DAIRY PROFIT PROJECTION MODEL FOR THE HIGH PLAINS REGION

by

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Abstract

Structural change within the industry, improved management, and volatility in commodity markets are reasons to evaluate and monitor the dairy industry in the future. The dairy industry has shifted concentration of production between regions over time. The Southern High Plains region, including the states of Colorado, Kansas, Oklahoma, New Mexico, and Texas, has undergone cow inventory growth in the past ten years. Dairies have become more concentrated, management has become more refined, and the commodity markets have become more volatile.

Education and tools are readily available to producers with issues on reducing production, animal health, and feed losses. Financial risk is a key area producers have limited knowledge and resources. Mitigating this risk is essential in today's marketplace to maximize gains and margins as well as create opportunities for the operation to succeed and be financially sound. There are several resources which approximate returns based on either a point in time reference or complete user input. This study allows users to reflect on 21 years of historical data, 1990-2010, as well as plug in their own data or use default market data to estimate projected returns over the next 12 months. This study also builds a modeling framework that will allow historical dairy returns to be estimated and future returns projected on a regular basis.

Over time average herd size has grown to reduce cost per head and producers are more efficient, milk production per cow has increased to over 70 pounds per day. Historically prices have increased over time, but the spread between highs and lows has escalated. This model solidifies that milk price and production are key revenue drivers while feed, replacement costs, and labor are large cost components at 39, 17, and 6 percent, respectively. Additionally, changing market prices can intensify the gain or loss an operation will incur over the short term, the projection model shows 2011 just below breakeven due to strong commodity markets. Dairy operations in the Southern High Plains region have shown positive returns in 108 of 252, 43 percent, months with greatest negative annual returns 2006 and 2009.

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I would like to thank those at Dairy Farmers of America who provided educational milk pricing publications and representative milk hauling and promotion costs. This information was greatly appreciated and instrumental in developing a more applicable model. Additionally I would like to thank the many other industry personnel who go unseen. These individuals were paramount in collecting, refining, and posting market and survey data that I used to develop this model.

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Dedication

Growing up in production agriculture and on a dairy farm allowed me to develop interests and skill sets I would not have otherwise obtained. A passion for production agriculture and the dairy industry was instilled in me at a young age through my involvement on the family farm. The standard of responsibility and work ethic expected to maintain the daily operations of the family dairy allowed me to gain more from my experiences in graduate school. I am greatly appreciative for the life lessons my parents, Ron and Debbie Schulte, taught me on the family farm.

Chapter 1 - Introduction

1.1 Introduction

The dairy industry has undergone considerable change over the last 21 years. These structural and technical changes have occurred due to several underlying factors which primarily are related to increasing profitability and efficiency. Structural changes have included geographical shift within the United States, increasing cow herd size and decreasing number of farms. Technical changes have included increased pounds of milk per cow, changes in feed ration ingredients, and more rigorous herd selection measures. These changes have allowed producers to become more efficient while profitability continues to be highly variable due to volatile commodity and energy markets.

In the early 1900's, agriculture was self-sufficient with dairy cattle and creameries or processing plants dotted across the countryside. By the 1970's farms became more specialized and the average dairy herd grew to 54 cows (Blayney). In the late 1990's much of the dairy industry was located close to the largest human populations of the West coast and Northeast regions of the U.S. However, producers discovered the implications of environmental regulations and increased feed costs of these regions. Today farms are larger with over 60 percent of dairy herd inventory on operations over 500 head, milk production is centralized to a few regions, and milk plants are larger and located close to pockets of dairy production (*Overview*; MacDonald et al. et al.). Thus, the historical approach of locating cows close to where consumption would occur has lessened. Now, it is more common to locate cows where milk can be produced at a low cost and then ship the milk and dairy products to consumers.

Animal agriculture has shifted geographically and become highly concentrated over the past 50 years. Specifically, the dairy industry changed from small farms, predominately in the Eastern states to large scale farms milking over 1,000 head in the Western half of the U.S. This change has come about from several factors including economies of scale, population growth, reduced transportation cost, weather, and environmental regulations (Ribaudo et al.). Dairies have relocated to the West, Southwest, Southern High Plains, and Mid-East from Eastern and Mid-West regions. The Southern High Plains region of Eastern Colorado, Western Kansas, New Mexico, Oklahoma and Texas panhandles is expected to continue the increase in cow inventory in the coming years (Blayney). These states are known for their dry weather and low populations along with ample agriculture production, which create an attractive market for livestock operations.

Several factors influence dairy herd size and location including weather, location to human population, labor availability, and environmental regulations. However, the driving factor of farm structure is profitability, the driver behind a dairy operation to be competitive and remain in business in the long run. Profit at the farm level is influenced by a number of monetary factors including milk price, feed cost, labor cost, land value, and opportunity costs. Additional herd management factors include reproductive management, health care, feed availability and storage, and labor management all of which can greatly affect production levels in terms of both quantity and quality (i.e., milk component levels), which both contribute to the price received for milk. Components of milk include water, lactose, protein, fat, minerals, and vitamins; the components which are referred to throughout this paper are protein, fat, and non-fat solids. Producers milk price is primarily based on these three levels of components in milk sold.

One factor commonly overlooked is the breed of cattle which make up the herd; the Holstein breed has dominated many herds due to their superior ability to produce a high quantity of milk. However, in recent years other breeds, such as Jersey, have gained precedence in the industry and in some instances have been introduced to Holstein herds to increase component values. Dairy managers have a multiple profit factors to manage to attain positive profit, but some aspects of production and revenue are outside their realm of control.

External forces of the variation in milk price received by producers include global and national drivers of supply and demand. The United States dairy cow inventory is closely tracked as it is a key indicator of milk supply entering the market. Increasing milk production per cow and the number of replacement heifers entering the market are additional factors that must be considered when analyzing cow inventory levels and their impact on milk price. Global demand drivers include import and export levels of all dairy products which have an effect on the fluid milk price through supply and demand equilibrium. Additionally, the level of government intervention through the amount of product kept in storage and the policies implemented at all production levels can have significant impacts on milk price, cow inventory, and profitability. Thus, there are numerous macroeconomic and industry factors that impact prices over time that are largely out of the control of individual dairy managers.

Agriculture and the dairy industry have shifted from small, diverse farms to larger, specialized operations. Profitability, the driver behind change in farm size, is a key indication of the financial stability of a business; producers have multiple monetary and management factors which must be controlled to remain profitable. This thesis outlines a model which was built to analyze historical returns from 1990 forward and to project profit out 12 months for large dairies in the Southern High Plains region. The remainder of this chapter will focus on the structural changes which have taken place in the U.S. dairy industry and outline the objectives of the profit projection model.

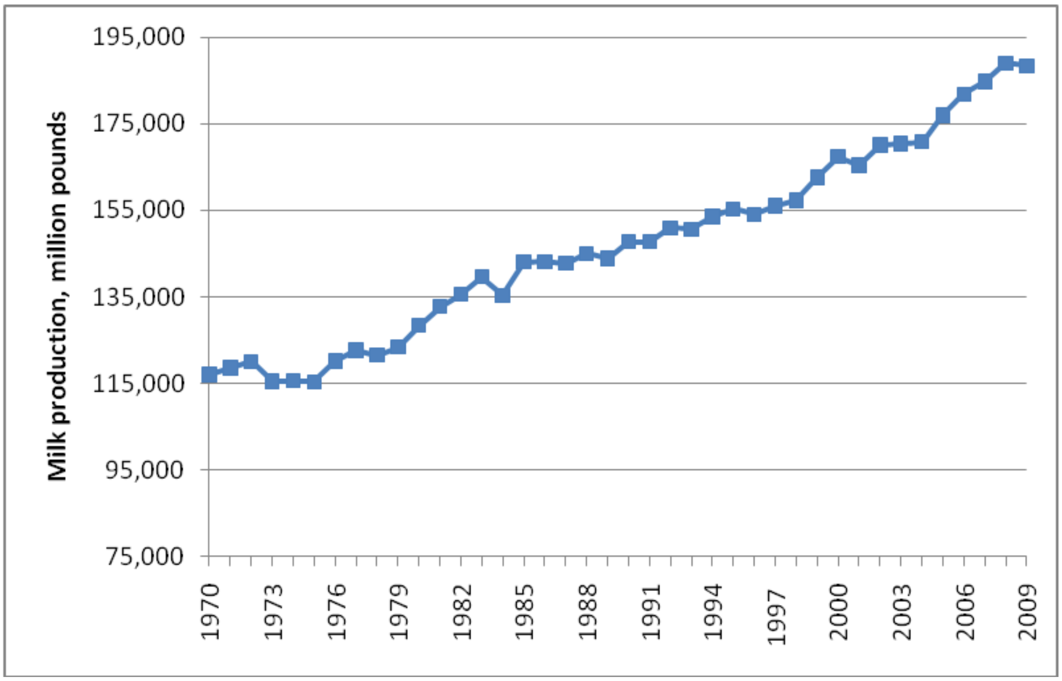
1.2 Dairy Industry – United States Dairy Industry Demographics

In the last century the geographical and demographic configuration of the dairy industry has changed significantly. Up until the 1960's agriculture was highly diversified with over 650,000 farms across the United States having dairy cattle (MacDonald et al. et al.). These farms were typically diversified in livestock and crop production. Over the next decade, the government mandate for use of on-farm milk cooling and bulk handling units caused many farms to transition out of the milk production business. Additionally this policy introduction caused closure of many small milk processing facilities and consolidation to larger, regional milk processing plants. The ability of farms to handle and store larger amounts of cooled milk in addition to improved genetics, introduction of artificial insemination, lower milk transportation cost, improved feed technologies, government dairy support programs, and increased cheese demand are a few of the overlying factors which helped to change and mold the dairy industry (MacDonald et al. et al.). Economies of scale and cost of production have also been driving factors for farms to continue to grow in size and specialty. Weather, feed availability, environmental regulations, proximity to population, and local infrastructure are also reasons for change, specifically in relation to the geographic location shift (MacDonald et al. et al., Rutt). The following two sections give an in depth look into the changing structure of the dairy industry.

1.2.1 Changes in Dairy Industry Structure

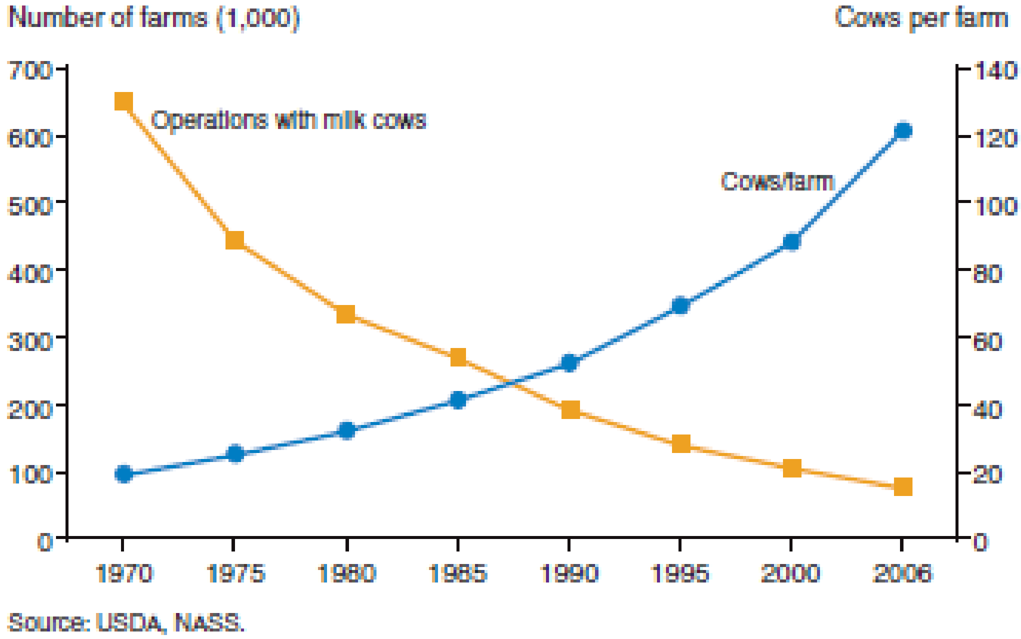
Over the last 30 years the number of farms with dairy cows has decreased by 88 percent, but the average herd size has increased by about 85 percent (MacDonald et al. et al.). Dairy production has increased from 117,000 to 188,400 million pounds from 1970 to 2009 as shown Figure 1-1 (NASS). Dairy operations are becoming highly specialized to milk production as the number of farms is decreasing and total herd size and milk production continues to increase as shown in Figure 1-2, (MacDonald et al. et al.).

Figure 1-1 United States Milk Production



Source: USDA, National Agriculture Statistics Service

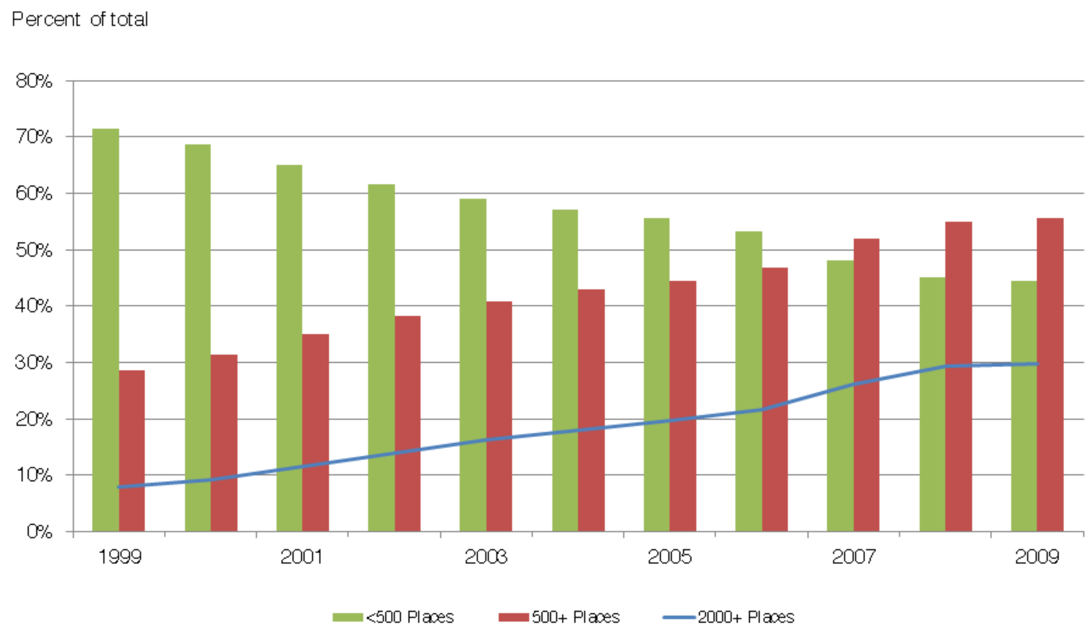
Figure 1-2 Number of Dairy Farms vs. Herd Size



Source: USDA, Economic Research Service

Herd size has continued to increase and the number of large farms has continued to increase over time as well. From *Overview of the United States Dairy Industry* report, the number of farms with less than 500 head have decreased over the past ten years while farms with over 500 and 2,000 head have increased (NASS). Operations with over 2,000 head have increased percent of total U.S. herd inventory from ten to 30 percent since 1999 (Figure 1-4).

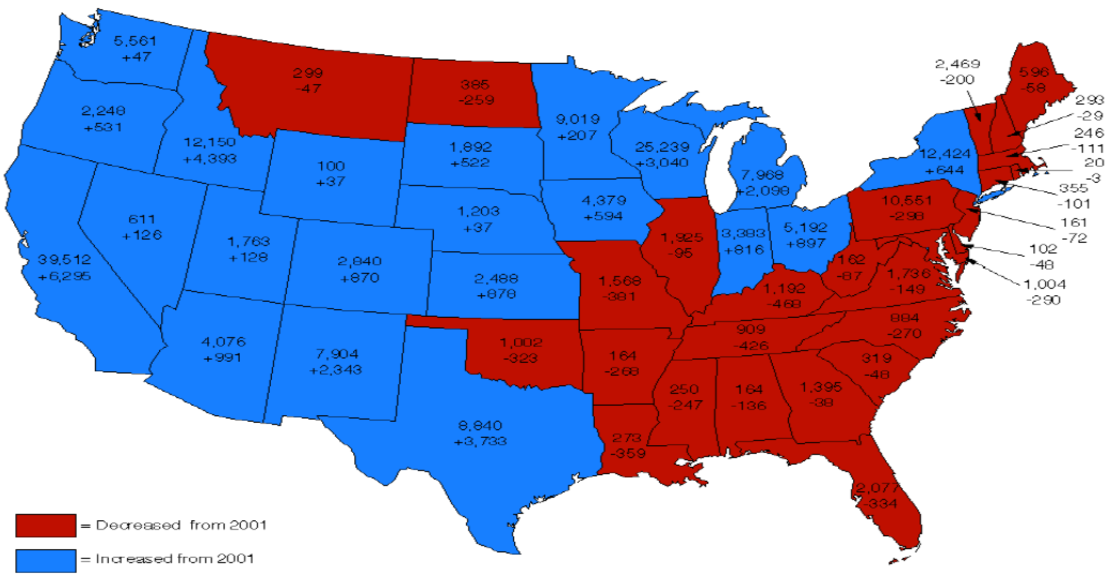
Figure 1-3 Milk Cow Inventory Distribution



Source: USDA, National Agriculture Statistics Service

This report also identified a shift in dairy production to states in the Western and High Plains regions as outlined in Figure 1-4. Figure 1-4 shows milk production growth across a majority of the Midwest and Western states and decreasing production in Southeast and Eastern states (*Overview*).

Figure 1-4 Milk Production - United States change from 2001 to 2009, million pounds



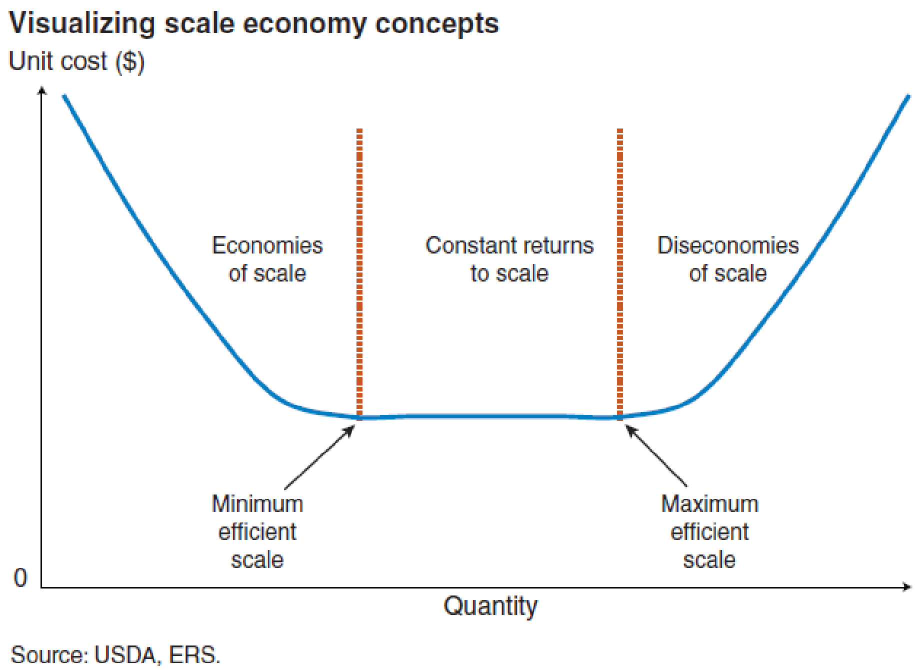
Source: USDA, National Agriculture Statistics Service

A report published by the Economic Research Service in 2007 demonstrates how economies of scale and cost of production have contributed to the changing structure of dairies in the United States (MacDonald et al. et al.). The study stated that production consolidation is going to continue with the western states of California, Idaho, and New Mexico increasing their share of total milk production. The size of farms has increased significantly with the number of farms with 2,000 head or greater more than doubling in the United States from the early 2000's. More notably, in the Midwest and Western regions farms between 3,000 and 10,000 head currently are the most common size of dairies being built. The number of larger farms are increasing in most states; however, milk production is shifting towards the western half of the United States due to the more aggressive growth and expansion of large, i.e., greater than 2,000 head, dairy facilities. Even though in the Upper Midwest and Eastern regions where smaller farms have typically received higher average milk prices, larger farms currently located in the West and Southwest can spread out production costs over a larger number of head. Therefore large dairies have more capital left to cover opportunity and economic costs making economies of size a key factor to changing farm structure.

As found in the ERS report, *Profits, Costs, and The Changing Structure of Dairy Farming*, “Costs per hundredweight of milk produced fall by nearly half as herd size increases from fewer than 50 head to 500 head, and continue to fall, but less sharply, at even larger herd sizes.(MacDonald et al., pp iii)” Separated out by herd size, dairy farms with over 1,000 head realized 15.4 percent lower average costs than the category of 500-999 head and an even greater margin exists compared to smaller herd size dairies (MacDonald et al.).

Economies of scale have been one of the driving factors behind the structural change in the dairy industry. As shown in Figure 1-5, the economics of scale vary due to quantity or number of head and cost level. Producers should strive to be in the constant returns to scale or the right of the economies of scale section to achieve efficiency of scale. Small operations will be in the left portion of the graph because as a firm increases quantity or production they will be decreasing average cost per pound of milk produced and increasing returns to scale. Farms with smaller lactating cow inventories, 50 cows or less, will likely not reach the minimum efficient scale mark. The maximum efficient scale mark is where farms grow to the point where they no longer receive economy of size advantages; the rate of diseconomies of scale is an extreme measure typically not seen in the industry. Minimum and maximum efficiency scale points along with demand factors help to determine what size of operations which will remain in the industry in the long run.

Figure 1-5 Economies of Scale



Large and small dairies can be differentiated not only by size, but also by the management styles to accommodate the price and structure differences. According to MacDonald et al. (2007), small farms typically depend on family labor, are more likely to utilize pasture, raise replacement heifers, and grow a higher percentage of feed. This is compared to large farms whom rely on hired labor, use larger confinement housing, and purchase replacement heifers and feed. Large farms are subject to higher variable cost fluctuation due to the greater number of variable expenses like labor, commodity feed prices, and transportation, but smaller operations typically overlook the opportunity costs associated with family labor, feed, and capital investment in buildings and land. In a 2005 United States Department of Agriculture (USDA)[1] survey, the range of assigned labor cost based on off-farm labor wages ranged from 15 to 21 dollars per hour. As stated in *Profit, Costs, and the Changing Structure of Dairy Farming*,

> "on average, farms in smaller size classes are not covering the opportunity costs of their investment in capital and operator's time. Correspondingly, large dairy farms are returning profits in excess of the owners' time and capital costs. The differences in

[1] All abbreviations and references used in this thesis are outlined in Appendix A-1.

> estimated returns mirror the changes in structure-production are shifting away from smaller farms, towards much larger dairy farms (MacDonald et al., pp 11)."

Another study, published in 2006, found that milk production per cow is higher in the Western states compared to the traditional milk production states in the East and Midwest (Miller and Blayney). Financial studies provide strong evidence to the structural change of the dairy industry, but other studies have also looked at external factors affecting dairy production relocation.

