheet: A-2. 1997.

Edwards, W., Smith D., and A. Schwager. "2001 Iowa Farm Custom Rate Survey." Iowa State University Extension. FM 1698, March 2001.

Elbehri, A. and R.D. Yonkers. "Economic Analysis of the Impacts of Bovine Somatotropin on the Profitability of Representative Dairy Farms in the Northeast." *Agricultural and Resource Economics Review* (April 1995):88-100.

Featherstone, A.M., Moss, C.B., Baker, T.G., and P.V. Preckel. "The Theoretical Effects of Farm Policies on Optimal Leverage and the Probability of Equity Losses." *American Journal of Agricultural Economics* 70(1988):572-579.

Forster, D.L. "Capital Structure, Business Risk, and Investor Returns for Agribusiness." *Agribusiness* 12(1996):429-42.

Frank, G., and J. Vanderlin. "Milk Production Costs in 1999 on Selected Wisconsin Dairy Farms." University of Wisconsin Center for Dairy Profitability. July 2000.

Freund, J. E. *Mathematical Statistics. Fifth Edition.* New Jersey: Prentice Hall. 1992.

Ginder, R. Presentation to The Graduate Institute of Cooperative Leadership, Columbia, Missouri, June 1994.

Greene, W.H. *Econometric Analysis.* New York: Macmillan Publishing Company. 1993.

Jones, B.L. "Wisconsin Enterprise Budgets For Parlor / Free-stall Dairy Systems." University of Wisconsin Center for Dairy Profitability, Working Draft, August 2000.

Jones, B.L. "Growth in Dairy Farms: The Consequences of Taking Big Steps or Small Ones When Expanding." University of Wisconsin Center for Dairy Profitability, 1997.

Jones, J.R., Fulton, J.R., and F.J. Dooley. "Hog Producer Investment in Value-Added Agribusiness: Risk and Returns Implications." Selected Paper at American Agricultural Economics Association Annual Meeting, August, 8-11, 1999.

Kotov, I. *New Generation Cooperatives: Case Study, New Generation Cooperatives: A Short History of the Idea and the Enterprise.* Macomb: Illinois Institute for Rural Affairs, 1999.

Kriegl, T. "To Expand or Not Expand – Which Strategy Pays?" University of Wisconsin Center for Dairy Profitability, Draft, May 1998.

McConnon, J. C. "Methods for assessing the likelihood of country grain elevator failure in the United States." PhD Dissertation, Iowa State University, 1989.

Merrett, C., Holmes, M. and J. Waner. *Directory of New Generation Cooperatives.* Macomb: Illinois Institute for Rural Affairs, 1999.

National Research Council. *Nutrient Requirements of Dairy Cattle,* 7th rev.ed. Washington D.C. National Academy Press. Updated 2001.

Poray, M.C. "Economic and financial analysis of large scale closed cooperative swine production under uncertainty in Iowa." Masters Thesis, Iowa State University, 1997.

Poray, M.C. "Comparing Alternative Closed Swine Production: Adding Value to Corn Under Uncertainty," *Journal of Cooperatives* 14 1999.

Reinemann, D.J., Holmes B.J., and G. Frank. *Milk Center Advisor: Labor and Capital Analysis of Milk Centers.* University of Wisconsin – Madison, Milking Research and Instruction Lab, Version 4/25/00.

Richardson, J.W., "Simulation: A Tool for Decision Making Under Risk," Department of Agricultural Economics, Texas A&M University, June 1999.

Sandin, J. "Discontent over Cows." JSOnline Milwaukee Journal Sentinel, February 18, 2001. http://www.jsonline.com/news/state/feb01/farm18021701a.asp.

Staiert, J. J. "Assessing the likelihood of country grain elevator failure in the United States: A logistic regression approach." Masters Thesis, Iowa State University, 1990.

Waner, J. *New Generation Cooperatives: Case Study, New Generation Cooperatives and The Future of Agriculture: An Introduction*, Macomb: Illinois Institute for Rural Affairs, *1999.*

Wisconsin Agricultural Statistics Service. *Wisconsin Agricultural Statistics: 1989 to 2001.* National Agricultural Statistics Service, USDA / Wisconsin Department of Agriculture, Trade and Consumer Protection.

ACKNOWLEDGEMENTS

I would like to thank everyone who helped me with this research. I especially want to thank Dr. Roger Ginder, my major professor, for all of his insights and encouragement in completing this dissertation. I am grateful to Dr. Ginder for his willingness to work with me given that I was away from campus when all of the research was completed.

I would also like to acknowledge my Program of Study Committee Members, Dr. Arne Hallam, Dr. John Schroeder, Dr. James Kleibenstien and Dr. Lee Kilmer for their support and comments on this dissertation. I would especially like to thank Dr. Kilmer for sharing his knowledge of dairy production. His contributions greatly improved the research.

I would like to thank all of the following individuals who contributed extremely helpful suggestions and data that was used in this research. Dr. Robert Cropp at the University of Wisconsin – Madison, who provided a number of extremely useful comments on this research. In addition, Dr. Cropp put me in contact with a number of individuals who were more than willing to answer questions that I had. Dr. John Clay with Dairy Records Management System and his staff for their assistance in providing the DHI data used in this research. Members of the Land O' Lakes Dairy Business Services, headed by Steve Watrin, who provided a number of helpful comments on the assumptions used for modeling the dairy operation. Kurt Brueing for his assistance in providing the dairy rations used in this research. Ron Tauchen, Deputy State Statistician with Wisconsin Agricultural Statistic Service, for providing the price data that was used in this dissertation. Carl Watson for his assistance in developing the farm-level financial model used in this research. Finally, Dr. Michael Poray for his encouragement and insights into modeling value added cooperatives.

Financial support from the USDA/RDA/Cooperative Service is gratefully acknowledged.

I would also like to express my gratitude to my parents for their support throughout all of my studies. You have always been there for me no matter what decisions I have made. Finally, and most of all, I would like to thank my family. Thanks to Emma, Hannah, and Isabelle for understanding that I had to work on my research when we all would have rather been playing. To my wife, Anita, who somehow managed to encourage me and believe in me even when I doubted myself. Without her patience, understanding and sacrifices, there is no way I could have managed to complete this research.