Peterson and Dhuyvetter (2001) implied that the difference between land held and feed purchased may be a primary factor for Western region dairies ability to relocate and expand. Large dairies similar to those found in Western Kansas typically purchase the majority of the ration components and therefore do not need a large land base except for facilities; this model is compared to a small dairy which typically raises all of their own forage so land adequate to grow feedstuffs in addition to facilities is required. However, as noted in the USDA ERS publication, larger dairies can quickly outgrow the available land for manure disposal and over one third of larger dairies documented paying up to 30 cents per hundredweight of milk produced for manure removal (MacDonald et al.). Additional studies by Cohen and Morrison-Paul., Herbst et al., and Rutt have been conducted to help explain the structural shifts in the dairy industry.

Rutt (2007) used spatial agglomeration economics to determine if dairies tend to locate near similar industry structures, either dairy or other livestock facilities. The study was done at a county level for a majority of the continental states over a five-year period, 1997-2002. For both 1997 and 2002 spatial agglomeration economies proved to exist with the spatially lagged dependant variable being significant at the 1 percent level. Local corn silage production, regulation under milk marketing orders, precipitation, and location relative to processing plants had a positive impact on milk production per county. However, corn production levels, higher income levels, and increased unemployment all were negative factors for dairy production location. Cattle operations over 500 head became a positive factor in 2002 at the end of the study for milk production location. This finding of spatial agglomeration economies is supported by previous studies. Cohen and Morrison-Paul (2004) found similar findings and gave reasons of access to input and output markets, location to supporting industry resources, and similar business environment for dairies to locate near one another and to other livestock operations.

Herbst et al. (2006) examined multiple factors in determining key factors in milk production location. They estimated a probit model and found that low land and feed costs, weather, relaxed environmental regulations, community economic incentives, Class 1 milk prices, and motivation to relocate due to urban sprawl in prior location were positive factors for large operations, greater than 500 head, to relocate to the Western region. These spatial location studies along with profit and cost analysis of regional production discussed above help to describe the structural shift of milk production to the West and Midwest in the past 10 years.

The dairy industry has changed from small farms located close to population centers to large scale dairies located farther from population in areas that offer lower costs of production. The relocation of dairy production is attributed to several factors including population, availability of resources, and land availability. Maintaining a positive profit margin is a key indicator of the health and longevity of a business, especially with a dairy due to volatile commodity markets. Drivers of profit between small and large are different due to management changes based on size and scale. Producers can partake in different management practices to help stabilize and control leading revenue and cost factors such as commodity prices or milk production. As time passes the industry will continue to undergo structural and technological change to increase efficiency and profits.

1.2.2 Projected Future of Dairy Industry in the United States

Recent years of economic hardship caused by low milk prices and high feed commodity prices have slowed the growth of the dairy industry compared to prior years. Additionally, farms have decreased cow inventory. The recent Cooperatives Working Together (CWT) buyout paid a premium to producers to sell off inventory which influenced producers to cull low producing cows. In turn, this has left a higher percentage of superior producing cows alongside a large replacement heifer inventory (Shields). The current replacement heifer inventory was created, in part, through technologies such as sexed semen and genomics, technologies that give the potential for increasing milk production and heifer inventory for years to come. Government intervention in the dairy industry is expected to remain with policy measures designed to keep volatility at a minimum for milk prices and production in future years (Shields). All of these factors point towards growing cow inventory and milk production which can lead to oversupply depending on foreign and domestic demand. Milk price outlook is volatile but positive; however, the expectation for feed and operating costs also are expected to continue climbing making producers unsure of expected margins in coming years for dairy production.

Over the next 10 years the number of cows in the United States is expected to increase by 3.6 percent while production per cow is expected to increase by 14.1 percent according to the Food and Agriculture Production Research Institution 2010 U.S. and World Agriculture Outlook Report. United States cow inventory in 2011 is projected to be between 8,950 and 9,100 thousand cows with annual production around 21,000 pounds per cow (FAPRI, USDA-NASS). From the estimated report data, several states were compared in terms of projected cow inventory, production, and milk price including the Southern High Plains states, Colorado, Kansas, Oklahoma, Texas, and New Mexico. Additionally top production states, California, Idaho, Wisconsin, and New York were included and used as a comparison to the Southern High Plains. As shown in Figure 1-8 and Figure 1-9, the number of cows per state does not change by a great degree from year to year; however, Kansas and Idaho inventories are expected to increase by 10.2 and 14.9 percent, respectively, while Oklahoma cow inventory is expected to decline by almost 40 percent (Table 1-1). Projected total milk production change from 2009 to 2019 for each state considered is reported in Table 1-1.

Figure 1-6 Projected Cow Inventory, Major Dairy States

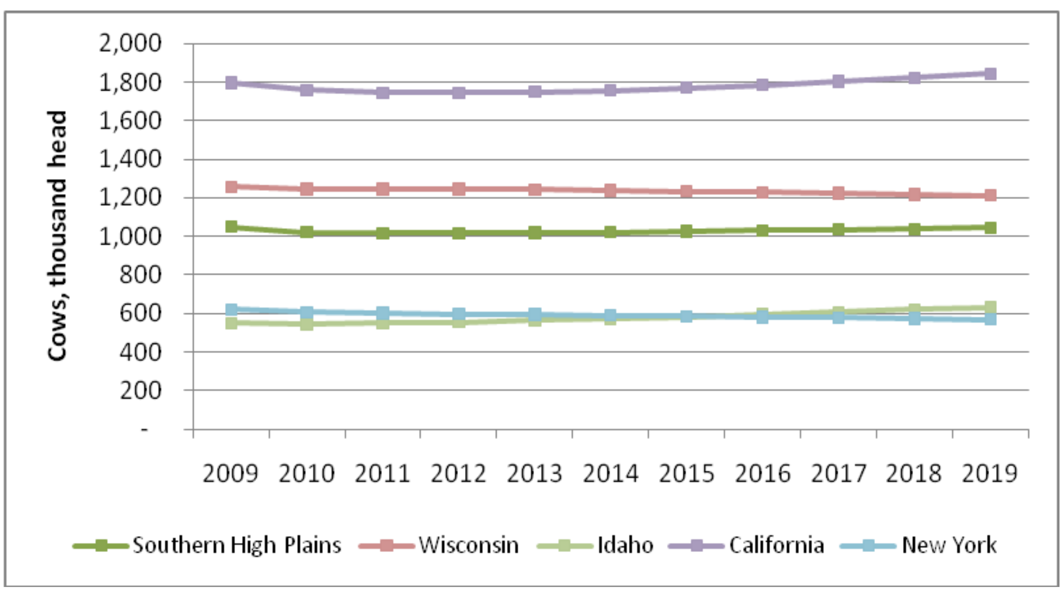
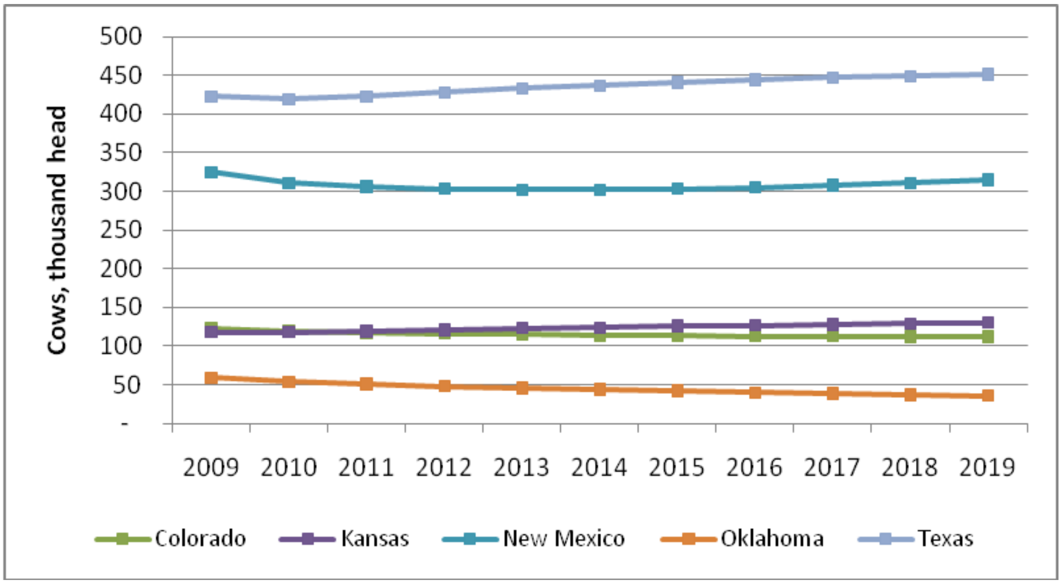


Figure 1-7 Projected Cow Inventory, Sothern High Plains



Over this 10-year period, milk production in Kansas is expected to increase production by 33.8 percent followed by Texas and Idaho at 28.9 and 27.8 percent. Contrary to aggregate growth for the Southern High Plains region, Oklahoma is expected to decrease their already low production levels by 27 percent.

Figure 1-8 and Figure 1-9 display milk production per cow per day for each of the states, calculated by dividing milk production by cows and 365, days per year. All states included are expected to increase efficiency with the production increases ranging from 6.6 to 21.4 percent. The Southern High Plains region is expected to exceed all states in efficiency by 2019. Kansas, Texas, and Oklahoma producers are projected to increase the milk produced per cow per day by about 20 percent from 2009 to 2019. Within the High Plains region, Kansas is projected to increase cow inventory and produce more milk both on an aggregate and per head level; Texas and Colorado are projected to have moderate changes in cow inventory, but expected to substantially increase milk produced per cow. New Mexico is projected to remain stagnant across all categories, and Oklahoma is expected to decrease cow inventory but become more efficient in milk production. Finally, milk price is projected to increase by almost 50 percent for all states over the 10-year period (Table 1-1); however, there was a significant jump from 2009 to 2010 and a continual increase to 2019 which is contradictory to the typical commodity price cycle which has periods of both increasing and decreasing prices. The dairy production outlook to 2019 is positive for the Southern High Plains region while many eastern states are decreasing cow inventory; this projected trend follows current geographic location and cost of production trends.

Figure 1-8 Projected Milk Production per Cow, Major Dairy States

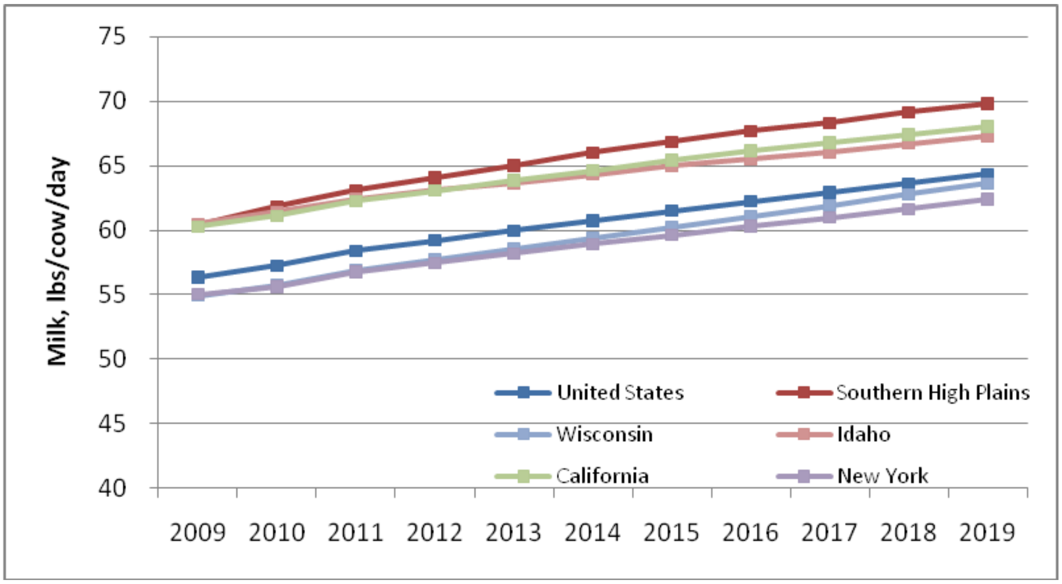


Figure 1-9 Projected Milk Production per Cow, Southern High Plains

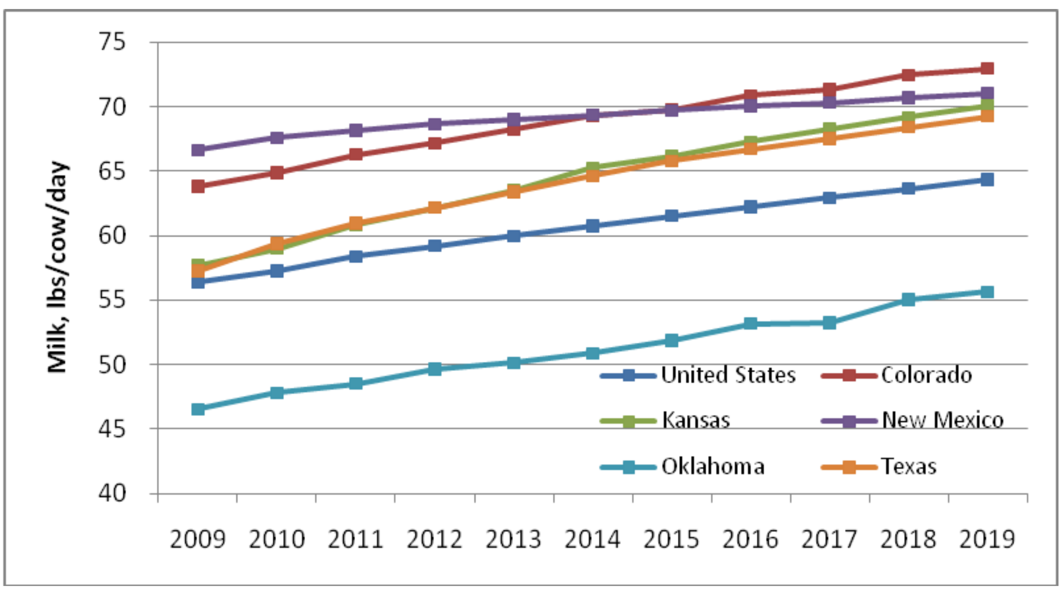


Table 1-1 Change in Production Factors (%), 2009-2019

	Percent Change			
	Milk Production	Cow Inventory	Production/Cow/Day	Milk Price
United States	10.1	-3.6	14.1	47.3
Colorado	4.1	-8.9	14.3	47.8
Kansas	33.8	10.2	21.4	44.0
New Mexico	3.3	-3.1	6.6	50.5
Oklahoma	-27.0	-39.1	19.6	47.7
Texas	28.9	6.6	20.9	46.1
Wisconsin	11.7	-3.6	15.8	47.4
Idaho	27.8	14.9	11.3	51.9
California	15.9	2.7	12.9	50.7
New York	4.1	-8.2	13.4	47.3

1.3 High Plains Region Demographics

The Southern High Plains region consists of Western Kansas, Eastern Colorado, Oklahoma Panhandle, Texas Panhandle, and Eastern New Mexico. However, data for this model will use aggregate data for the states due to the inability to obtain county or district data per state. This region has a relatively dry climate, low population density, and access to various natural resources, which help to stimulate agriculture production and the local economy. The Ogallala Aquifer and other underlying aquifers allow this region to be productive when producing agriculture commodities, specifically, corn and alfalfa hay – both important feedstuffs for the dairy industry.

The arid climate allows for dry lot facilities to be used on dairies in this region. A dry lot dairy consists of minimal confinement housing and large dirt lots with shades and wind blocks for protection from the weather elements. Dry lot housing structures require the least amount of capital to build due to minimal materials required compared to a full confinement or land required for a pasture dairy. Typical dry lot dairies in the High Plains are 2,000 head or greater and have a rolling herd average of 23,000 pounds (Frazer Frost). Feed cost is the major component of costs with grain and by-product prices driving the total cost; large dairies are more likely to purchase a large portion of feed inputs which can affect costs compared to a dairy that raises all feedstuffs. Average feed cost per cwt of milk production can range from five to ten dollars depending on feed input prices and milk production (Short and McBride). Large dairies are more likely to depend on Hispanic labor, use technology to increase production, and purchase a majority of feed used (MacDonald et al.). Dairies in the High Plains region have access to relatively low cost land, labor, and feed resources and the opportunity to easily expand due to land availability and a low population density. These advantages along with climate and environmental regulations continue to attract large, greater than 1,000 head, dairies to the region.

1.4 Objectives

Numerous factors influence a producer's ability to maintain a positive profit margin; the focus of this study is the monetary measure of profit assuming all management factors are accounted for by using the average revenue and costs for large dairies. A model will be built that can be used for both historical and projected profit analysis. A 21-year historical analysis will be completed to analyze how profit levels have varied over time for large dairies. Additionally, a projection model will be developed to determine the potential profitability out 12 months for large dairies. The model developed will provide a framework for regularly calculating historical returns and projecting future returns on an ongoing basis.

Due to relocation of dairy cow inventory and milk production to the West and Southern Midwest regions, the model will focus on dairies in the Southern High Plains region of Colorado, Kansas, New Mexico, Oklahoma, and Texas. The profit model will outline all of the major accounting and economic revenue and costs which a producer incurs to operate a dairy in this region. Data will be collected from various resources within United State Department of Agriculture (USDA) and associated organizations, budgets and models built for large dairies published by extension programs, and farm data from proprietary firms. Flexibility will be added to the model by allowing for user entry of projected commodity prices for milk and feed components and management factors. The outcome will help to determine where this segment of the industry has been in the past 21 years as well as the potential profit levels and margins which producers in the High Plains region can expect to see in the coming months and years.

In addition to the model, a literature review of dairy profitability and operation location studies was completed along with an in-depth analysis of determining milk price to gain a better understanding of how milk sales revenue is determined. This thesis will give an in-depth look at the dairy industry on the production side and the supporting model will be a tool for educators and producers to determine expected profitability for large scale dairies in the Southern High Plains region.

1.5 Outline of Study

This thesis is organized in eight chapters. This introduction is followed by Chapter 2, a literature review of milk pricing and related dairy profit and location studies. Profit budgets and models published by extension programs are reviewed in Chapter 3. Chapter 4 will outline the data used within the model which includes 21 years of historical milk prices and associated production costs in addition to projecting monthly returns for 12 months into the future. Chapter 5 describes the models used to build the historical and projected trends for all revenue and cost components. The dairy production profit trends and margins are then discussed and analyzed in the results section, Chapter 6. Finally, discussion and concluding remarks regarding the research completed and model designed are offered in Chapter 7.

Chapter 2 - Literature Review

Dairy profit, calculated by subtracting costs from revenue, is known to have great variability across time due to vast swings in the commodity markets. Dairy revenue is primarily driven by milk price and production. Thus, understanding milk price calculations and policy-related factors are important for producers to understand to reduce related risk. Likewise, understanding the impact production has on revenues and how to manage the various factors impacting production (e.g., heat stress) is also crucial to managing risk for dairy operations. This chapter focuses on milk pricing, profitability, and spatial location affecting the dairy industry. The chapter starts with a review of milk pricing, policy, and marketing. This is followed with an overview of various dairy profit projection models and budgets being used in the industry today for different regions of the United States. Historical based, point in time profitability models are reviewed to summarize profit driving factors found in the literature. The last section of this chapter examines and discusses the structural change of the dairy industry by reviewing spatial location studies.

2.1 Determining Milk Price

Several factors influence milk price received including component levels, dairy product supply levels, regional and national consumption, global markets, government policy, and cooperative involvement. Government policies and programs have influenced milk price since the Great Depression while cooperative organizations have had more recent impacts in reducing volatility in the milk markets (Jesse and Cropp). Futures and options markets have recently been introduced to producers as a price discovery tool and a means to reduce the volatility in the milk price they receive.

2.1.1 Milk Price Overview

Milk is comprised of butterfat, protein, solids-nonfat, and water which are utilized in the manufacturing process to make butter, nonfat dry milk, cheese, ice cream, and fluid milk among an extensive list of dairy products produced from milk. The variability of the components in milk and location of processing plants in relation to operations are two factors that lead to variability in the price manufactures are willing to pay across the United States at a point in time. Milk from dairies located close to large population centers will likely be utilized for fluid and soft manufactured products which affect the pay price based on utilization of butterfat and casein in the products manufactured and transportation distance from the farm to consumers (Jesse and Cropp). However, in areas like California where supply is greater than demand, milk price is historically lower and cheese plants have located to these areas to capture low prices.

Milk price paid to farmers is based on formulas set by Federal Milk Marketing Orders (FMMO) which link fluid milk price to supply and demand factors of manufactured dairy products. Milk is regulated in FMMO areas, which are defined as geographical regions which sell a minimum amount of fluid milk, i.e., a minimum amount of milk exchanged between producers and handlers. Federal Milk Marketing Orders main objectives are to regulate Grade A milk, set price minimums, and regulate handlers. Milk is classified as Grade A or B based on quality and production standards. Grade A milk is classified as milk, which is eligible for beverage consumption. In 2005, over 99 percent of all milk produced in the U.S. classified as Grade A. All other milk is classified as Grade B and can only be used in manufactured goods. The 10 FMMO areas are outlined in Figure 2-1. These 10 areas handle over 120 billion pounds of milk, 68 percent of the U.S. Grade A milk (32 percent of Grade A milk is in California and other non FMMO areas) (Jesse and Cropp).

Under Federal Marketing Orders, milk is also defined as Class I, II, III, or IV type milk. The classes, defined by the dairy products made from the milk and utilized to price milk, are outlined in Table 2-1 as described in the Dairy Backgrounder published by the ERS (2006). These classes are the basis for milk price formulas guided by fluid milk amount and component levels; the formulas as given by the USDA released on June 21, 2010 are listed in Table 2-1.

Figure 2-1 Federal Milk Marketing Order Areas

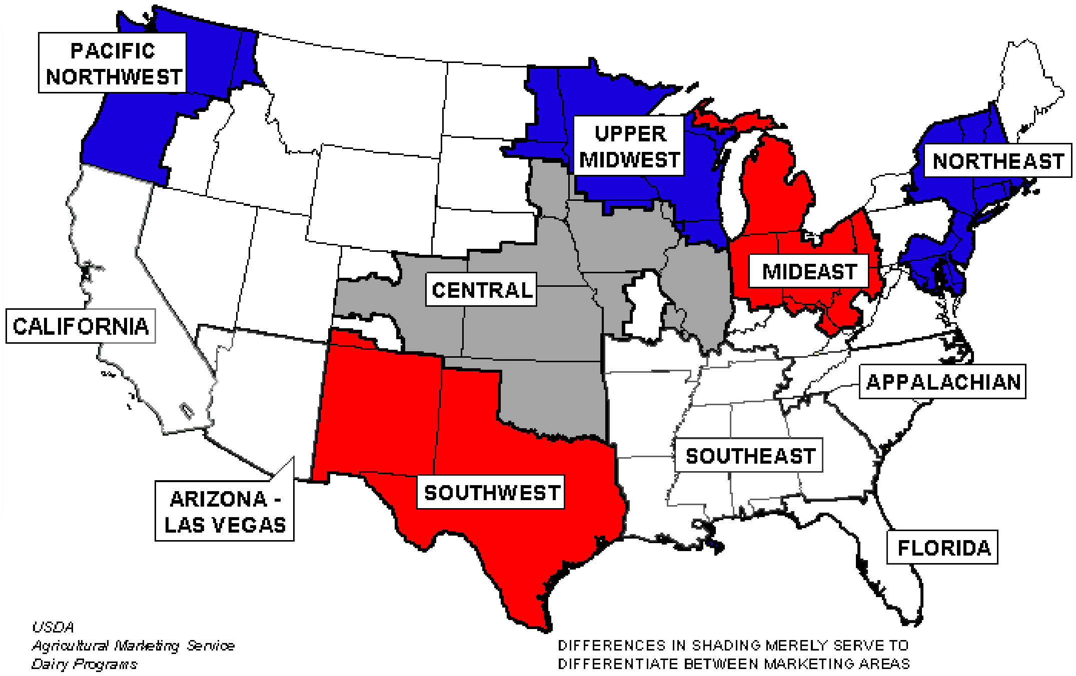


Table 2-1 Milk Class Definition and Utilization

Class	*Milk Grade*	*Milk Product Utilization*
I	A	Beverage milk
II	A or B	Fluid cream products, yogurt, perishable manufactured products (ice cream, cottage cheese, sour cream)
III	A or B	Cream cheese, and hard cheese
IV	A or B	Butter and dry milk

Table 2-2 Milk Price Formulas

Class	*Class Price*	*Class Skim Milk Price*
I	(Class I skim milk price x 0.965) + (Class I butterfat price x 3.5)	Higher of advanced Class III or IV skim milk pricing factors + applicable Class I differential
II	(Class II skim milk price x 0.965) + (Class II butterfat price x 3.5)	Advanced Class IV skim milk pricing factor + $0.70
III	(Class III skim milk price x 0.965) + (Class III butterfat price x 3.5)	(Protein price x 3.1) + (Other solids price x 5.9)
IV	(Class IV skim milk price x 0.965) + (Class IV butterfat price x 3.5)	Nonfat solids price x 9

Component and product prices are established by FMMO's based on weekly sales volumes and prices for butter, block and barrel cheddar cheese, nonfat dry milk, and dry whey which are used to calculate prices for butterfat, protein, other solids, and nonfat solids (Jesse and Cropp, 2000). The component price is defined as

Component price/lb = (product price/lb – make allowance/lb) x yield. **(1)**

The component and Class III and IV prices are announced monthly; Class I and II prices are announced bi-monthly using adjusted product prices based on a two-week weighted average of component sales. *Product price* used in the above formula is a four- to five-week weighted price and *make allowance* is the cost to produce the given product. *Yield* is the amount of product that can be generated from a pound of the component; it can be also be interpreted on average, there are 3.5, 3.1, 5.9 and 9.0 pounds of butterfat, protein, other solids, and solids nonfat, respectively, in a cwt of milk. Jesse (2008) from the University of Wisconsin Extension found, "NASS prices for butter and cheese are highly correlated with the CME prices lagged one week, emphasizing the extensive use of reference pricing at the wholesale level and the related influence of the CME cash markets on all milk prices (Jesse and Cropp, p 11)." The differential utilized in the Class I formula is to attract milk to high population areas where plants are also located. The Producer Price Differential (PPD) increases based on greater location from large metro areas where proportionally a larger amount is used in fluid milk versus dairy product manufacturing.. The upper Midwest is known to have lower PPD due to a greater supply of milk close to large population centers. The PPD can be associated with the additional value of milk above or below Class III utilization. Hence plants closer to more dense populations will produce more fluid and soft products due to fewer transportation miles; therefore, more milk will be utilized for Class I and II so the PPD is higher in these areas (Jesse and Cropp). The 'Class I price mover' was designated in 2000 as the higher of advanced Class III or IV skim milk prices. Prior to this it was the Basic Formula Price (BFP) utilizing the Minnesota-Wisconsin (M-W) Price with an adjusted average for change in manufacturing product prices (Miller and Blayney). The M-W price was the average price paid to producers in Minnesota and Wisconsin for Grade B milk which coupled the Class I milk price with the cheese market.

Producers are not solely paid based on class prices; rather they are paid the classified price based on utilization of milk by the handler. Milk being utilized for Class I will receive a higher pay price based on the class pricing system. The payment to the producer equates to the price paid for each component, protein, butterfat, and other solids; somatic cell count adjustment relative to the base level of 350,000; and PPD based on volume. Additional handler profits are contributed to a producer settlement fund which is distributed to producers under a uniform price also identified as pooling. Uniform price is a blended or weighted average price of milk across all uses and classes. Under each class the handler pays for butterfat in addition to skim milk volume, nonfat, protein and other solids, and nonfat solids for Classes I, II, III, and IV, respectively, based on the volume and their utilization of each class (Jesse and Cropp). Each Federal Milk Marketing Order area posts the mailbox price which is the average milk price received by producers in the respective area reflecting the actual price received in addition to premiums or deductions.

2.1.2 Milk Supply and Pricing Policy

Government dairy policies and programs have attempted to reduce volatility in the fluid milk price received by farmers through various legislation and rulings. These policies have included price support programs such as dairy product purchase, direct payments, and subsidized dairy product exports; marketing orders; and food-aid programs (Miller and Blayney). According to Shields (2011) in *Previewing dairy policy Options for the Next Farm Bill* by the early 1900's producers pushed for buyers to pay a price for milk in correlation to its processed product use. The bottom fell out of milk markets during the Great Depression and the government intervened in the dairy commodity markets with the Agriculture Adjustment Act of 1933. The Agriculture Marketing Agreement Act of 1937 created the Federal Milk Marketing Order system to stabilize market power between producers and processors and to mitigate downward pricing competition (Shields). The FMMO's were permanently authorized in 1937, but were revised in 2000 under the Farm Act primarily to reduce the number of order areas to 10 federal areas. California, the largest state in terms of milk production, is not part of a FMMO, rather it operates under a state marketing order rule (Manchester et al). While marketing orders were established early, milk price supports were not established until 1949 where the set prices were typically above announced prices. However, since 1989 the support price has been only a protection against the extremely low side of commodity market prices (Miller and Blayney). As a price support program, the Commodity Credit Corporation (CCC) purchases excess processed, storable dairy products that processers desire to get rid of at the stated support price ensuring both producers and processors received minimum price support for the product. The stated support price was calculated to cover average efficiency. As explained by Jesse (2008, p 7) in *Basic Milk Pricing Concepts for Dairy Farmers*,

> "If milk supplies are large relative to demand, then the supply of milk not needed for perishable products will increasingly be diverted to the manufacture of storable products. Prices for these products will fall with increased supply. At some point, the CCC purchase prices will represent a more profitable market for some plants than commercial outlets."

The CCC remains in existence today operating under the Dairy Product Price Support Program (DPPSP). DPPSP has not been a factor in the past 10 years due to the support price, $9.90 per cwt, being well below the average market price (Shields).

Another program in place is the Dairy Export Incentive Program (DEIP); it subsidizes up to a set quantity or value of dairy product exports in foreign markets (Manchester et al). The drivers behind the DEIP are to counter foreign dairy subsidies and to develop export markets. Import barriers including quotas, licenses, and fees on any imports which display the ability to interfere with USDA market stabilization initiatives are examples of actions DEIP may take to maintain stability in the dairy market.

Additional programs include direct payments under the Dairy Market Loss Assistance (DLMA), which occurred in the early 2000’s, and the Milk Income Loss Contract (MILC) enacted in 2002 (Miller and Blayney). The MILC is based on the actual Class I price in a region compared to a base Class I price in Boston of $16.94 per cwt. A payment is made when the actual price falls below the support price. In this case participating producers are paid 45 percent of the difference between the Boston and respective pay price. The ceiling for this program payment per farm is 2.985 million pounds annually which is roughly equivalent to a 160-cow operation. When the fluid milk market is depressed, the MILC program generates the greatest expense to the government compared to all other programs targeted to help stabilize prices and production (Shields).

In addition to government programs and policies, private efforts have been taken by the National Milk Producers Federation (NMPF) to increase dairy exports and regulate milk supply. NMPF represents milk cooperatives and has guided several initiatives, one being the Cooperatives Working Together (CWT) program, which has enacted several herd buyout programs. As of December 31, 2009 these buyout programs had removed over 5.4 billion pounds of annual milk production through the purchase of over 276,000 cows and 5,700 heifers from herds across the United States (Shields). These government and privately directed programs have aimed to reduce volatility in the market and provide opportunities for producers to either remain in or exit the dairy industry with less financial hardship than would have otherwise been the case.

According to Shields (2011), current dairy policies have been passed to remain in place until 2012. New dairy policy has been initiated in Congress to help dairy producers mitigate price risk, enhance producer revenue, and stabilize the market in addition to managing the milk supply. Market stabilization or supply management has been proposed in two different pieces of legislation (Dairy Supply Management Bill and Dairy Market Stabilization Act). Both of these proposals introduce a base level of production for individual farms based on the current milk-to-feed ratio with penalty fees for marginal production above the assigned level. These penalty fees are a fee per cwt based on the milk-to-feed ratio for the Dairy Supply Management Bill and a reduction or partial percentage of revenue paid based on the margin (milk price over feed cost) level for the Dairy Market Stabilization Act.

Additional aspects of dairy policy are market based which minimize price risk and increase revenue for producers; these programs include margin insurance, farm savings account, improved price discovery, and tiered pricing. The primary market based program is margin insurance where the government would solely support payments to producers up to 90 percent of a historical base production when margins fall below a guaranteed level. The farm savings account program offers tax incentives for participation when farmers invest money. Improved price discovery pushes for elimination of Class I, II, and III prices in exchange for a competitive price structure for milk pricing. The final initiative of the new policy is tiered pricing; this program rewards producers for producing a quality product and is built into the current FMMO's where premiums are received from the handler (Shields). New policy measures can offer mitigated price risk as an increasing portion of the policy protects against the volatility in feed commodity markets as well as milk price volatility. The potential of the proposed policies on the health of the dairy markets long term is uncertain due to varying unknown outside market conditions and scenarios.

2.1.3 Milk Price Marketing

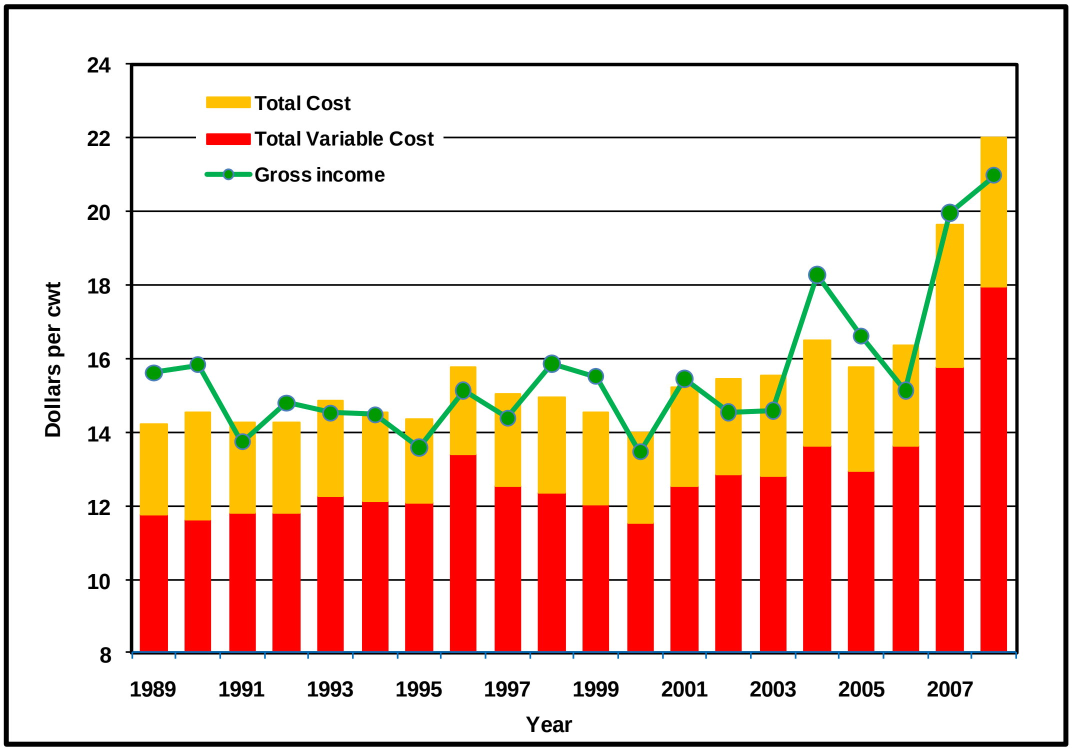
In the early 1900's, as production efficiency increased along with an increasing urban area demand, producers started selling a larger percentage of their milk rather than keeping it for on farm use. The industry at this time consisted of small scale processors who could competitively price due to relative number of producers and milk per farm being sold. Then producers began to band together to market their milk creating market power to lobby for improved prices through collective bargaining (Manchester et al; Shields). Cooperatives are a key part of the industry today as they serve as both marketers and processors where they handle four-fifths and one-third of milk, respectively, for each role they serve (Miller and Blayney; Manchester et al).

In addition to utilizing cooperatives to market their milk, producers have price risk mitigation alternatives available through commodity future and options markets. Butter futures have been listed on the CME since the early 1900's. Cheddar cheese, in the form of 400-pound blocks and 500-pound barrels, and nonfat dry milk futures have been traded on the New York Board of Trade (formerly the Coffee, Sugar, and Cocoa Exchange) since 1993, (Manchester et al). The Chicago Mercantile Exchange (CME) created a Basic Formula Price (BFP) futures and options market in 1997. Then in 2000, Class III and IV contracts were developed and introduced on the CME. Grade A milk futures markets are utilized solely for risk management purposes as contracts are not filled, rather contracts are bought and sold by producers and cooperatives to hedge their milk price in a profitable manner and to reduce price volatility. The butter, cheddar cheese, and dry whey futures market contracts are traded for five minutes daily, and the closing prices are utilized as a reference point for the milk market. Although rarely traded or filled, these markets are pivotal in component and fluid milk pricing.

2.2 Dairy Profitability Studies

Market price volatility has been a key factor in variability of returns for dairy operations in recent years. This is due to milk price and feed input costs being driven by the commodity markets and also being relatively large factors of profit, cost, and returns. However, high milk prices are not consistently highly correlated with greater levels of profitability. Historical dairy operation returns over a 20-year period (1989-2008) were analyzed for key economic factors impacting profit and variability in returns across producers at a point in time (Schulte and Dhuyvetter). Data were obtained from the Kansas Farm Management Association (KFMA) where the average number of operations per year is 66 with an average herd size of 101 cows, ranging from 85 to 120. Over the historic 20 years of data available, variability in milk price has been greater in the last 11 years, 1998-2008, with a range from $14.50 to $19.50 per hundredweight (cwt). As shown in Figure 2-2, when analyzed on a per cwt basis, producers were able to cover total cost in nine of the last 20 years; however, marginal changes in inputs and outputs do not correspond to one another allowing for variability in returns. In their analysis of costs and income for Kansas producers from 1989-2008, Schulte and Dhuyvetter reported that variable costs averaged $12.87/cwt (ranged from $11.55 to $17.96) and total costs averaged $15.59/cwt (ranged from $14.00 to $22.02). In all years, gross income received was sufficient to cover total variable costs, but not to cover total costs, which include unpaid operator labor, depreciation, taxes, and interest charges.

Figure 2-2 Annual Variable and Total Costs versus Gross Income per Hundredweight of Milk Produced



When data were analyzed by high-, middle-, and low-return years there was a $392 per cow difference in returns over total costs between the high- and low-return years. Correlation analysis was completed to measure the key variables which impact the level of return over costs. Milk price in correlation with returns over variable cost had the strongest correlation at 0.66 and 0.59 on per cow and per hundredweight milk produced basis, respectively. These results reflect that milk price is a key driver of returns over costs; however, the correlation is not strong enough to suggest it is the only driver, producers must analyze all factors affecting marginal returns to remain profitable.

The second part of the study analyzed operations which had reporting data for at least three of the five years from 2004-2008. Forty farms were included in this analysis with the average number of cows being 115. The farms were sorted into three categories, top, middle, and bottom, according to average returns over total returns. For each return category data were reported in nine cost groups, three revenue groups, and four additional factors including pounds of milk per cow, culling rate, milk price per hundredweight of milk, and income over feed cost.

Regression models were estimated to analyze relationships between dependant variables, aspects of profit and cost, and independent variables, farm characteristics including herd size, milk production, and milk price. Analysis showed that milk production per cow had the greatest impact on profit across producers and milk price had a greater impact for low-production farms than high-production farms. In the cost categories, high-profit farms had higher feed cost per cow but lower labor cost which can be reflected in higher production levels and larger farm size, respectively. Regression analysis results are shown below in Table 2-3; pounds of milk produced was economically significant in both profit and cost models while percentage of labor allocated to livestock was significant ($P < 0.10$) in the cost model. Additionally, milk price per hundredweight was statistically significant ($P < 0.05$) in the profit model and cull rate was statistically significant ($P < 0.05$) in the cost per cow model.

Table 2-3 Regression analysis for profit and cost models (Schulte and Dhuyvetter)

	Profit ($/cow)		***Cost ($/cow)***	
Variable	*Coefficient*	*P value*	*Coefficient*	*P value*
Intercept	36,901	0.113	-42,958	0.025
Cows, number of head	1.00	0.385	-0.26	0.798
Milk production, lbs/cow/day	25.48	0.000	29.52	0.000
Milk price, $/100 lbs milk	176.82	0.024		
Culling rate, %	1.14	0.793	9.64	0.038
Feed percent of total cost	17.07	0.175	-15.27	0.157
Livestock labor percentage	-3.64	0.464	7.68	0.079
Years	-398.91	0.080	421.27	0.021
R-square	0.4547		0.6217	

These results indicate that milk price is significant in determining profit levels and that culling rate positively affects cost per cow, but it does not significantly impact profit per cow (Schulte and Dhuyvetter). From these studies we can conclude that milk production, milk price, and controlling labor costs are key factors to determining profitability for smaller dairies in Kansas. In addition to looking at Kansas data when analyzing profitability factors on a dairy operation, other dairy profitability analysis studies were reviewed as outlined below.

A study based on results from the *1993 Farm Costs and Returns Survey – Dairy Cost Production* was conducted by the Economic Research Service and National Agriculture Statistics Service to determine the economic and structural differences between farms of the traditional states (north and northeast) and nontraditional (south and west) (El-Osta and Johnson). Improving production per cow, decreasing forage, purchased feed, and capital investment cost, and decreasing debt-to-asset ratio were indicators of ways to improve returns per cow across the United States. Data from 503 commercial dairy farms were used in the regional study to determine the characteristic differences like size, labor, balance sheet data, and farm profitability. On a whole farm basis, the major factors that affected net income were farm size, level of indebtedness, labor cost, and level of technological advancement used in the operation. The amount of debt commercial farms have per hundredweight of milk sold is $6.98 for non-traditional states and $11.04 for traditional states. In comparative analysis, on a per cow basis, pounds of milk produced, forage production cost, and purchased feed cost were the largest factors affecting net returns. Across the United States, for each additional hundredweight of milk produced returns increased $0.05; and net returns increased for each $1.00 decrease of combined feed and capital investment of buildings, land, and machinery cost. Additionally, a dairy that focuses on lowering purchased and forage feed costs, increasing pounds produced per cow, and lowering debt-to-asset ratio will increase net return per cow. However, the nontraditional states also must focus on decreasing capital investment in land, buildings, and equipment to increase returns. These results are logical as farms in the north and northeast are traditionally small and thus they tend to have higher cumulative debt per head whereas the farms in the south and west are larger and have more recent capital start up debt as well as higher cost of feed due to location, but more cows to spread debt over when measuring on a per cow or cwt basis. One of the weaknesses of a profitability study, as stated in the paper, is that in order to measure returns one must include market price of milk sold, which is an uncontrollable factor to the dairy producer. An additional weakness of this analysis is reporting outcomes on a whole farm basis and due to the size variability between farms of the Northeast to the Southwest states which creates an unfair comparison of cost and returns. More specifically, conclusions about regional differences are likely due more to dairy size than they are due to region. In some aspects of the study when evaluating concentration and general characteristic differences, a whole farm measure is appropriate; when measuring returns the data must be normalized to per cow or hundredweight milk sold to accurately compare management practices (El-Osta and Johnson).

Kumbhakar, et al. found that larger farms (greater than 500 cows) are more profitable due to their ability to excel at both technical and allocation efficiencies as well as to earn an economic profit in a free market. Data from the 1985 Farm Cost and Return Survey were used to study the variability of profit among farm sizes using relative economic efficiency measures, farm size coefficients, and returns to scale measures. To normalize the data, results were separated by region and farm size, less than 100 cows, 101-500 cows, and greater than 500 cows. The study used coefficients for technical efficiency factors, education of the producer and forage hay quality, and allocation factors, returns to scale and farm size. The results showed that large farms are more profitable than small farms due to being more efficient and having lower returns to scale. Given the same output price per hundredweight of milk sold, larger farms are more likely to cover their cost and have positive return whereas smaller farms have a harder time covering their variable costs and in some years depend on government price supports to create a positive return. This article is beneficial in analyzing how categories of farms stack up against one another in terms of profitability; however, the resulting profit measures are difficult to interpret how a producer can use and apply the output results. A more beneficial analysis would be focusing more on the returns to scale and net profit return per animal unit to validate how improving returns can be beneficial in a comparative analysis across farm sizes.

Tigges, et al. found that milk production, in terms of total pounds produced or pounds of components produced, revealed to be the factor that has the highest influence upon net income on a per cow basis. The study included data from 182 cows across three lactations collected from Dairy Herd Improvement Association data and evaluated relative to net income. Once relative net income was calculated, it was compared back to individual variables to determine correlation strength to evaluate which factors have a greater impact on net income. Pounds of milk produced per cow displayed the highest correlation with relative net income. When estimating regression models with various factors, milk production, in terms of pounds of milk produced and pounds of fat produced, proved to be the most influential factor on returns per cow. While this paper evaluated the income factors in relation to profitability of a cow, the study did not reveal any statistical information on how an increase in expenses affected the net profitability of a dairy cow

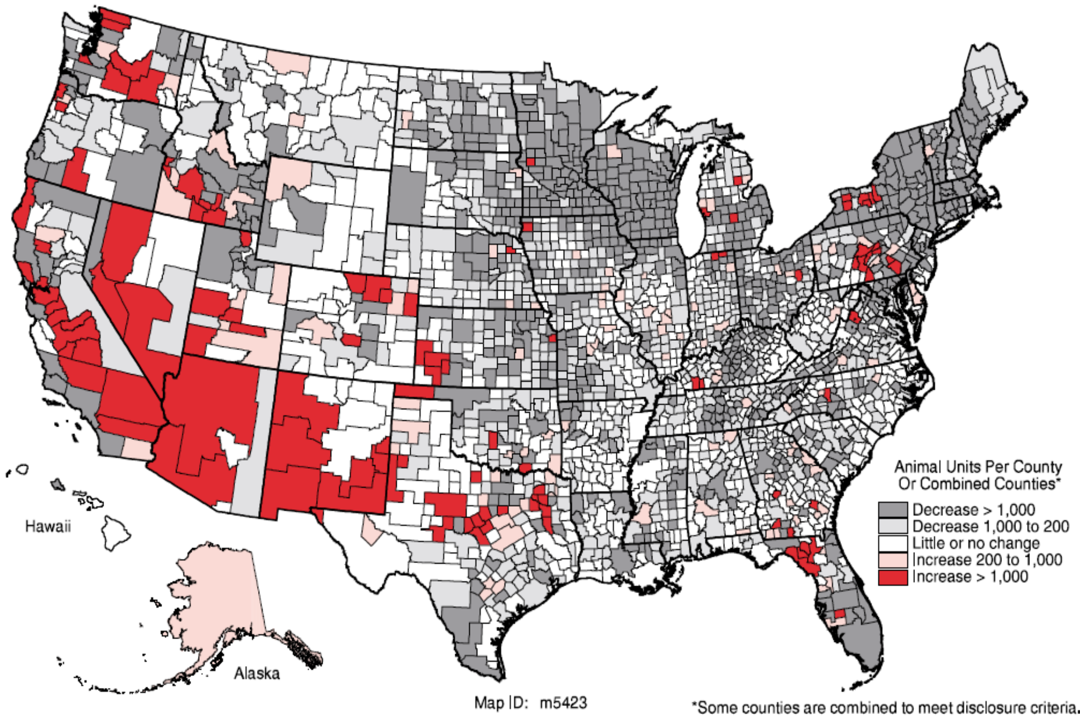
Studies reviewed indicate that milk production has a significant impact on the profitability of a dairy cow, whether it is evaluated on per cow or per hundredweight basis. The largest difference between studies is how they evaluated profit per cow Schulte and Dhuyvetter; Tigges et al.; and El-Osta and Johnson focused primarily on economic factors whereas Kumbhaker, et al. calculations were more complex and included noneconomic factors like reproduction, health determinates, and level of producer education. Although the studies including noneconomic factors are more complex, they seem to be more realistic and believable due to a diverse approach to variability of income due to multiple factors. Profitability can be measured in many ways, but the primary evaluation method was done using linear analysis with profit factors being represented with coefficients. Profitability was then compared back to the variables to determine regression and correlation results which typically resulted in total pounds produced being the leading factor followed by feed input price, milk price received, and capital investment.

2.3 Spatial Location of Dairy Operations

The dairy industry has undergone structural change over the past 30 years which has brought forth the question of the reasoning behind relocation of the dairy industry. Spatial location studies have been done to measure the importance of various factors on the location of a dairy operation.

Figure 2-3 displays changes in the U.S. dairy cow inventory from 1982 to 1997 by county (Ribaudo et al.). Counties in red are those which have attracted dairy operations over the stated 15-year period. Animal agriculture has not been immune from government oversight; with the increase in cow density per square mile in areas across the U.S. concerns of potential pollution hotspots and level of environmental regulations have risen.

Figure 2-3 Change in Animal Units for Confined Milk Cows from 1982 to 1997



Source: USDA, Economic Research Service

Based on Figure 2-3, it is evident that dairies have relocated to Southern California, Nevada, Southern Idaho, New Mexico, Arizona, Northern Texas, and Western Kansas. The majority of these areas have valuable natural resources, mostly water systems which provide municipal water to large cities, the Ogallala aquifer being a one example for Western Kansas and Texas Panhandle. Livestock systems depend on these resources for use on the farm and crop growth. Preserving the quality of these water resources is the primary concern of citizens, legislators, and regulators as clean, nutrient balanced water ecosystems are needed to sustain human, animal, and plant life. Associated environmental quality standards and regulations have been inflicted on animal agriculture as a result and have helped define where livestock are located within the U.S.

A study by Herath, et al. looked at the effect of environmental regulations on the spatial location of Confined Animal Feeding Operations (CAFO) in the United States over 26 years. The study looks at the swine, dairy, and feeder cattle industries from 1975 to 2001 compared with timing of both federal and state regulations. The study includes an empirical model determining significant factors affecting relocation of CAFOs within these three industries.

At the time of the study, the dairy sector was the least concentrated of the three industries as measured by the Gini coefficient, measure of inequality of distribution. Concentration has shifted from the Great Lakes and Northern Great Plains to the Western and Southwestern states of the U.S. Over the 26-year period, California increased its cow inventory by 90 percent contributing to the Western region increase by 61 percent. Five-year averages of annual inventory growth rates for the period were used as the dependant variable while the independent factors included variables that fall under the following categories: environmental regulation stringency, relative prices, relative business climate, livestock infrastructure, and climate. Regulation stringency is measured as the mean of various indexes formulated by other researchers or organizations and is adjusted for each state by associated input costs to build facilities and meet regulations. The independent variables were used to capture differentials in profitability between states. The change in production location is measured as the relative profitability, which guides the user to answer 'where to relocate production to in the U.S. based on current location.' This empirical model found population density and unemployment rate were the two drivers behind livestock relocation. However, the authors also found that state or regional environmental regulations become more stringent after production levels start to increase in the surrounding area (Herath, et al., p 45-68). The study supported regional movement due to lower population density and underdevelopment of regulations.

Osei and Lakshminarayan conducted a study in 1996 examining location of dairies as a function of environmental regulation, which regulated the storage and application of dairy waste and associated runoff or leaching. The independent variables measuring environmental regulations included measures of air quality, groundwater quality, soil conservation, and environmental policy stringency indexes. Other variables of location change in their empirical model included milk price, cost of production, climate, population density, and topography. County-level cow inventory for 1987 and 2002 were collected from census data and compared in the model to determine spatial location measures. Output is measured as the marginal effect of an independent factor on location change; the marginal effect is then converted to elasticity measures of probability of location change based on an explanatory variable. A county with a higher positive elasticity is interpreted as one that is more probable to have dairies than ones with lower or negative elasticities. Results showed that environmental variables were generally significant and negative in nature; this is interpreted as stringent environment regulations are likely to deter dairy location while counties with less stringent regulations will gain dairy operations. It was also found that when environmental regulations and population density are analyzed together, a marginal change in regulations changes elasticity of location to a smaller degree than if population density were not included. The interpretation of results is that when population is more dense environmental regulations will be more stringent and therefore dairies will be deterred to a larger degree from locating within that county. This study analyzed environmental quality and standards with the spatial location of dairies which resulted in a lower regulation impact effect on dairy location.

As one of the largest dairy production states, California has the most stringent environmental regulations compared to other states. The California legislature created nine regional Water Quality Boards in 1970 designed to create regulations for their specific area, this was before the federal government added agriculture to the Clean Water Act (CWA) in 1972. Then in 1984, state-wide regulations were set to regulate manure storage and application; in 1997 additional regulations were set on storage and disposal of waste water and livestock access to surface water. The majority of dairy production in California has resided in the Chino Basin, east of Los Angeles, and in the Central Valley Region. The Chino Basin Regional Board established application standard levels that lead to mandatory permits by 1994. In 1999, this area of concentrated dairies had to also comply with the NPDES permits, secure CNMPs, and new CAFOs were prohibited. During this time the Central Valley region was less stringent on implementing environmental regulations, which caused dairies to relocate from the Chino Basin. It was not until the early 2000's when producers in the Central Valley area started to experience the level of environmental regulation their neighbors to the South in the Chino Basin had been experiencing for nearly two decades (Sneeringer and Hogle). A study by Sneerininger and Hogle examined the timing impact of environmental regulations and changes in cow inventory numbers and location in California. They used 1991, 1997, and 2001 census data to extract county-level inventory numbers that were transferred into density coefficients by dividing number of cows by square miles in the county. It was found that federal and state implementation of environmental regulation timing did not correlate with change in movement of dairies out of the state. However, regional changes did occur corresponding to timing of enforcing new regulations. In 1994, waste permits were implemented in the Chino Basin which corresponds to a decreasing trend of cow density that declined sharply after 2004. About the same time, 1994, the cow density in the

Central Valley began increasing and has not dropped off for data analyzed up to 2008 (Sneeringer and Hogle 133-146). The analysis of California data is a great example of regional regulation implications; however, other measures of population and business climate need to be included in a regression model for accurate analysis. Overall, from the studies reviewed we can conclude that California is representative of how regulations are not a driver of spatial location, rather regulations tend to be implemented after dairies have moved into an area.

Chapter 3 - Analysis of Current Profit Models

3.1 Dairy Profit Projection Model

There are limited tools and studies which include models to project profit for dairy production. Many of the models that were found are not specific to a region or type of operation. This can lead to generalized equations and assumptions, which may over or underestimate production costs, margins, and profit for a particular dairy. However, a review and analysis of these models is important to gain an understanding of how to forecast or estimate milk production and profitability. Several private models are available through consulting groups and Wisconsin Extension has published a proforma calculator which is outlined below and included in Appendix B.

3.1.1 Wisconsin Center for Dairy Profitability – Dairy Proforma Calculator

The Dairy Proforma Calculator published by the Center for Dairy Profitability based out of the University of Wisconsin is farm-level driven with two tabs of information for farm input data and several supporting worksheets to calculate projected profit. The workbook generates a monthly proforma cash flow which projects out three years along with profitability measures calculated on an annual basis. Additionally included are risk and sensitivity analysis worksheets that examine margin coverage when shocking various input commodity prices, debt levels, and interest rate on debt.

To use this tool, users need to enter mortality rates, livestock sale prices, herd inventory, ration ingredients, feed prices, and other operating costs for current and projection years. Additionally, users are asked to provide cost estimates for all livestock and crop expenses in addition to crop acre and yield estimates for all years. The last items required from the user are tax return data from Schedules F and 4797 to measure and cross check revenue and expense calculations from prior entered data. From the entered farm data, balance sheet, income statement, financial ratios, cash flows, profitability values, and sensitivity and risk analyses are calculated. The primary calculations focused on in this analysis are the cash flow and profitability calculations to gain a better understanding of how this tool estimates projected margins.

Projected Income

Projected income for both the profitability and cash flow calculations come from sales of milk, cull cows, calves, crops, and miscellaneous income. Monthly milk production is projected based on producer provided annual estimates of number of cows, milk production per cow, and milk price with percent adjustments taken for each month on each factor. Yearly projected milk sales is the sum of the projected milk income for each month. The number of cows is multiplied by milk shipped in pounds per cow per year, which is divided by 100 to convert to hundredweight measurement. This production calculation is multiplied by price of milk per hundredweight and adjusted for monthly production and price indices.

Remaining income factors are cull cow sales, replacement calf sales, non-replacement calf sales, crop sales, and miscellaneous income. These remaining income categories are calculated for the year then divided out by month based on the value adjustment given for each month. Yearly income per category is calculated by summing monthly income per corresponding category per month by the monthly adjustment for the given category. Cull cow sales is a function of the cull cow price, cull rate, and number of cows, all of which are annual estimates entered by the user. Replacement sales is the number of surplus heifers, difference between fresh heifers and replacements needed to maintain herd size, multiplied by the expected heifer replacement price and percent of replacement sales realized. Calf sales is a function of calf price and number of calves available for sale, bulls and excess heifers not being raised for replacement. Crop sales is a function of crop prices and crops produced in excess of livestock feed required. Finally, miscellaneous sales is a direct entry by the user to reflect any additional income received not included in the prior categories.

The income categories are added together to create cash income; in the profitability model changes in inventory of breeding stock, replacement heifers and cows, are added to calculate total income.

Projected Expenses

Expenses are evaluated differently between the profitability and cash flow analysis. In the profitability analysis, annual expenses are viewed as variable and fixed costs; fixed cost include paid and unpaid labor and depreciation, interest, taxes, insurance, and other management costs on land, building, machinery, and livestock. Estimated percent charge for interest, tax, repairs and insurance are entered by the user. Interest, taxes, repairs, and insurance cost values are calculated based on the corresponding asset category market value, adjusted for inventory change or financial statement valuation, given by the producer, multiplied by the corresponding rate entered. Depreciation is entered by the user or calculated by using the actual value of the assets by the assigned percent charge. The profitability model costs are estimated on asset values and can incorrectly estimate costs of the firm if the market values or percent charges are not accurately represented.

In the cash flow figures, cash expenses are utilized and are analyzed on a monthly basis using the same values as in the profitability model. The annual variable costs are broke down to monthly increments by a percentage adjustment. Monthly expense per corresponding cost category and is derived from the category cost, from the profitability analysis, multiplied by the monthly percentage adjustment. Monthly expenses include vet and medicine, farm supplies, custom hire, breeding fees, purchased forages, purchased grain, crop expense, fuel, oil, and gas, utilities, labor hired, land rent, purchased replacements, other expenses, property taxes, farm insurance, building repairs and insurance, livestock insurance, and machinery repairs and insurance. These expenses included in the cash flow model represent cash expenses and do not include adjustments for opportunity costs. The cash flow model also includes deductions for interest and debt payments as calculated by loan payment calculations included in the workbook. The profitability and cash flow models are organized differently and display cost and expenses in different fashions depending on each model's desired end output.

Model Analysis

A profitability model measures the ability for a firm to generate returns over designated costs. In the Wisconsin Extension Dairy Proforma Calculator the profitability model measures total income, cash less change in animal inventory, over variable cost and total costs on an annual basis for a base year plus three projection years. Variable costs include the typical operating costs for an operation. Cash costs include variable costs, repairs,insurance, taxes, and interest paid; total fixed costs also includes depreciation and estimated interest, in addition to the cash costs.

Cash flow models are designed to show a firm when high or low periods of cash flow occur in a year to determine if additional credit is needed to carry the operation through a time of low returns to when cash flow is positive. The cash flow model in the Wisconsin Proforma workbook measures incomes, expenses, interest, debt repayment, family living, credit needs, surplus funds, net line of credit, and number of replacement females purchased on a monthly basis for the base year and three projection years. Income, expenses, interest, debt repayment, and family living are the determining factors for additional lines of credit needed or surplus funds. If income less all other cash outlays is less than zero, then this amount is additional credit needed; whereas if the net income is greater than cash outlays then the user has surplus funds to carry over to the corresponding time period or pay off operating debt. Net line of credit is the difference between credit needed and surplus of funds. If there is a surplus, the net line of credit will decrease, which is desired. Additionally, the number of replacement females required is a cost that is classified as an operating expense but may be an infrequent purchase and therefore reflect additional credit needed in times of purchase.

3.2 Dairy Production Budgets

Dairy budgets are a glimpse of the financial structure of an operation at a point in time and are often built upon historic or projected data. This section will review dairy budgets published by Kansas, Wisconsin, and Missouri which offer different levels of flexibility and output analysis; these budgets are also included in Appendix B.

3.2.1 Kansas Dairy Enterprise Budget

Kansas State University publishes four dairy budgets per year customized for herd size (100, 600, and 2,400 lactating cows) and facility type (confinement or dry lot). Due to the majority of the dairies in the Southern High Plains region being dry lot facilities, the 2,400 Lactating Cow Dry lot Dairy budget will be reviewed in this section. This budget formulated by extension specialists from Kansas State is a read only budget which offers output for two production levels on a per cow and hundredweight milk sold (cwt), but offers a section for the user to enter their operation’s returns and costs to compare to the calculated budget. This budget analyzes a 2,400 lactating cow dry lot dairy for two production levels, 19,000 and 23,500 pound rolling herd average. The budget is for 2010 based on the 2009 production year, and uses average of future prices or current commodity prices to calculate returns and costs along with equations and data from previous research (Dhuyvetter et al.).

Analysis of Returns

Income for dairy operations is directly related to the dairy cow; this budget includes returns for milk sales, volume premium, dairy program government payment, calves sold, cull cows, and a credit for manure. Milk sales are based on production, projected rolling herd average (19,000 or 23,500 lbs milk sold per cow per year), and milk price. Milk price is the average of the 2010 futures prices adjusted by basis to account for location with hauling and promotion costs, $0.85 and $0.25, respectively, added to milk price to calculate a gross milk price, $16.32 per cwt. A volume premium of $1.00 per cwt was added, and no government payment was issued due to projected average milk price being above MILC payment levels. Calves sold is based on 95 percent of the lactating herd expected to calve and all calves sold at calving due to the assumption that replacement females are purchased prior to calving. The calf price was calculated based on equation derived from Missouri market data which found calf price as an equation of cow and milk price as outlined in the equations below. In the equations, bull calves have a greater and positive intercept compared to heifer calf price is more positively affected by cow price and less negatively affected by milk price.

Percent of eligible heifers to be sold as marketable replacement heifers is assumed to be 49 percent based on the heifer to bull calf ratio. This results in an average calf value of $199 per calf due to heifers and bull calf prices being $336 and $67 per head, respectively, and given a 95 percent calf crop the revenue from calf sales is $190 per lactating cow. Revenue from cull cows is based on cull rate percent, weight, and market price for cull cows. The budget assumes a 34 percent cull rate, however it assumes that only 28 percent are marketable (i.e., six percent death loss or non-marketable), cull cows to be sold at 1,350 pounds, and cull cow market price equivalent to $47.51 per cwt. The market price used in the budget is based on the beef cull cow market; a prior hedonic model study has shown beef and dairy cull markets are comparable across time. These assumptions result in cull cow revenues of $641.39 per head sold and just under $180 per cow on a herd basis.

Manure credit is an opportunity cost calculated to measure the value of nutrients available in manure which are applied as fertilizer to crop ground. Manure is a revenue typically not collected by producers, but provides cost saving measures for crop farmers. Manure nutrients available are nitrogen, phosphorus, and potassium valued at commercial fertilizer price at $0.39, $0.43, and $0.59 per pound, respectively. Nitrogen and phosphorus are applied at 93 percent of total nutrient available levels produced; however, only 20 percent of nitrogen and 90 percent of phosphorus are available for crop nutrient uptake. Potassium is included at zero percent in the calculated due to soil not being deficient in this nutrient. It is estimated that a lactating cow producing 23,500 rolling herd average generates 59.1 (295.5 generated lbs*20 percent nutrient availability) and 103.3 (114.8 generated lbs*90 percent nutrient availability) pounds of available nitrogen and phosphorus to crops, respectively. Total manure credit is calculated by multiplying the price of nutrient, utilization of nutrient produced, and nutrient levels available in manure less manure application cost; this equates to a net loss of approximately $12 to $16 per cow and $0.06 to $0.07 per cwt of milk for the two production levels with the higher loss being attributed to higher production. Total projected returns for 2010 are $3,647 and $4,422 per cow and $19.19 and $18.82 per cwt for the production levels of 19,000 and 23,500 pounds of milk sold, respectively (Dhuyvetter et al.). This budget analyzes the primary revenue categories associated with a dairy operation; however, the estimation of selling cull cows at 1,350 pounds is a high measure, and due to recent improved reproduction management and genetics some operations may be selling a higher percentage of heifer versus bull calves.

Analysis of Costs

Analysis of returns over total costs between production levels unveils net profit and loss differences for dairy operations. Cost categories which were significant contributors to total costs were feed (43.1% and 44.2% of total cost for 19,000 and 23,500 production levels, respectively), genetic capital replacement (12.8%, 11.5%), labor (8.1%, 7.3%), milk hauling and promotion (5.7%, 6.4%), depreciation on buildings and equipment (5.4%, 4.8%), and interest on land, buildings, and equipment (4.5%, 4.1%). Feed is calculated with the amount of feed required for maintenance and milk production by the ration cost per pound of dry matter. The ration for a dry lot dairy is a high forage diet consisting of corn, sorghum, and small grain silages in addition to medium quality alfalfa hay, grass hay, corn, soybean meal, dried distillers grain, soybean hulls, and minerals. Feed ingredient prices are based on current (at the time budgets are published) market prices in Kansas or futures market prices adjusted for location (basis). For a dry lot dairy, low and high milk production herds feed 83.12 to 104.11 pounds per cow per day on an as-fed basis. When adjusted for dry matter, lactating diet costs an average of $0.0895 per pound ($4.56 and $5.24 per cow per day for low and high production) and the dry cow diet costs $0.0495 per pound ($1.94 per cow per day). Feed cost per cow is $1,572.89 and $1,785.94 ($8.28 and $7.60 per cwt) for the low and high production levels, respectively. Capital replacement is the cost for purchasing replacement heifers. Based on markets and prior research, replacement heifers are valued at $1,370 and purchased at a 34 percent replacement rate of lactating cows. Replacement cost is $465.80 per cow and ranges from $2.45 to $1.98 per cwt for low and high production levels. Labor cost is based on the ratio of 109.1 cows per full time position, where the average annual dairy worker salary is assumed to be $38,000. These calculations bring total labor cost for a 2,400 cow operation to $295.17 per cow and $1.55 per cwt for 19,000 pound production level and $295.17 per cow and $1.26 per cwt for 23,500 pound production level.

Milk hauling and promotion costs were the next largest cost category at $1.10 ($0.85 hauling and $0.25 promotion) per cwt milk sold. The final two categories which represent a sizable percentage of total cost are opportunity costs for the dairy operation, depreciation and interest on land, buildings, and equipment. Depreciation, calculated on asset values, salvage value percentage, and annual depreciation charge, is $195 per cow and represents $1.03 and $0.83 per cwt of milk produced for low and high production levels. Interest calculated using average asset values and interest charge, is $165 per cow and represents $0.87 and $0.70 per cwt of milk produced for low and high productions levels. These two additional costs represent how varying levels of production can affect profitability; as more milk is produced these costs are spread over more assets so the cost per unit decreases making the operation more profitable. The total costs per cow sums to $3,651 and $4,036 per cow and $19.22 and $17.68 per cwt for 19,000 and 23,500 production levels, respectively. Based on these assumptions, the projected returns over total costs for 2010 is a loss for low production herds (-$4.30 per cow and -$0.02 per cwt) and a profit for high production herds ($385 per cow and $1.64 per cwt) (Dhuyvetter et al.).

Model Analysis

The model also calculates a breakeven milk price and net return on assets. Because many of the costs are fixed regardless of production level, higher production herds can endure a lower milk price than low production herds. Likewise, because the investment is similar across production levels, high production herds have twice as great of return on assets than low production herds. Adjustable rolling herd average and the use of current market prices are key factors which allow this model to be utilized across different operations.

3.2.2 Wisconsin Dairy Enterprise Planning Budget

University of Wisconsin Extension and Center for Dairy Profitability published an enterprise planning budget in 2008 which allows for farm customization and analysis of returns and costs on per cow and cwt of milk produced basis. Gross return is solely driven by milk sold and is calculated based on producer input of milk price per cwt and annual milk production per cow. Feed cost is calculated through a set ration included in the model and producer input commodity prices per unit; the feed ration is a high forage ration which also includes corn, soybean meal, dical, and salt ingredients.

Additional livestock operating costs are broken down into the following categories: milk hauling; bedding; vet and medicine; breeding; utilities, power, and fuel; and supplies. Other cost categories include marketing and other costs; ownership costs; labor and management; and facility and equipment costs. The livestock operating expenses are entered on a per cwt or cow basis by the user which then are translated to a per cow and cwt basis, respectively. Accounting for a 33 and 2 percent cull cow and death rate, respectively, cow ownership cost is cull cow and calf sale revenue less replacement female purchases. Per head market prices for replacement cows, cull cows, young stock, number of calves per year, and cow death and cull rates are entered by the user to calculate cull cow and calf sale revenue and replacement female purchases on a per cwt and cow basis. Labor and management costs are driven by labor cost per hour, management fee percentage of gross income, and labor hours per cow in the following categories: milking, feeding, cow care, and all other activities. Facility and equipment costs are broken down into milking equipment and milk center, housing, and manure storage structure cost. These costs are calculated from user input of cost per cow, depreciation value, and rate for repairs, taxes, and insurance. All categories of costs are then calculated to summarize total costs per cow and cwt, and costs are deducted from gross returns to get net returns to assets. (Jones et al.)

With the exception of internal calculations for feed and fixed costs (facility and equipment costs) the model is solely driven by user input to calculate net returns. This user entry allows for flexibility and higher accuracy between users and operations due to the ability to customize production and costs.

3.2.3 Missouri 3,000-Cow Dairy Model

University of Missouri Extension formulated a model to estimate the returns for a progressive 3,000 cow dairy from 2006 through 2010 of which they estimate will bring $13,737 per cow to the state economy based on a study out of University of Minnesota (Dairy Focus Team; Conlin). This model uses a basic framework for startup capital and daily operations to build a 5-year balance sheet, income statement, and statement of cash flow at the farm level, in addition to an enterprise budget, at farm, cow, and per hundredweight milk produced levels. Also included are four sensitivity analyses tables to measure how the net cash flow, net income, and total operating expenses per hundredweight will change in relation to variation in milk production, milk price, feed costs per cow, and percent of debt load. This analysis relies upon input numbers based on prior research and the results are given for comparative analysis or representative data for new dairy opportunities. The model developed does not provide a framework that allows users to readily modify input assumptions.

The Missouri model farm of 3,000 cows is housed on 80 acres and requires over 7,000 acres for feed and waste management; the system is based on a confinement model utilizing a double 44 parallel parlor. The model is structured as a new dairy starting in 2006 with no debt load or all costs being covered by cash capital funds.

Enterprise Budget – Income from Operations

The model assumes daily production at an average of 74.74 pounds of milk per day (range from 70.4 to 77.0) equating to an annual five-year rolling herd average of 23,905 pounds. Milk price is set at $15.00 until 2009 when a $1.50 per cwt three-year start-up incentive under the Southeast Federal Milk Marketing Order expires. Cows have a 14.6 month calving interval (389 days in milk and 55 days dry) where 87.6 percent of cows are in the lactating herd at all times of the year. Milk sales, a component of production and milk price, for the five-year time span is $3,266 per cow and $14.38 per hundredweight (cwt) produced. Additional income comes from the sale of young stock are sold at birth, $100 for bull calves and $450 for heifer calves. The net income per cow for sale of young stock is $222 per cow or $0.98 per cwt produced. Total receipts equal $3,487 per cow and $15.36 per cwt produced for a 3,000 cow dairy in Missouri.

Enterprise Budget – Operating Expenses

Key expenses on a dairy are feed, herd replacement, labor, depreciation, veterinary, marketing, supplies, and utilities at 42.2, 12.0, 14.9, 8.1, 6.6, 6.5, 2.2, and 2.1 percent of total operating expenses, respectively. This model uses a total mixed ration which includes corn silage, alfalfa silage, corn, and byproduct feeds as the main components of the diet. The lactating cow ration is assumed to cost $3.50 per cow per day. The ration cost for dry cows is $1.76 per cow per day. Annual total feed expenses are estimated at $1,259 per cow and $5.54 per cwt milk. Herd replacement costs include cows culled less replacement heifers purchased and depreciation of dairy cows. The net replacement cost is a result of 1,050 cows being sold (30% voluntary cull rate and 5% death rate) at $650 while 1,050 replacement heifers are purchased for $2,000 per head. On an annual basis, herd replacement costs equate to $444 per cow and $1.95 per cwt milk produced.

Labor expenses, which include wages, benefits, and Social Security taxes result in 12 percent of total operating expenses, $359 per cow, and $1.58 per cwt milk produced. For labor, this 3,000 cow dairy required 38 full-time employees including 20 milkers, eight feeders, four barn personnel, and three managers. The next largest cost was a non-cash cost, depreciation; this expense cost the operation $243 per cow and $1.07 per cwt milk produced. Marketing which included milk hauling, milk promotion deductions, marketing fees, and beef marketing expenses are $196 per cow and $0.86 per cwt. Veterinary expenses cost $193 per cow and $0.85 per cwt, respectively. The last two notable expenses, supplies and utilities cost the operation $65 and $63 per cow and $0.28 per cwt milk produced. Total expenses for a 3,000 cow confinement operation in Missouri will have operating costs equivalent to $2,984 per cow and $13.14 per cwt milk produced annually. Given the income and expense assumptions for the 3000 cow dairy, the operation is projected to receive $503 per cow and $2.21 per cwt milk produced in net profit per year based on the five-year average.

Enterprise Budget - Analysis

This model is a structured, closed model that does not allow for flexibility in expenses except for feed cost, debt load, and milk price reflected in the sensitivity analysis. Supporting spreadsheets with this model could be beneficial to analyze or update milk and feed prices which are extremely volatile across time and farms. This model was published as a resource to explain the economic benefits for local crop producers and the economic benefits of a large dairy; however, this model could be utilized as a budget or profit projection tool for dairies in operation if supporting spreadsheet and formulas were available for customization per operation.

Chapter 4 - Data and Methods

Dairy related price and inventory data are maintained by numerous organizations in both the public and private sectors. Data for this thesis were primarily obtained from USDA, extension, and commodity market databases. This chapter will provide an overview of where data were obtained along with analysis of the data used in the historical and profit projection models outlined in Chapter 5. The model outlines monthly historical revenue from 1990 to 2010 with reported market and industry data while the projection portion outlines monthly revenue and expenses for 2011 with available market data, price indexes, and user input.

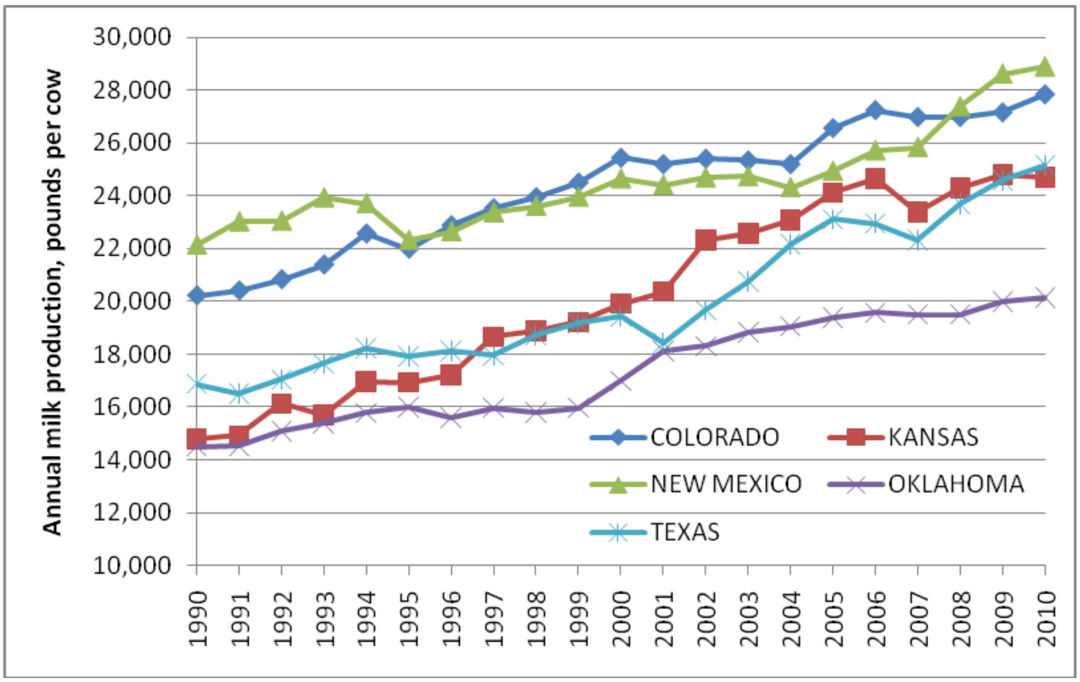
4.1 Revenue Data Analysis

Dairy operation specific revenue is primarily generated from milk sold and sale of livestock, young stock and cull cattle. As outlined in the models reviewed in Chapter 3 additional revenue can be generated from government payments, excess feed crop sales, or genetic proceeds. The revenue data reviewed below are for an operation which generates revenue from milk and livestock sales.

4.1.1 Milk Production

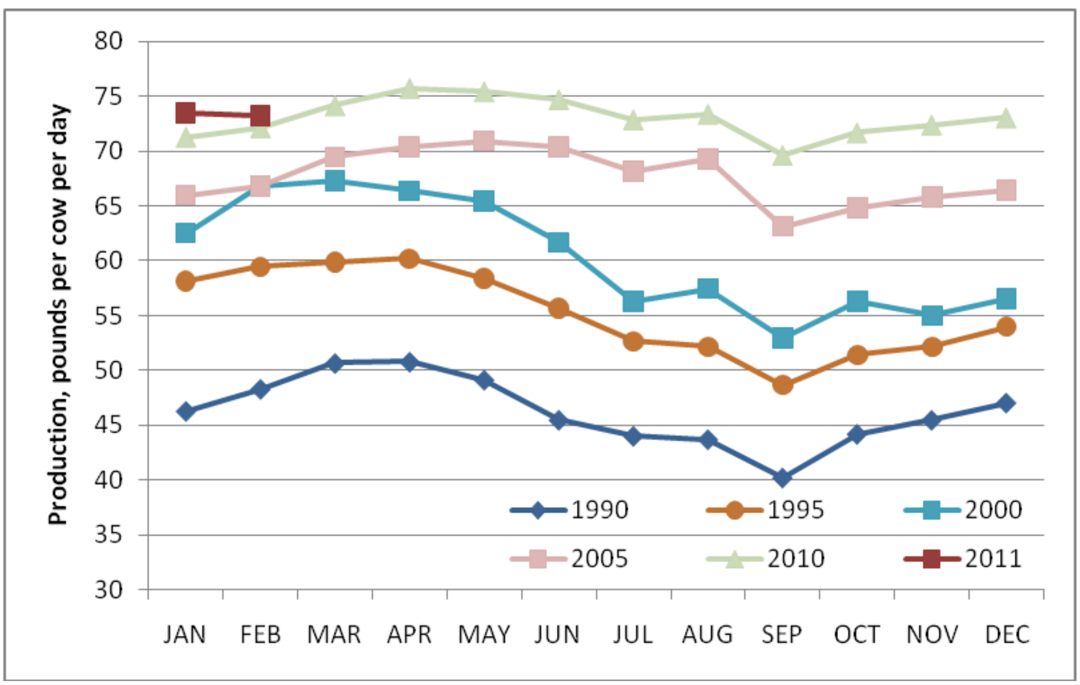
Based on survey results from the National Agriculture Statistics Service (NASS), since 1990, the average production per cow in inventory is 18,095 and 21,289 per lactating cow for the Southern High Plains region. Data from 1990 to 2010 were obtained for the states of Colorado, Kansas, New Mexico, Oklahoma, and Texas for annual milk production per cow. Because average production reported by NASS is on a per cow in inventory basis, annual milk production was adjusted by 85 percent, industry average number of lactating cows as a percent of total herd inventory. Milk production per lactating cow is graphed in Figure 4-1 showing that Colorado and New Mexico have been the leaders of milk production per cow since 1990 for the Southern High Plains region. The average annual rolling herd averages for New Mexico and Colorado are 24,563 and 24,355 lbs per lactating cow, respectively, which exceeds Kansas, Texas, and Oklahoma (20,170, 20,022, and 17,334). In the past two years, New Mexico has surpassed Colorado with production increasing above 28,000 lbs per cow. Additionally, Texas has seen fast growth in production per cow over the past four years increasing annual milk production to over 23,000 lbs. Over the 20-year period, annual milk production per cow in the Southern High Plains region has increased by at least 5,600 pounds per state (5,644 for Oklahoma to 9,910 for Kansas). On a percentage basis, milk production has increased at least 23 percent over the 21-year period; Kansas and Texas led milk production growth at 40 and 32 percent while Oklahoma, Colorado, and New Mexico had 28, 27, and 23 percent growth, respectively. Comparing actual milk produced and percentage growth we can conclude that high production states are not increasing milk production efficiency, percent change, as fast as those states that had lower annual rolling herd averages in 1990.

Figure 4-1 Southern High Plains Region Milk Production per Cow, lbs



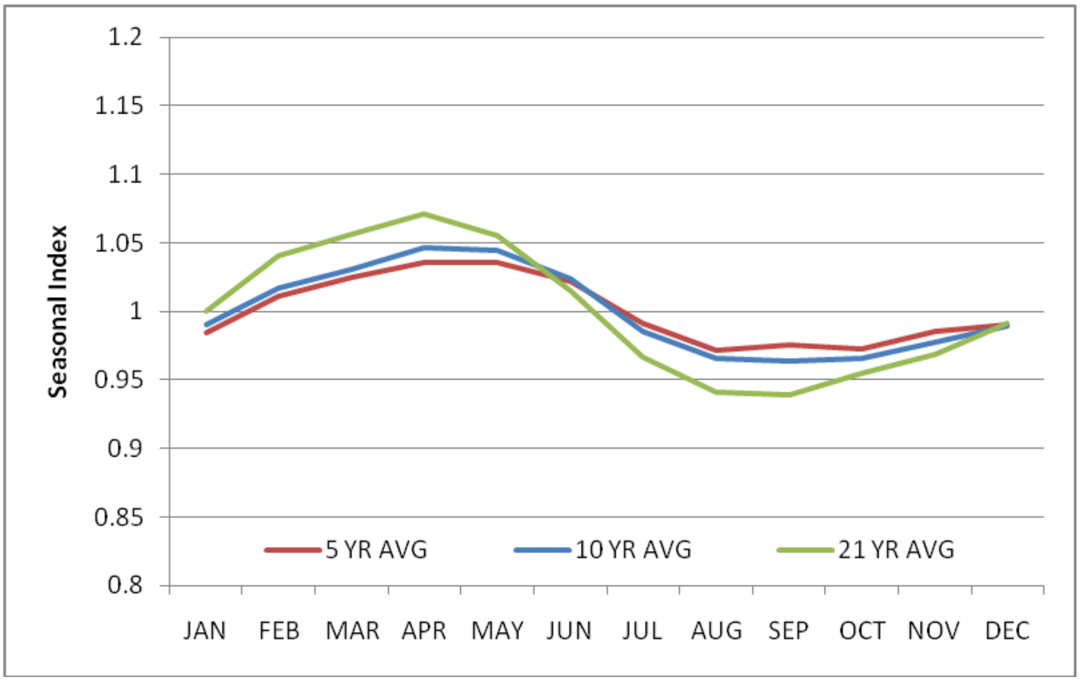
Annual milk production is useful for analyzing trends over time; however, more detailed data are important to analyze seasonal patterns throughout the year, i.e., production across months. Monthly milk production data were obtained from USDA, NASS for Colorado, Kansas, New Mexico, and Texas for 1990 through 2011, monthly data were not available for Oklahoma. Data were adjusted to a per day basis by dividing monthly milk production per cow by the average number of days per month and for lactating cow inventory, which was assumed to be 85 percent of total inventory. The average daily milk production per cow has increased from 46.29 lbs in 1990 to 73.04 lbs in 2010. Over the past two decades, average daily milk production is highest in April (67.07 lb average) and is lowest in September (58.50 lb average). This seasonal pattern can be explained by weather conditions, during the cooler months of late fall, winter, and early spring cows produce relatively more milk. As temperatures increase in the summer months, May through September, milk production typically decreases due to heat stress. Figure 4-2 displays monthly milk production for the years 1990, 1995, 2000, 2005, 2010, and 2011. This graph displays seasonal milk production increasing through April then decreasing through the summer months to September, and finally regaining strength at the end of the year. Although recent years, 2005 and 2010, still display a seasonal pattern, the variation in production across the year is less. For example, average daily production has a range of 6.61 pounds across months in the past five years whereas the 1990 to 2005 range of production in a year is 10.38 lbs per year.

Figure 4-2 Southern High Plains Milk Production per Cow per Day, lbs



The monthly index of production for the last 5, 10, and 21 years was calculated to examine the seasonal index change over time and is displayed in Figure 4-3. These indexes were calculated by dividing average production per cow per day for each month by the annual average production per day. The average over designated years for each month was calculated to examine historical indexes, which show decreasing variability in milk production as the number of years included decreases to more current data. The five year index is used calculate monthly projected milk production based on research or user given projected milk projection for the projection year.

Figure 4-3 Milk Production Seasonal Index



A possible explanation for the changing seasonal pattern is that producers are making management or structural changes, which reduce heat stress and increase cow comfort to help reduce the loss of milk production during the summer months. The unadjusted monthly data are used for the historical analysis model while projected milk production calculated from FAPRI or user defined rolling herd average are used to calculate projected milk production. The projected model allows users to input their current number of lactating cows and rolling herd average, $prod\_rha_y$ -- where y refers to the year being projected, along with anticipated increase in the number of lactating cows and pounds of production per cow per day to calculate a projected average production per day, $prod\_day_{t+1}$. This user driven input along with the 5-year seasonal index is used to project milk production as outlined below,

$$prod\_day_{t+1} = (prod\_rha + prod\_day_{y+1} * lactdays) * prod\_index_{t+12} / lactdays . \qquad \textbf{(2)}$$

If user input is not provided then the projected projection for 2011, 63.09 pounds for the Southern High Plains, as reported by FAPRI along with the 5-year seasonal index are used to project milk production for the projection model.

The USDA, World Agriculture Outlook Board publishes "World Agriculture Supply and Demand Estimates" monthly which provides outlook on agriculture markets and estimated projections for production and market prices. World milk production is expected to increase due to higher milk prices, growing inventory of replacement heifers, and increased export opportunities, but the reduction in milk production per cow growth has reduced estimates since the beginning of the year (Interagency Commodity Estimates Committee 4, 31-33). Milk production is estimated to be at 196 billion pounds in March 2011 up from 192.8 billion lbs in March 2010. According to the World Agriculture Outlook Board, the price for all milk in 2011 is forecast to average $18.10 to $18.70 per cwt and the Class III price is expected to range between $16.35 and $16.95 in 2011 (Interagency Commodity Estimates Committee 4, 31-33). The improved milk price and opportunities for milk demand are positive for the global dairy industry in the next year.

An updated agriculture long run projection report was released by the USDA for the United States in February 2011. It is estimated that total milk cow inventory will continue to decline while output per cow will continue its steady incline to 25,000 pounds per cow per year by 2020. Increasing domestic cheese demand and global exports of cheese and nonfat dry milk is expected to keep markets strong; however, producer milk prices are expected to rise at a lower rate than inflation due to increased efficiency of milk production (*USDA Agriculture Projections for 2011-20: U.S. Livestock*). The USDA long-term projections for 2011-2020 estimate milk production per cow for 2011 to be at 21,425 pounds and the all milk price to be at $16.35 per cwt. With 190,000 less cows, the rolling herd average, i.e., annual milk production per cow, is expected to continue to increase to 24,950 lbs that will be sold at $18.70 all milk price in 2020 (*USDA Agriculture Projections for 2011-20: U.S. Livestock*81). When adjusting the projected milk production to a 340-day lactation period, the projected U.S. dairy cow milk production per day is 63 pounds, one pound above the 2010 average for the Southern High Plains region.

4.1.2 Milk Price Data

Milk price is published in several different forms including Federal Milk Marketing Order (FMMO) mailbox, Class III announced, producer, and futures price. Comparisons of these various price series are reported in Table 4-2. As stated by the Atlanta Market Administrator, "mailbox price is defined as the net price received by dairy farmers for milk, including all payments received for milk sold and deducting costs associated with marketing the milk" (USDA – Dairy Programs). Mailbox prices are published at the average butterfat sold on the market and are representative of the milk sold in the market order area. FMMO mailbox prices are published by the Agriculture Marketing Service; the Atlanta Market Administrator office has compiled a database of mailbox prices for all market orders back to 1995 (USDA - Dairy Programs). Mailbox prices were collected for the FMMOs of Central, Texas, and New Mexico in addition to Kansas. Kansas mailbox prices from December 2001 forward were provided by Robert Schoening, economist with the Central Federal Milk Marketing Order 32. For each location of mailbox price reported, missing historical data are calculated as a function of the Class III announced milk price. Equation 3 represents the relationship between mailbox milk price and Class III announced price where *r* is the FMMO or state represented and *t* is the time period,

$$P\_Milk_{r,t} = b + \beta * P\_ClassIIIMilk_t + \varepsilon, \qquad \textbf{(3)}$$

where *P_MILK* is the price of milk for the location *r* at time *t*, *P_ClassIIIMilk* is the announced price at time *t*, *b* and β are coefficients to be estimated, and ε is an error term. The coefficiemt on *P_ClassIIIMilk* (β) was found to be statistically significant at the one percent level for all four locations. In Table 4-1, the intercept, coefficient, number of observations and R^2 are reported for each mailbox price, i.e., Kansas, Central Region, New Mexico, and Texas.

Table 4-1 Coefficients and Estimates for Mailbox Prices

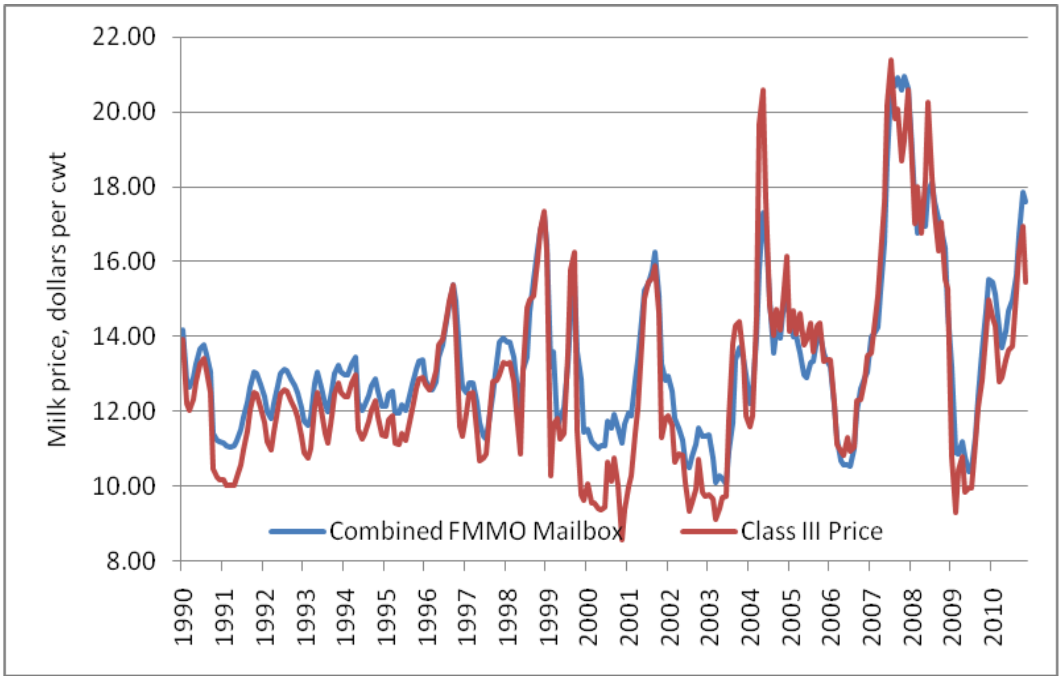
	Kansas	Central	New Mexico	Texas
B	1.964	3.266	3.946	3.397
P_ClassIIIMilk	0.871	0.807	0.761	0.738
Number of Observations	108	179	179	179
R^2	0.863	0.807	0.761	0.813

In Table 4-2 annual average mailbox prices for 2006-2010 are listed for Kansas and a combined FMMO price of Kansas, Central region, Texas, and New Mexico. The combined FMMO mailbox price is calculated using weights of 0.75, 1.25, 1.0, and 1.0 for the Central region, Kansas, Texas, and New Mexico, respectively. A lower weight is used for the Central area due to other states not in the Southern High Plains region being a part of this FMMO. Figure 4-4 displays both combined FMMO and Class III announced prices; over the past 10 years there have been three-year price swings with price spikes in 2001, 2004, and 2007.

Table 4-2 Milk Price, dollars per Hundredweight

Year	***Combined FMMO Mailbox***	***Kansas Mailbox***	***Class III Announced Price***	***Producer Price***	***Basis***
2006	11.71	11.67	11.89	12.31	-0.18
2007	18.10	18.28	18.04	18.64	0.06
2008	17.23	17.64	17.44	17.37	0.21
2009	12.12	12.71	11.36	11.77	0.76
2010	14.59	14.68	14.41	15.46	1.01
5-year average	14.75	15.02	14.63	15.11	0.28
5-year std dev	3.41	3.27	3.24	3.26	0.90
10-year average	13.90	13.87	13.75	14.24	0.24
10-year std dev	2.83	2.91	3.04	2.86	1.08

Figure 4-4 Monthly Milk Price, January 1990 – December 2010



The announced price is taken from Central Federal Milk Marketing Order; this is the monthly Class III price at 3.5 percent butterfat released for each month. The Class III price collected includes adjustment for components and is the base price handlers pay the producers for milk utilized in this class. Class III prices are used in the analysis due to milk being utilized at greater percentages for Class III in the Central region and representation of cash settlement futures price. Since 2000 milk has been utilized for Class III in 88 of 132 months (66.7%); in months when Class III utilization was low milk was primarily used for Class I. ("Central Federal Market Order No. 32.") Class III price is cash settlement price based on the last closing Class III futures price while the mailbox price adjusts for the class utilization, component levels, and location. These adjustments in the mailbox price can be denoted as the basis difference between cash and announced prices. Producer price is the statistical uniform price that is based on producer price differential, component prices, and somatic cell count (SCC). Monthly reports include the component prices and percentages, producer price differential, and SCC price and average level (Central Federal Market Order No. 32) (Agricultural Marketing Service). Table 4-2 displays the average annual price for the various price series for the last five years, 2006 through 2010, along with a 5- and 10-year average and standard deviation (std dev). This table also displays the basis, difference between Class III announced price and combined mailbox price, representative of the adjustment for location from the declared market price. The basic formula for basis is mailbox less Class III cash settlement (Class III announced price); therefore, basis measures the utilization payment difference between actual payment and Class III milk.

In comparing the combined FMMO mailbox and Kansas mailbox prices, four of the past five years Kansas has received a higher price than the combined FMMO area representing the High Plains region. The five-year average is $0.027 higher for Kansas than the combined FMMO price, $15.02 versus $14.75, respectively. The ten-year average mailbox price for the combined FMMO and Kansas are not statistically different, but the standard deviation is larger for Kansas. Except for 2008, the producer price is higher than the announced price (futures) with both the five- and ten-year averages being higher by just under $0.50 per cwt. This can be explained by the make-up of each price, the announced price which is an estimated fluid milk price does not include the producer payments, producer price differential, and SCC payment or penalty, all of which are included in the producer price which also reflects Class utilization. Producer price is a representation of actual price received by producers adjusted for utilization, nationally adjusted mailbox price. Although individual year comparisons between producer and mailbox prices vary, the five- and ten-year producer price averages are higher than both mailbox prices by at least $0.09 for the five-year average and $0.34 for the ten-year average. These price differences mean that producers in the Southern High Plains region, on average, receive a lower price over time for milk than other regions of the United States. For all represented milk price categories, standard deviation is higher for that last five years than for the last ten years indicating that price volatility is increasing in recent years. Basis calculated with combined mailbox price and Class III announced price has increased in the last five years (-$0.18 in 2006 versus $1.01 in 2010), but the five- and ten-year averages are $0.28 and $0.24, respectively, with standard deviations of $0.89 and $1.08. This shows that basis can deviate across time due to several factors including change in component levels (class utilization) and location to processing plants.

Futures markets from the Chicago Mercantile Exchange (CME) are used as a price discovery tool and therefore used as the base for projected milk price. Futures market closing prices for the announced Class III price were taken for the week of March 21-25, 2011 and used for projecting milk price for March through December 2011. The five-day average of the closing settlement prices are reported in Table 4-3. To adjust for location from the CME to the farm, futures prices are adjusted by historical basis, which is the difference between the closing futures price and price received by the producer. A five-year average basis is calculated for each projected month based on corresponding monthly 2006 through 2010 basis amounts. The price of milk, *P_Milk*, used in the projection model is the futures market price, *P_MilkFutures*, plus the calculated five-year average basis, *P_MilkBasis*,

$$P\_Milk_{t,m} = P\_MilkFutures_{t,m} + \sum_{1}^{n=5} P\_MilkBasis_{t-i,m} / n, \quad i = 1, 2, 3, 4, \text{ and } 5 \qquad \textbf{(4)}$$

where the subscript *t* denotes year and *m* denotes projected month.

Table 4-3 Futures Milk Prices and Basis

Month, Year	***Futures Price, $/cwt***	***5-year basis, $/cwt***
March 2011	19.46	-0.013
April 2011	16.54	0.114
May 2011	16.54	-0.178
June 2011	16.64	-0.107
July 2011	17.25	0.107
August 2011	17.48	0.223
September 2011	17.53	0.422
October 2011	17.35	0.748
November 2011	16.65	1.081
December 2011	16.62	0.042

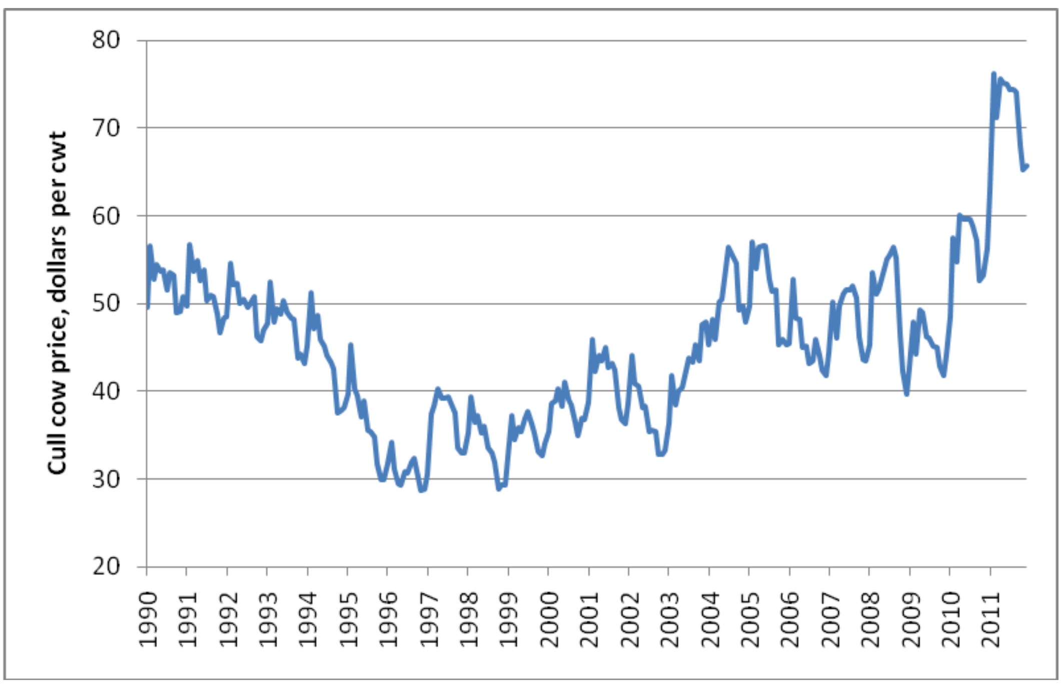
The prices used for the historical model are the combined FMMO mailbox price. Available announced Class III or futures prices plus five-year average basis outlined above or user defined prices will be used for the profit projection model. Futures prices adjusted for basis for March through December and the announced Class III prices adjusted for basis for January and February bring the 2011 average milk price to $16.74 with a standard deviation of $1.28.

4.1.3 Livestock Sales

In addition to milk revenue, returns are generated from the sale of livestock on the farm, culled and young stock. Dairy producers cull dairy cattle for a variety of reasons including those pertaining to milk production, reproductive performance, feet and legs, health, and genetics. Cull cows range in age and body condition which affects the quality and price received. Standard fat cattle market prices are not representative; therefore, market prices specifically for cull cows are tracked. In models reviewed in Chapter 3, farms culled 30 to 34 percent of the herd per year (Dhuyvetter et al.; Dairy Focus Team).

Cull cow market data were collected from the University of Wisconsin Dairy Marketing and Risk Management Program and replacement cow prices as reported by NASS. Data obtained from the Wisconsin Extension Dairy Marketing and Risk Management Program (DMRMP) were reported on a per cwt basis for the High Plains States and U.S. average. The average price per cwt received was calculated per month across all five states, Colorado, Kansas, Oklahoma, New Mexico, and Texas. As displayed in Figure 4-5, 1996 displayed the lowest cull cow price per cwt at $32.08 since 1990 and 2010 had the highest reported price at $56.83 with the trend moving upward as February 2011 reported U.S. average price of $76.29 per cwt.

Figure 4-5 Monthly Cull Cow Price, January 1990 – February 2011

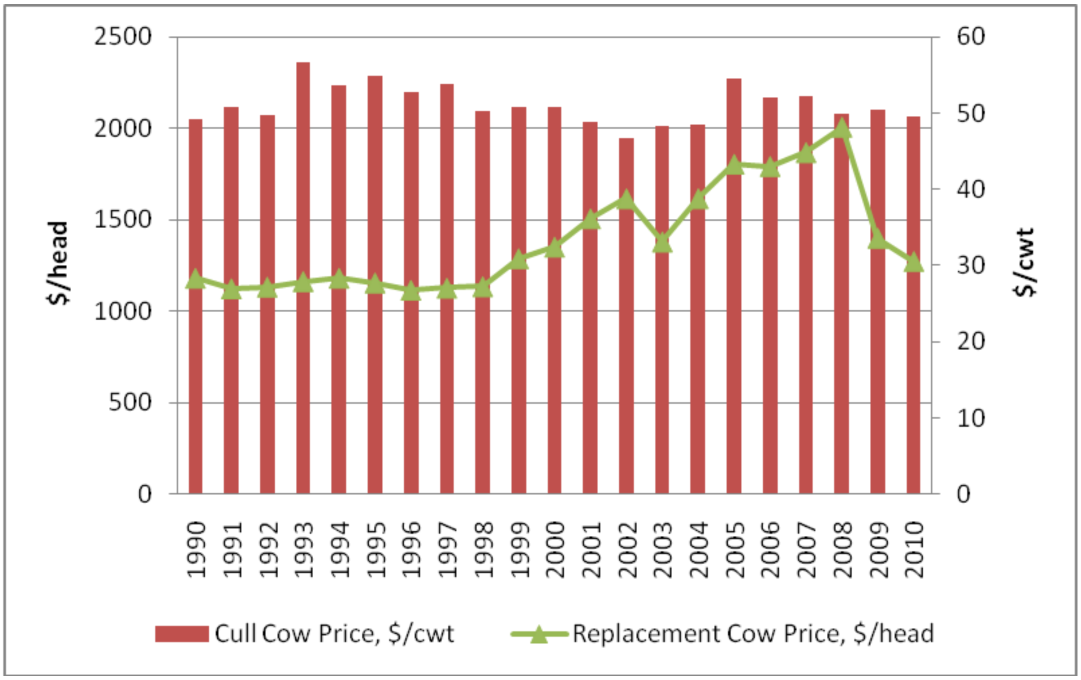


Cull cow sales in the historical model are based on cull cow prices per cwt with the average cull cow being sold at 1,160 lbs. The average cull cow weight was based on available cull cow market types, premium (over 1,400 lbs), breakers (over 1,250 lbs), boners (over 1,100 lbs), lean (over 1,000 lean) and low dressing lean with assigned weights as designated:

$$CullCowWeight = 0.2*1{,}400 + 0.2*1{,}250 + 0.3*1{,}100 + 0.3*1{,}000\,. \quad \textbf{(5)}$$

Weights were assigned with heavier weights on lighter or leaner cows due to the nature of the conditions of cull cattle and culling tendencies on operations. Price per cwt for cull cows will also be used for profit projections due to availability of market data and user input of average weight at sale. NASS reports dairy cow prices quarterly on a per head basis from 2003 forward and on an annual basis prior for each state, these prices will be referred to as replacement cow prices. State data were collected for the Southern High Plains region for the years of 1990 to 2011. An average price was calculated for each year and state with these prices then averaged across the five states to arrive at the annual replacement cow price displayed in Figure 4-6. Replacement cow prices per head remained steady or increased over time except for 2003, 2009, and 2010 as these years show a notable decrease in price per head. According to NASS, in 1990 cow prices were $1,182 per cow and increased to $1,278 in 2010. The five-year average for replacement cow price for the five states in the Southern High Plains is $1,168 with each state reporting a decrease of at least $490 per head in 2009 (USDA, NASS). NASS replacement cow prices are not representative of the cull cow market so cull cow price data obtained from Wisconsin DMRMP were annualized by taking the average across 12 months. Cull and replacement cow prices are compared in Figure 4-6. Replacement cow prices in terms of dollars her head shows much greater volatility across time compared to cull cow prices, dollars per cwt.

Figure 4-6 Annual Cow Market Prices, 1990 – 2010



In further analysis of the cow market price data by state, no state received higher (or lower) price for cull or replacement cows consistently over time. The reported U.S. average cull cow price per cwt is lower than the average of the five states in the Southern High Plains Region for 82.9 percent of the reported months (209 of 252 months) suggesting producers in this region typically receive above average price for cull cows. Cull cow prices are impacted by a variety of external market factors including slaughter cattle markets, milk prices, health of the beef industry, and dairy industry programs. A key dairy program which affected the cull cow and beef slaughter markets in recent years was the herd buyout program, Cooperatives Working Together (CWT) sponsored by the National Milk Producers Federation (NMPF). This program increased the number of livestock, both cull and replacements, entering the market in an attempt to reduce U.S. herd inventory to regain strength in the fluid milk market. The CWT initiatives and push for more intensive cull rates due to a larger replacement heifer inventory are factors that have contributed to the increase in the number and quality of cull cows which can contribute to the spread starting in 2009 of price per cwt and head.

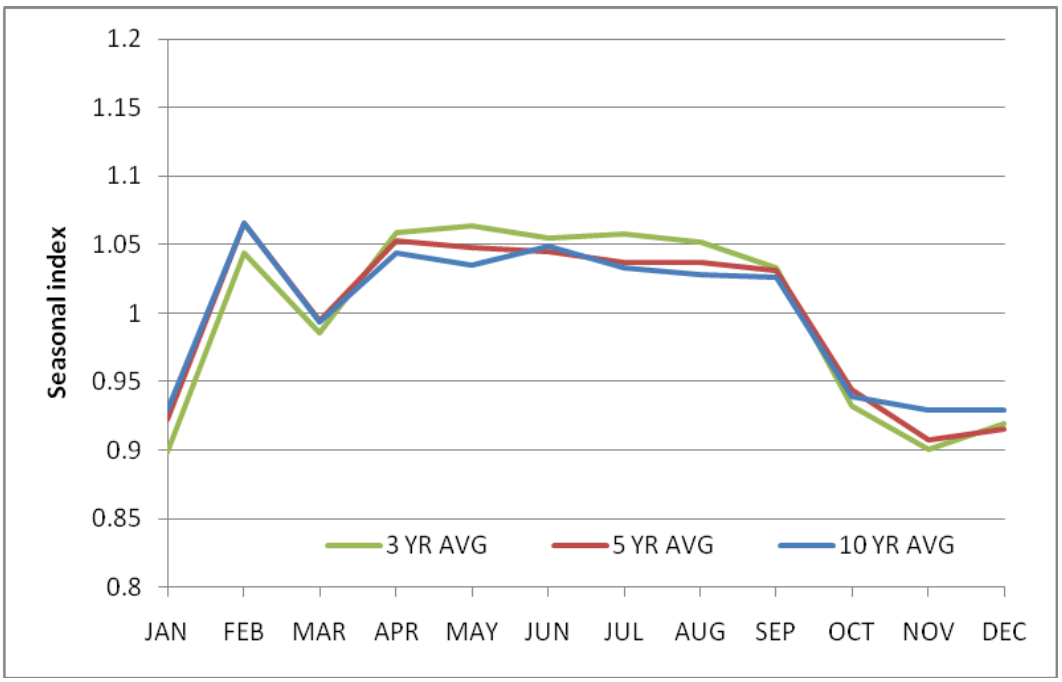
Projected cull cow sales are based on user input weight per head and price per cwt or calculated price per cwt and weight. Default estimated weight used in the projection months is outlined in Equation 7. The estimated price per cwt in any given month month, P_REPF_{t+1}, is based on the prior month price, P_REPF_t, adjusted by a five-year average seasonal price change, $[A]_{repf}$, based on the change between concurrent and corresponding months,

$$P\_Repf_m = P\_Refp_{m-1} * [A]_{repf} . \qquad \textbf{(6)}$$

$$[A] = P\_change = (\sum_{1}^{n=5} P_{t-i,m} / P_{t-i,m-1}) / n \qquad i = 1, 2, 3, 4, 5 \qquad \textbf{(7)}$$

where [A] represents the seasonal price change, *P_change*, which is the sum of the change in price between corresponding months, $P_{t-i,m}$ and $P_{t-i,m-1}$, for n years, t, divided by n. Figure 4-7 displays the three-, five-, and ten-year average seasonal price indexes for cull cow prices. The seasonal pattern is similar for all three averages with price highs occurring in February and April and a price plateau of higher values over the summer months followed by lower prices in the winter months.

Figure 4-7 Cull Cow Seasonal Price Index



Additional revenue is gained on a dairy operation from the sale of young stock, replacement heifers, non-replacement heifers, or bull calves. In the model outlined in Chapter 5, the operation will contract raise or sell and buy back heifers, selling heifer calves to a grower and purchasing back replacement heifers prior to calving, and sell all non-replacement heifers and bull calves at local market price. Historical market data for replacement heifer prices were accessed through Wisconsin Extension Dairy Marketing Risk Management Program (DMRMP) and Missouri Extension. Weekly market prices per cwt were reported for replacement heifer calves (90-120 lbs) for the years of 1996 to 2009 by the Wisconsin Extension DMRMP. These prices are representative of the replacement heifer market in Wisconsin. The average of weekly prices per month was taken to get an average heifer price per head per month for each reporting year. For the years 1990 through 1995 Wisconsin monthly prices were estimated by an OLS regression where calf price is a function of milk and replacement cow price. Monthly announced Class III prices are used for milk price due to it being a uniform published cash settlement price across regions and representative of actual milk price received. USDA replacement milk cow data were used for cow price measured in dollars per head. Equation 8 displays Wisconsin replacement heifer price as a linear function of replacement cow and milk prices

$$P\_Repf_t = b + \alpha * P\_Repf_t + \beta * P\_MilkClassIII_t + \varepsilon, \quad \textbf{(8)}$$

where *P_REPC* is the price of heifer calf; *P_REPF* is the price of replacement females; *P_CLASSIII* is milk Class III futures price; *t* denotes month; *b*, α, and β are coefficients to be estimated; and ε is an error term. Table 4-4 reports the regression results from estimating equation 8 for replacement heifer calf price. The coefficient on replacement female price is statistically significant at the one percent level and the coefficient on milk price is significant at the 10 percent level in determining heifer calf price.

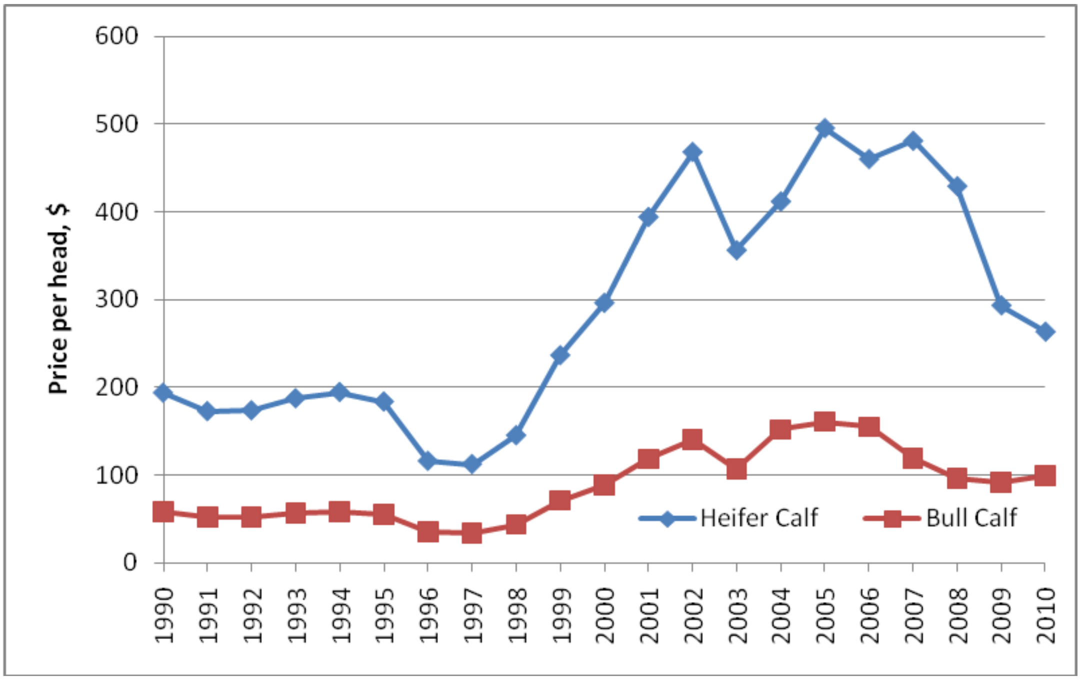
Table 4-4 Coefficients and Estimates for Replacement Heifer Calf Price

Characteristic	***Variable description***	***Coefficient***	***P-Value (P>|t|)***
b	Intercept	-301.650	<.00001
P_MILKCLASSIII	Class III announced milk price	-4.562	0.0535
P_REPF	Average of state reported values and Missouri auction market data	0.477	<.00001
Observations = 161			
$R^2 = 0.785$			

Springfield, Missouri monthly dairy auction prices were available for baby calves from 2003 forward for Holstein, Jersey, and crossbred calves. Holstein calves had the highest frequency of data. The high and low calf prices were reported by gender, heifer or bull, and size, average and small. Averages of the high and low Holstein heifer and bull prices were used to represent the Missouri dairy calf market. Between January 2003 and May 2009 actual market data were available for both Wisconsin and Missouri; during this period Missouri calf price was on average 87 percent of the Wisconsin calf price. Missouri heifer calf prices were calculated by adjusting the Wisconsin actual or calculated heifer calf price by 87 percent. The average of the Wisconsin and Missouri heifer calf price was taken on a monthly basis and these data are used in the historical model for heifer calf sale price per head. Annual prices were found by taking the average across all monthly prices and are graphed in Figure 4-8. Since the program started tracking actual market price data in 1996, replacement heifer (90-120 lbs) value increased to 2008 with market downturns in 2003 and 2006, and the market decreased by $200 per head in 2009. The market for replacement heifer calves peaked in 2002, 2005, and 2007 at $504, $545, and $567, respectively. When looking at monthly patterns, prices tend to peak in September (eight of 13 years) or December. Market prices in Springfield, Missouri on March 23, 2011 were $185 to $240 for Holstein heifer calves and $110 to $190 for crossbred heifer calves and in Sulphur Springs, Texas on March 17, 2011 were $80 to $220 for heifer calves ("Sulpher Springs Livestock Auction Report")("Missouri Dairymen's Resource Page").

Monthly bull calf prices were available from Springfield, Missouri dairy auction from January 2003 forward. During the time period which data were reported, bull calf price was on average 30 percent of dairy heifer calf price. For monthly bull calf prices prior to 2003, Missouri heifer calf price was multiplied by 30 percent. Annual bull calf prices were found by taking the average price across the represented monthly data which are graphed in Figure 4-8. It is apparent from historical and current market prices that replacement heifers are valued higher than bull or non-replacement heifers. However, each market is influenced by different factors. Replacement heifer inventory and health of the dairy industry influences replacement heifers market while the beef industry, specifically the cow-calf sector, influences the bull calf market. This can contribute to the vastly different trends of prices over time for the two markets as shown in Figure 4-8.

Figure 4-8 Annual Dairy Calf Market Price, 1990 – 2010



Market prices for dairy bull calves were $130 to $160 in Springfield, Missouri on March 23, 2011 and $25 to $160 in Sulpher Springs, Texas on March 17, 2011. Projected number of replacement and non-replacement calves are calculated from calf inventory based on user defined calving rate, replacement offspring rate, and lactating cow inventory. Projected calf prices are calculated on the prior month's price and a five-year average corresponding monthly seasonal price change:

$$P\_REPC_t = P\_REPC_{t-1} * [A]_{repc} \qquad \textbf{(9)}$$

$$P\_NREPC_t = P\_NREPC_{t-1} * [A]_{nrepc}. \qquad \textbf{(10)}$$

Where *P_REPC* represents replacement calves and *P_NREPC* represents non-replacement calves and the subscript *t* is projected time period (month). The corresponding prices are in time *t-1* which is the prior time period and indexes are the respective five-year seasonal index as outlined in equation 7. Average price change across months is calculated for the prior ten, five, and three years. Replacement calf price indexes are displayed in Figure 4-9 where prices decrease over the winter months and increase in the summer months except for June. Non-replacement calf price indexes are included in Figure 4-10 where typically prices trend up over the year with drops in February, late spring, July and November.

Figure 4-9 Replacement Heifer Calf Price Index

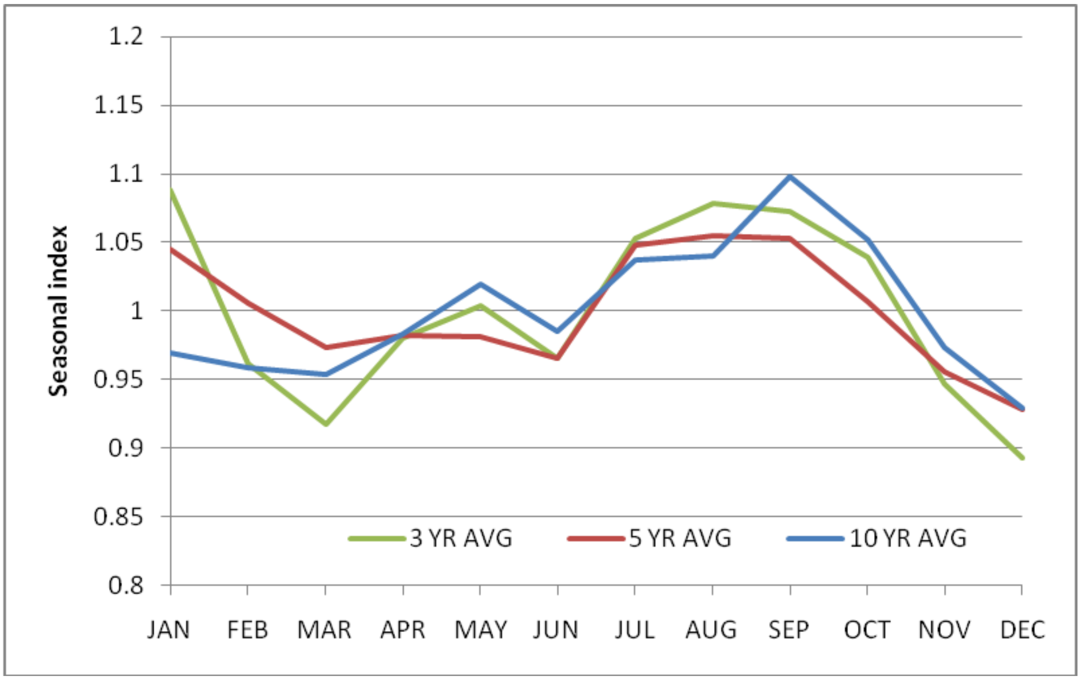
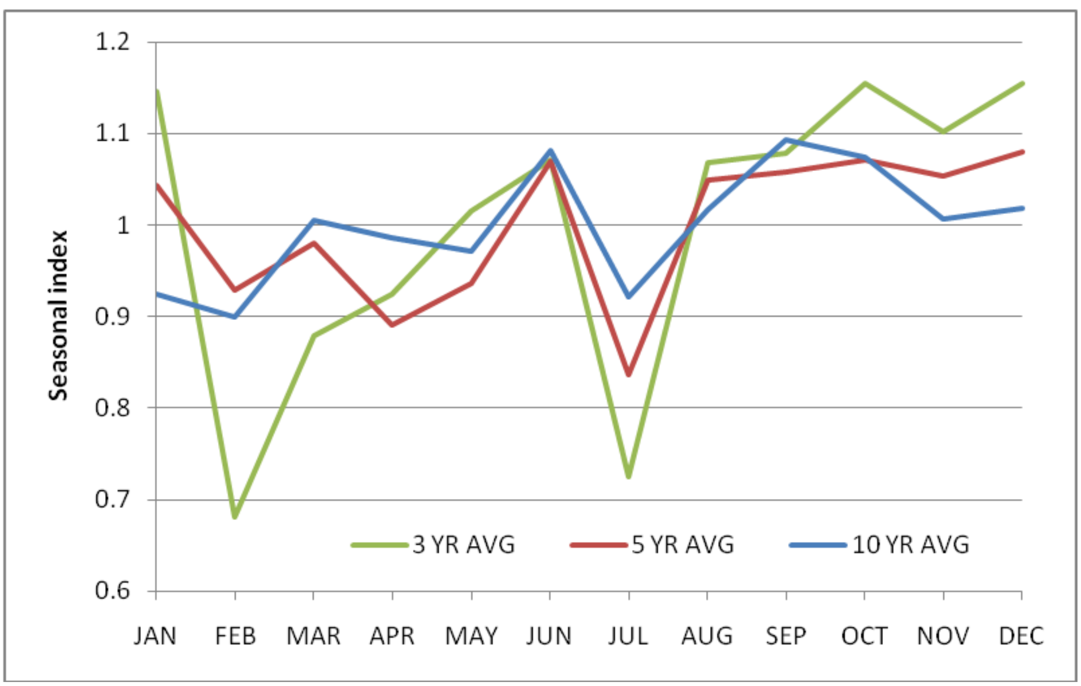


Figure 4-10 Non-Replacement Calf Price Index



Additional areas of returns that are commonly measured in budget and profit models are crop sales and other revenue. The model outlined in Chapter 5 defines the operation as a closed model so only returns and costs are included which are directly associated with dairy operations. Therefore, crop sales are irrelevant to the model and other revenue is variable and not clearly defined and therefore not included in this model.

4.2 Cost Data Analysis

Based on historical budgets and models reviewed and previous research, the major expenses for a dairy operation are feed and labor costs. Because the model being outlined is based on selling all calves, another large expense will be replacement female cost. Additional cost categories include milk hauling, breeding, supplies and veterinary, marketing, gas, fuel, and oil, professional fees, repairs, utilities, other, insurance, interest, and taxes. Cost data for dairy operations are available as cost of production estimates through USDA, budgets published by state extension programs, and real farm data available through benchmarking and proprietary accounting firms. Cost of production estimates published by USDA are calculated using projected estimates and indexes causing uncertainty as to the validity of the results and therefore not used in this model. Assumptions and resources utilized in other models have been analyzed and used as references to estimate historical and projected feed, labor, replacement female, and opportunity cost data. The models used are published by Kansas, Missouri, and Wisconsin extension programs and are included in Appendix B. Additionally, proprietary data from a private accounting firm were also used in approximating other cost categories. The following section outlines the historical and calculated projections for feed, labor, replacement female, other operating, and fixed costs.

4.2.1 Feed Cost Data

Feed cost is dependent on feed ingredients fed, pounds fed of each feed ingredient, shrink percentage, and cost per ton of feed. Pounds of feed fed are based on rations driven by the level of production and percent of shrink per ingredient. Cost per ton of feed fed is equivalent to corresponding market prices for the Southern High Plains region. The historical model is based upon historical market data or NASS data for the Southern High Plains region. The projected model uses either user driven feed ingredient prices, pounds fed, and percent shrink or production and market driven calculations outlined for each ingredient below. This section outlines the feed rations used in this model and analysis of feed ingredient prices and how historical and projected prices were derived.

Feed Rations

Six feed rations, based on eight ingredients, were formulated based on level of milk production. Ingredients included are corn silage, alfalfa hay, grass hay, corn, mineral, and by-products including, dried distillers grain (DDG), soybean meal, and whole cottonseed. The feed rations used in the model were provided by Dr. Mike Brouk, Kansas State University Dairy Extension specialist, rations are included in Appendix C. Each ration was formulated based on the assumption that it was the average diet fed over the lactation cycle; therefore, additional diets such as fresh and late lactation are not included. The rations were made for the following milk production levels measured in pounds per day, less than 60, 60-65, 66-70, 71-75, 76-80, and greater than 80 pounds. As milk production per cow per day increases, by-products are added into the ration. On a dry matter basis, as production increases corn silage decreases from 45 to 39 percent and alfalfa hay from 22 to 18 percent of the total diet while corn, soybean meal, whole cottonseed, and mineral increase. A dry cow ration which includes the same eight ingredients is included to account for the dry period. The dry cow ration is comprised of mainly grass hay, 70 percent of total diet, corn silage, corn, DDG, and mineral. Total feed cost per cow includes both lactation and dry cow diets; the lactation cycle is based on 305 days and dry period on 60 days. The feed cost per cow per day, *FEEDCOST_DAY*, is then adjusted by a multiplier to include dry and lactating cost in total feed cost.

$$
\begin{aligned}
&FeedCost\_Day_{COW,t} = FeedCost\_Day_{LACT,t} * (305/360) \\
&+ FeedCost\_Day_{DRY,t} * (60/305)
\end{aligned}
\qquad \textbf{(11)}
$$

where subscripts *LACT* and *DRY* refer to lactating and dry cows, respectively, at time t (month). Each feed ingredient is adjusted by corresponding dry matter and shrink percentage to calculate lbs of feed per cow per day. Dry matter percentages, outlined in Table 4-5, are held constant over time. Corn silage dry matter is 35 percent, alfalfa and grass hay are 85 percent, corn is 88 percent, dried distillers grain (DDG) and whole cottonseed are 90 percent, and mineral is 95 percent. Feed rations adjusted for dry matter percentage are included in Appendix C. Shrink percentage is the amount of feed lost due to storage, weather, transportation, and feeding methods. In the Southern High Plains region corn silage is typically stored in drive over piles; producers have improved loss by improving location, packing, and face management. Corn silage shrink was assumed to improve over time starting at 25 percent in 1990 and decreasing 0.5 percent each year until reaching 15 percent in 2009. Hay shrink varies between five and seven percent, five percent shrink is used for alfalfa and seven percent for grass hay as the grass hay is typically lower quality hay and stored in lower quality conditions than high dairy quality alfalfa hay. Corn, whole cottonseed, and mineral have a three percent shrink while DDG and soybean meal have a six percent shrink owing to larger subjectivity to loss due to the combination of physical characteristics of the ingredient and weather conditions. Both dry matter and shrink percentages are highly variable; however the percentages outlined are industry averages utilized across budgets outlined by extension programs.

Table 4-5 Feed Ingredient Dry Matter and Shrink Percentage

Feed Ingredient	***Dry Matter, %***	***Shrink, %***
Corn silage	35	15-25
Alfalfa hay	85	5
Grass hay	85	7
Corn	88	3
Mineral	95	3
Dried distillers grain	90	6
Soybean meal	90	6
Whole cottonseed	90	3

Feed Ingredient Cost

Feed ingredients can be measured at market value or cost of production; for this model market prices are used to measure all feed inputs. Historical monthly prices for a bushel of corn for the states of Colorado, Kansas, New Mexico, and Texas (Oklahoma data were not available) were obtained from the Wisconsin Extension DMRMP. The corn price average is calculated across the four states for each month with adjustments for processing, $0.176 per bushel average over 22 years, and hauling, \$0.25 per bushel. The price per bushel was converted to price per ton for each data point from 1990 forward due to dairy operations purchase feed in ton increments. The average feed corn price from 1990 to 2010 is \$115.47 per ton (\$3.38 per bu.); average price has increased in the past ten and five years, \$125.37 and \$151.13, respectively. In the projection model, corn price, *P_corn*, is based on user input or on futures price, *P_cornfutures*, adjusted for basis (*basis*) plus processing (*processfee*) and transportation costs (*transfee*). Average of closing prices for corn futures from March 21-25, 2011 were taken to represent corn price projections for April through December 2011. These prices plus a five-year average basis are used to calculate corn price per bushel and ton. A five-year average was used to minimize impact of an outlier due to adverse change in the commodity grain markets over the past five years.

$$P\_corn_{t,m} = P\_cornfutures_{t,m} + \sum_{i=5}^{n=5} basis_{t-i,m} / 5 + processfee_{t,m} + transfee_{t,m} \qquad \textbf{(12)}$$

where the subscript t and m represent year and month, respectively, the projected time period. Based on the week futures prices were obtained, corn price is expected to increase in June to just under \$6.75 and then decrease to under \$6.00 by the end of the year.

Corn silage cost per ton is calculated to be eight times the price of a bushel of corn in the market. Corn silage cost has an average price of \$22.42 per ton from 1990 to 2010 that increases to \$30.18 over the past five years. Displayed in Figure 4-14, corn silage has the lowest cost per ton and has limited price variability over time compared with other feed ingredients.

Hay prices for alfalfa and 'all hay' were obtained from Wisconsin DMRMP on a monthly basis from 1990 forward. Southwest and South Central Kansas monthly dairy premium alfalfa hay prices were obtained from 1991 forward and dairy supreme alfalfa hay from July 1998 forward from USDA Hay Market News. When data were available, the price of premium dairy alfalfa hay was 31 percent higher than the average for all alfalfa hay in Kansas. Supreme dairy hay price is, on average, 39 percent higher than the average alfalfa hay market price in Kansas. Missing data for dairy premium alfalfa hay, *P_PREMALF*, in any given month, t, was calculated based on a linear equation on reported Kansas alfalfa hay price, *P_KSALF*:

$$P\_PREMALF_t = b + \beta * P\_KSALF_t \,. \qquad \textbf{(13)}$$

Regressions results are listed in Table 4-6. The price of alfalfa hay is statistically significant at the one percent level when estimating premium alfalfa dairy hay for the Southwest region of

Kansas. The coefficient suggests that for every $1 per ton increase in the price of average alfalfa, premium alfalfa dairy price increases by $1.20/ton.

Table 4-6 Coefficients and Estimates for Premium Dairy Alfalfa Hay

Characteristic	***Variable description***	***Coefficient***	***P-Value (P>|t|)***
B	Intercept	9.403	0.006
P_KSALF	Average market price in Kansas for alfalfa hay	1.195	<.00001
Observations = 242			
$R^2 = 0.800$			

The price of supreme dairy alfalfa hay, *P_SUPALF*, for months prior to July 1998, *t*, was calculated based on the price of Kansas alfalfa hay market price, *P_KSALF*, and premium dairy hay price, *P_PREMALF*:

$$P\_SUPALF_t = b + \alpha * P\_KSALF_t + \beta * P\_PREMALF_t \,. \tag{14}$$

Regressions results for equation (17) are listed in Table 4-7. The price of premium alfalfa hay is statistically significant in explaining supreme alfalfa hay prices at the one percent level, but average alfalfa prices is not significant. Supreme hay prices are about $4.06 per ton higher than premium prices (intercept term) and then move almost dollar for dollar with premium prices (i.e., slope coefficient = 1.01).

Table 4-7 Coefficients and Estimates for Supreme Dairy Alfalfa Hay

Characteristic	***Variable description***	***Coefficient***	***P-Value (P>|t|)***
B	Intercept	4.059	0.0198
P_KSALF	Average market price in Kansas for alfalfa hay	0.054	0.1936
P_PREMALF	Market price for premium alfalfa hay in Southern region of Kansas	1.010	<.00001
Observations = 152			
$R^2 = 0.977$			

Assigned weights on the price of alfalfa hay in each state, dairy premium, and dairy supreme alfalfa hay were used to calculate average historical alfalfa hay price. Half of the weight used was assigned to dairy quality hay, premium and supreme alfalfa hay. Dairy operations feed higher quality alfalfa hay, this weight structure reflects this by assigning half of the weight to higher dairy quality hay. Weighted average alfalfa hay price ranged from $115 to $180 until June 2006 when prices increased to around $200 per ton. All other hay, non alfalfa, is also referred to as grass hay; prices were collected for the five states from 1990 forward. The monthly average price per ton for other hay, across the five states, is typically 58.74 percent lower than the alfalfa hay price. All other hay price per ton ranged from $75 to $100 per ton until May 2006 when price started an upward trend to $139 in March 2007, prices then dropped off and since rebounded to $125 in December 2010. Both alfalfa and all hay prices per ton are included in Figure 4-14.

Projected hay prices, P_hay_t, are calculated on the prior month's price, P_hay_{t-1}, and multiplied by a five year average of the corresponding monthly change in hay price, $[A]_{hay}$ as outlined in equation 7, where *t* represents time (month). The following equation outlines the equation used for both alfalfa and other hay used to project prices for the projection model

$$P\_hay_t = P\_hay_{t-1} * [A]_{hay}. \qquad \textbf{(15)}$$

Monthly price indexes for the past three, five, and ten years are displayed in Figure 4-11 and Figure 4-12 for alfalfa and all other hay, respectively. Alfalfa hay price trends down in the first part of the year and upwards in the last half of the year while all other hay price is fairly consistent with notable price spikes in May and November. Hay price was more inconsistent in the past three years compared to the past five- and ten-year indexes.

Figure 4-11 Alfalfa Hay Monthly Price Index

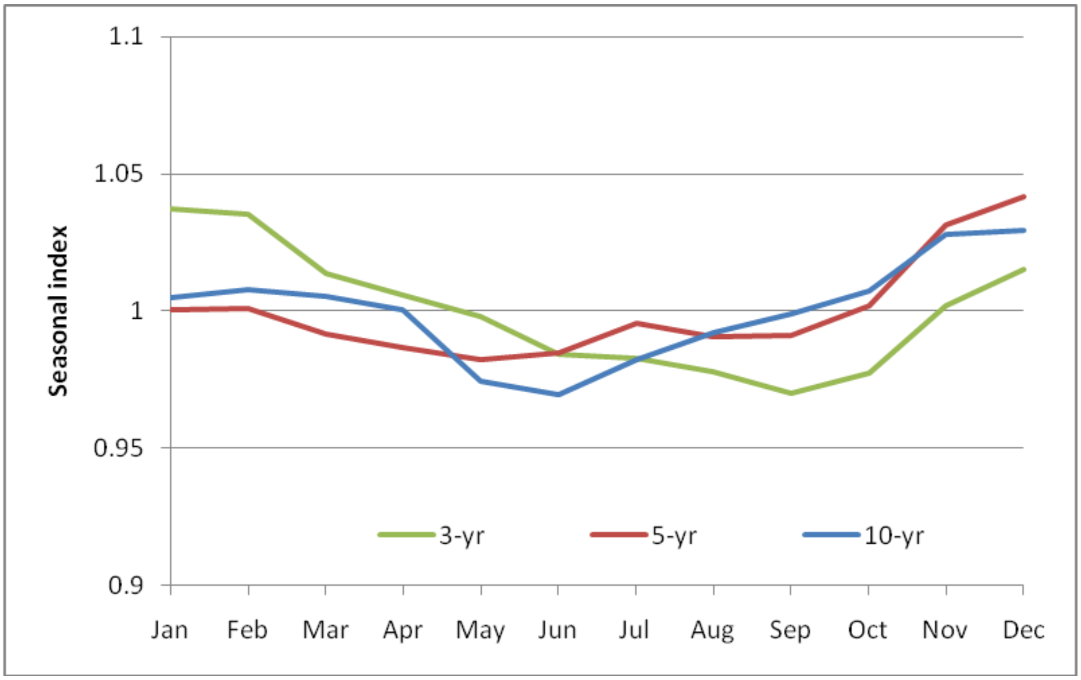
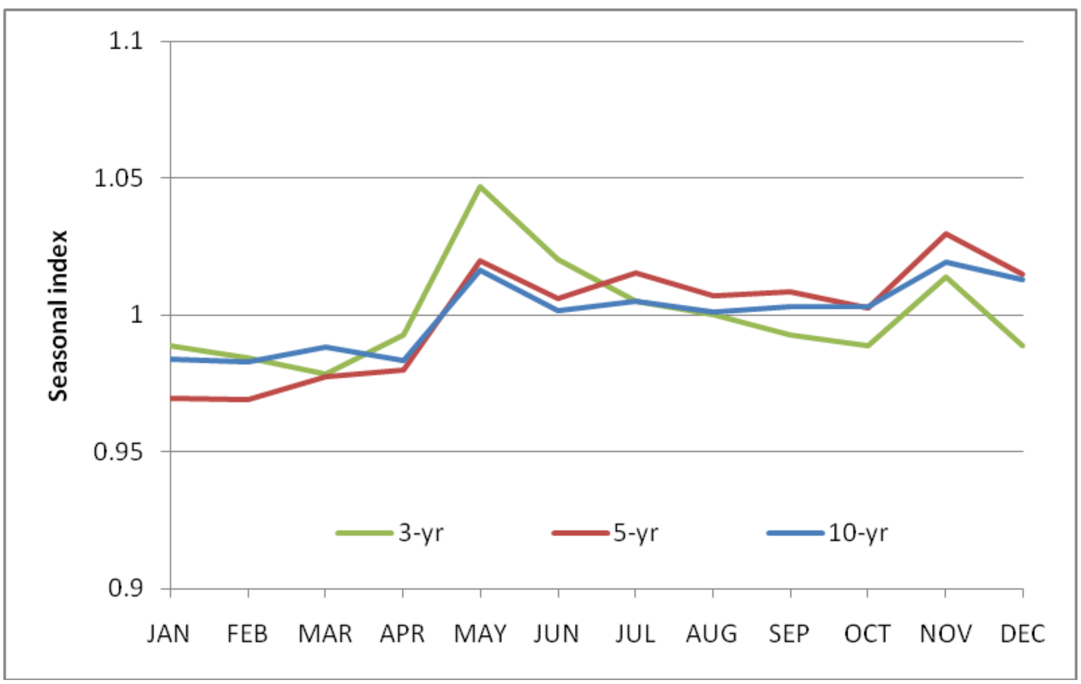


Figure 4-12 All Other Hay Monthly Price Index



Weekly market by-product prices were obtained from Feedstuffs for soybean meal and DDG from Kansas City and Fort Worth for whole cottonseed. These market sites were chosen based on frequency of available data and location to the Southern High Plains Region. Over the relevant time period, prices were missing for several weeks that were “filled in” with a smoothing technique. Specifically, a single missing data point was calculated by taking the average of the week prior and the week after, two consecutive missing data points were filled in with a linear trend between the prices prior and after the missing data. When more than two consecutive were missing, weekly price is calculated by using the percent change in price at a secondary location to adjust the prior week’s price at the primary location. Secondary locations were Chicago for both soybean meal and DDG and Los Angeles for whole cottonseed.

Soybean meal and whole cottonseed follow similar price patterns over the past 21 years, whereas DDG prices follow corn prices. DDG was priced at an average of 141 percent of corn price per ton in the 1990’s. However, in the late 1990’s the spread between corn and DDG prices started to shrink, and in the 2000’s DDG price was an average of 105 percent of corn price per ton. The price per ton of DDG from 1990 to 1999 and from 2000 to 2010 is $93.65 and $107.06, respectively. The past five-year average is $120.19; price in the past five years has increased at a greater degree which follows the corn price trend. Projected prices, P_DDG_t, were obtained based on the corn futures price, P_corn_t, and five-year average of the difference between corn and DDG price per ton. The five-year average DDG percent of corn price was used to calculate DDG price per ton, P_DDG_t, due to the close price relationship and strong price correlation of the two feed inputs.

$$P\_DDG_{t,m} = P\_corn_{t,m} * \left(\sum_{i=1}^{n=5} P\_DDG_{t-i,m} / P\_Corn_{t-i,m}\right) / n \quad \text{i= 1, 2, 3, 4, 5} \qquad \textbf{(16)}$$

where the subscript t (year) and m (month) represent time.

As displayed in Figure 4-14, soybean meal price per ton is highly variable over time with prices peaking in 1997, 2004, 2008, 2009, and trending up again in late 2010. The average price over the past 21 years is $207.57 versus $279.97 for the past five years with the standard deviation increasing from $64.60 (21 years) to $76.19 (5 years). Calculated price for the projected model is based on soybean meal futures closing prices for March 21-25, 2011. An average of the closing prices was taken for each contract, a five-year average basis was then applied to calculate the price used in the projected model. Projected soybean meal prices, *P_sybnmeal*, are calculated using futures price, *P_sybnmealfutures*, and a five-year basis:

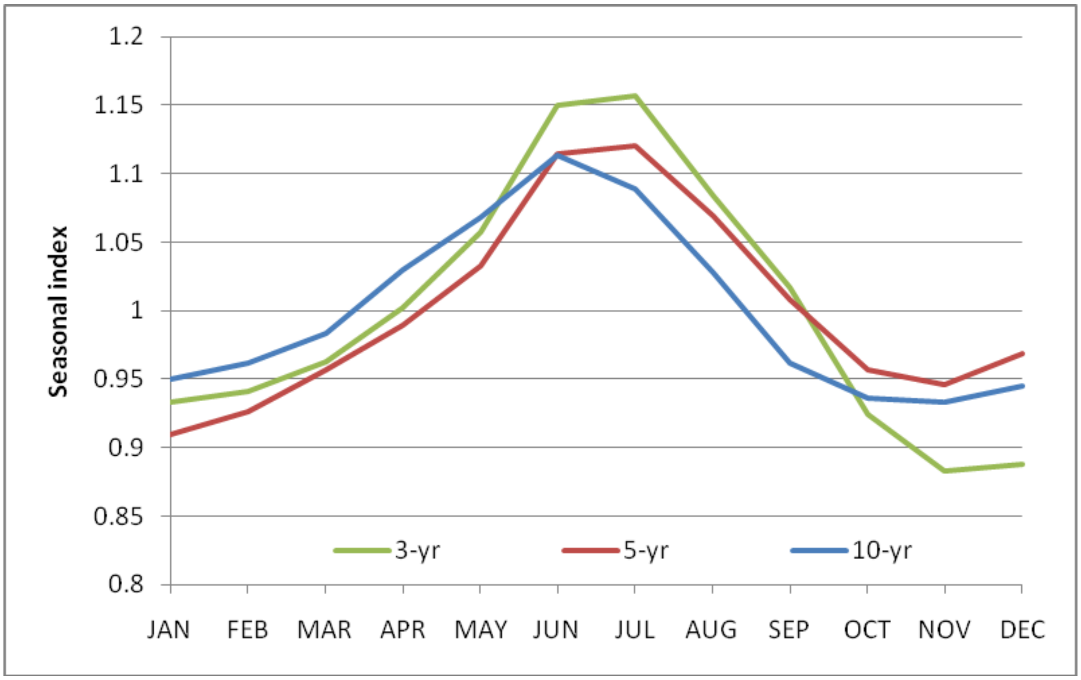
$$P\_sybnmeal_{t,m} = P\_sybnmealfutres_{t,m} + \sum_{i=5}^{n=5} basis_{t-i,m} / 5 \quad \text{i = 1, 2, 3, 4, 5} \qquad \textbf{(17)}$$

Subscripts *t* (year) and *m* (month) represent the time period. Projected prices increase from $339 the beginning of the year to $387 in July and decline to $360 by the end of the year.

Whole cottonseed price has generally followed the same trend as soybean meal price, but with less variability between price peaks and troughs. However, the past five years have shown significant price spikes compared to the past 21 years. Whole cottonseed average price for 1990 to 2010 is $180.12, the past ten- and five-year averages are $194.43 and $243.13, respectively. Whole cottonseed prices per ton have increased over time and the standard deviation of prices has increased almost $10 when comparing historical 20- and 5-year price horizons. Cottonseed price has exhibited a seasonal pattern of increasing from the beginning of the year to June and July then receding the remainder of the year. Projected prices for 2011 whole cottonseed average approximately $300 following the monthly price trends outlined in Figure 4-13. Whole cottonseed projected price, $P\_wcottonseed_t$, is calculated based on the price the previous month, $P\_wcottonseed_{t-1}$, and the average seasonal index of the past five years corresponding price change between months, $[A]_{wcottonseed}$,,as outlined in equation 7 :

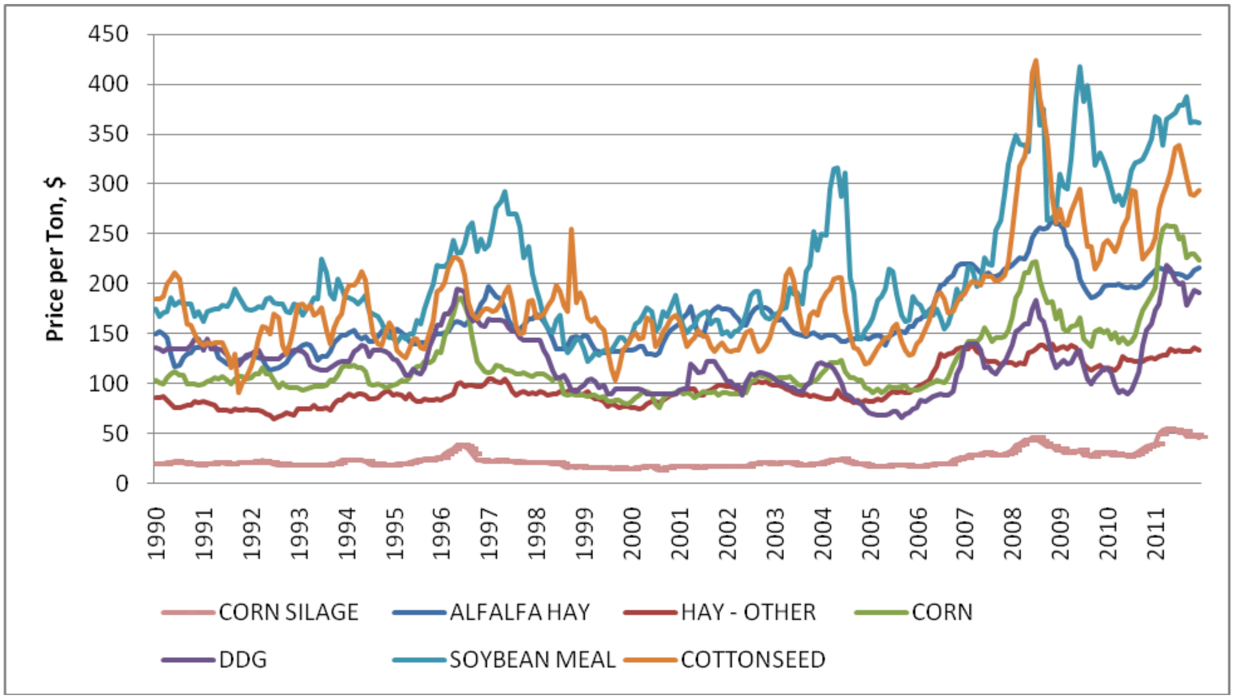
$$P\_wcottonseed_t = P\_wcottonseed_{t-1} * [A]_{wcottonseed} . \qquad \textbf{(18)}$$

Figure 4-13 Cottonseed Price Index



Minerals are fed to dairy cattle in the form of supplement or additive to the ration in trace amounts; however, the extensive cost per ton can significantly impact feed costs per cow. An historical series of mineral prices was not available; therefore, price per ton was obtained from cooperatives throughout Kansas for 2010. The 2010 price, $995 per ton, was indexed back to 1990 based on supplement prices paid indices that were obtained from NASS. A feed-supplement prices paid index obtained was for 1997 forward and prior to that the broader producer price paid index (PPI-Paid) was used. Mineral prices have shown a steady incline in prices since 1990 with a notable increase in price in late 2010. Mineral price per ton is significantly higher than other feed inputs as the last five-year average is $672.21, up from $474.04, average for 1990 through 2010. For the projected model, the current mineral price per ton for 2010 is used for 2011.

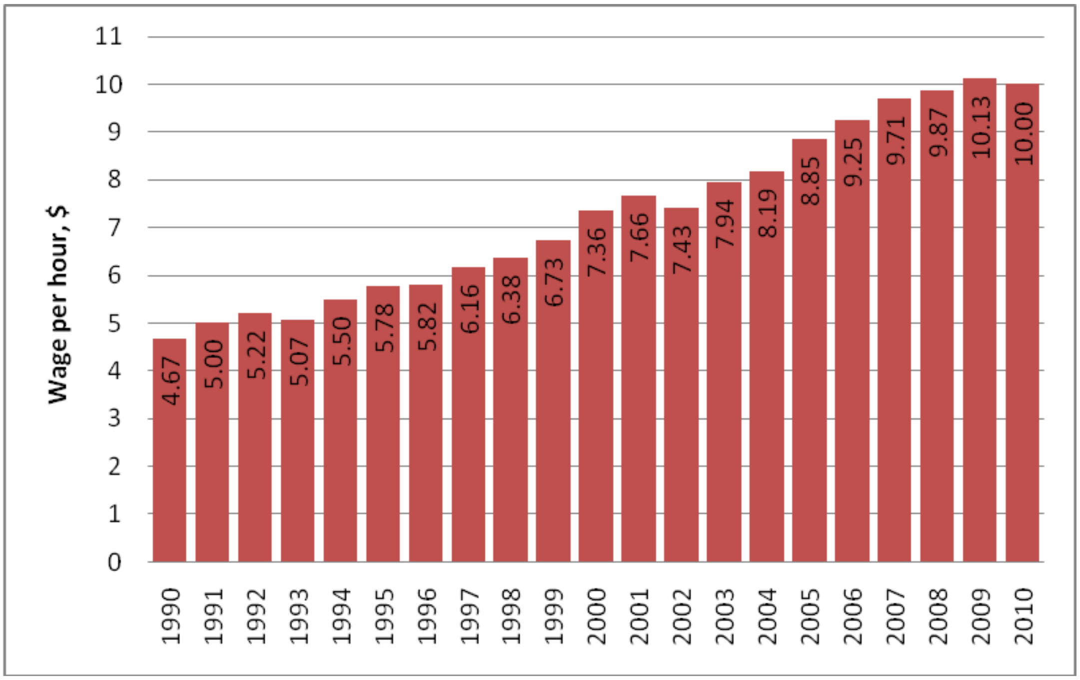
Figure 4-14 Monthly Feed Ingredient Prices, January 1990 – February 2011



4.2.2 Labor Cost

Labor cost is based on historical quarterly wage rate, labor hours required per cwt milk produced, and milk production. Hourly wage for the animal agriculture sector was obtained from NASS on a quarterly basis for the Southern Plains region from 1990 forward. Quarterly data were adjusted to monthly data based on corresponding months per quarter. Annual average hourly wage rate for animal agriculture is displayed in Figure 4-15 for 1990 to 2010. The wage rate in 1990 was at $4.67 and has increased an average of 3.94 percent per year to $10.00 in 2010. Monthly wage per hour amounts will be used in the historical model to calculate labor cost per cow.

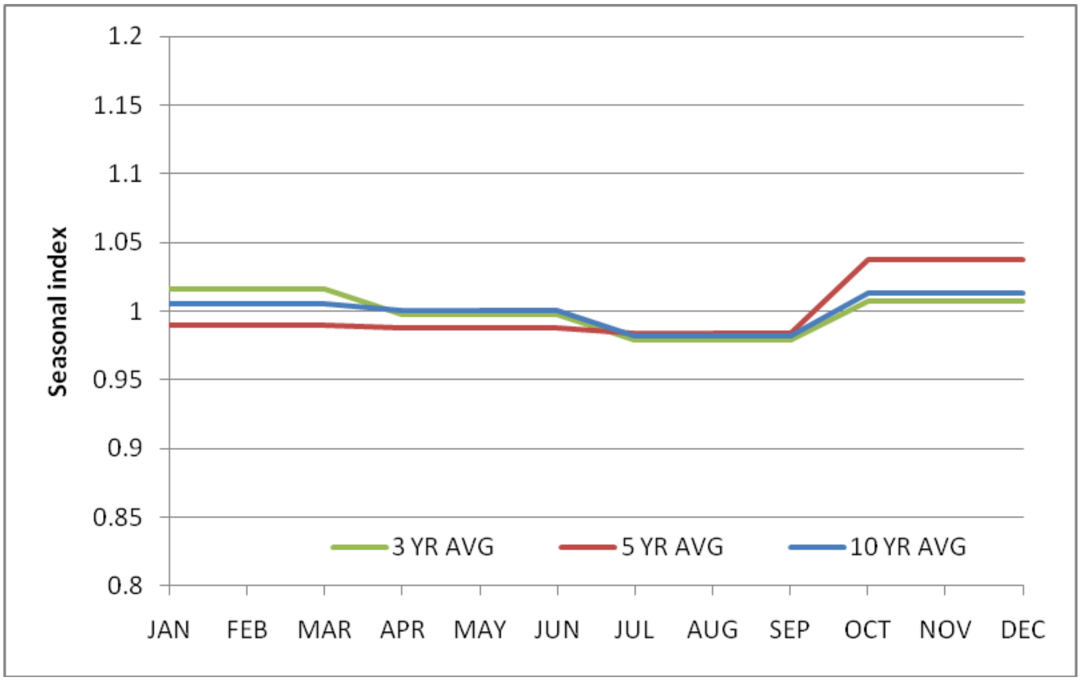
Figure 4-15 Animal Agriculture Wage per Hour



Additional data required to calculate labor cost is a labor required per cwt or cow, cow labor multiplier, and production or cows per month. Characteristics and Production Costs of U.S. Dairy Operations (2004) published by the ERS gives production and performance benchmarks for various regions across the United States. The Fruitful Rim-West, Arizona, California, Oregon, Washington, and Idaho, is the closest representative region available to the Southern High Plains with the largest average herd size, 469 head, and output per cow at 18,000 pounds per year. Labor efficiency for the Fruitful Rim was statistically significant compared with all other regions and was estimated at 0.12 hours per cwt milk sold, 0.07 for paid and 0.05 for unpaid (Short).

Projected labor cost is based on user entry of total paid labor, total unpaid labor hours, and unpaid labor wage rate per hour or calculated labor cost based on historical data. The projected labor is a calculation of historical agriculture, livestock wage rate and a five-year average seasonal index measure of corresponding change between months. The seasonal price indexes for the past three, five, and ten years are displayed in Figure 4-16; in the past ten years wage has been lowest during the third quarter of the year and higher during the first and fourth quarters. This seasonal price trend can be associated with increase in availability of labor during the summer months and therefore wages decrease. These price patterns and the labor efficiency multiplier are applied to calculated milk production to calculate projected labor cost if actual paid and unpaid labor expenses are not provided by the user.

Figure 4-16 Agriculture Wage Index



4.2.3 Replacement Female Cost

Replacement female cost is calculated on herd replacement rate and the value of replacement females. In this model, the herd replacement rate is equivalent to cull rate to maintain herd size. If the user desired to increase herd size, the replacement rate would need to be greater than the cull rate. Dairy female replacement values per head were obtained for the five states individually as well as the U.S. average from USDA, NASS, and springer replacement heifer market data were obtained from Springfield, Missouri Dairy Auction. NASS data were collected on a quarterly basis and converted to monthly prices by assigning the quarterly data to the designated months. Data for Colorado, Kansas, Texas and the U.S. were available for all quarters, but New Mexico and Oklahoma data were incomplete. Prices for months without data for these two states were estimated from data from the other states. New Mexico data were available from January 1992 forward; a linear equation as a function of replacement female prices in Colorado *(P_COREPF*), Kansas *(P_KSREPF)*, Texas *(P_TXREPF)*, and U.S. *(P_USREPF)* was calculated for 1990 and 1991:

$$P\_NMREPF_t = b + \beta_1 * P\_COREPF_t + \beta_2 * P\_KSREPF_t + \beta_3 * P\_TXREPF_t + \beta_4 * P\_USREPF_t + \varepsilon \quad \textbf{(19)}$$

where *b* is the intercept and subtitle t is the point in time.

Table 4-8 Coefficients and Estimates for New Mexico Replacement Female Price

Characteristic	***Variable description***	***Coefficient***	***P-Value (P>|t|)***
b	Intercept	94.506	<0.0001
P_COREPF	Market price for replacement females in Colorado	-0.004	0.9286
P_KSREPF	Market price for replacement females in Kansas	0.010	0.9035
P_TXREPF	Market price for replacement females in Texas	0.181	0.0293
P_USREPF	Market price for replacement females U.S.	0.776	<0.00001
Observations = 228			
$R^2 = 0.970$			

Oklahoma replacement female data was represented up to the end of 1999. For 2000 to 2010, prices were estimated as a linear function of replacement female prices at other locations:

$$P\_OKREPF_t = b + \alpha * P\_COREPF_t + \beta_1 * P\_KSREPF_t + \beta_2 * P\_TXREPF_t + \beta_3 * P\_USREPF_t + \varepsilon. \quad \textbf{(20)}$$

In the above equation *P_OKREPF*, price of replacement females in Oklahoma, is a function of replacement female prices in Colorado *(P_COREPF*), Kansas *(P_KSREPF)*, Texas *(P_TXREPF)*, and U.S. *(USREPF)* where *b* is the intercept and subscript *t* is time period.

Table 4-9 Coefficients and Estimates for Oklahoma Replacement Female Price

Characteristic	***Variable description***	***Coefficient***	***P-Value (P>|t|)***
b	Intercept	152.208	0.0064
P_COREPF	Market price for replacement females in Colorado	-0.310	<0.0001
P_KSREPF	Market price for replacement females in Kansas	0.119	0.1799
P_TXREPF	Market price for replacement females in Texas	-0.216	0.0772
P_USREPF	Market price for replacement females U.S.	1.248	<0.00001
Observations = 120			
$R^2 = 0.796$			

When calculating New Mexico replacement female price, U.S. and Texas replacement female prices are statistically significant at the one and five percent levels, respectively. Colorado and U.S replacement female prices are statistically significant at the one percent level and Texas at the 10 percent level when estimating Oklahoma replacement female price. Texas and U.S. replacement heifer prices are both significant ($P < .001$) in calculating replacement female price across the Southern High Plains.

Missouri auction market data are available monthly from April 2002 forward; missing data are estimated as a function of state, *P_STATEREPF*, and U.S., *P_USREPF*, replacement female prices outlined above, dairy replacement inventory in the U.S. and Southern High Plains, *REPLCFINV*, and milk price per cwt, *P_MILKCLASSIII*:

$$P\_MOAUCTF_t = b + \sum_L (\alpha_{L,t} * P\_STATEREPF_{L,t}) + \beta_1 * REPLCFINV_{r,t} + \beta_2 * P\_MILKCLASSIII_t + \varepsilon. \quad \textbf{(21)}$$

In Equation 21, subscript *L* represents each state in the Southern High Plains region, *r* represents U.S. or Southern High Plains region for replacement heifer inventory values, and *t* is time period. Milk price is the calculated average price for the Southern High Plains region at the current time period. Regression results indicate that Texas replacement female price, number of replacement females in the Southern High Plains, and milk price are statistically significant (Table 4-10). For each dollar increase in milk price Missouri auction market replacement female price increases by $37.98.

Table 4-10 Coefficients and Estimates for Missouri Auction Replacement Female Price

Characteristic	***Variable description***	***Coefficient***	***P-Value (P>|t|)***
b	Intercept	958.218	<0.0001
P_COREPF	Market price for replacement females in Colorado	-0.042	0.8427
P_KSREPF	Market price for replacement females in Kansas	0.108	0.7677
P_TXREPF	Market price for replacement females in Texas	0.638	<0.0001
P_NMREPF	Market price for replacement females in New Mexico	-0.093	0.7726
P_OKREPF	Market price for replacement females in Oklahoma	-0.013	0.9678
$REPLCFINV_{US}$	Total replacement female inventory in U.S.	-.00006	0.1941
$REPLCFINV_{SHP}$	Total replacement female inventory in the Southern High Plains region	-0.002	<0.0001
P_MILKCLASSIII	Calculated price of milk for the Southern High Plains region	37.975	<0.0001
Observations = 103			
$R^2 = 0.847$			

The average replacement female price is a weighted average based on represented price data. All state and U.S. data are assumed to be replacement cow prices and the auction market data are representative of the dairy springer heifer market. Typically, dairy operations calve in springer heifers to maintain herd size rather than buy dairy cows; dairy cows are generally purchased for herd expansion purposes. Therefore in valuing replacement females for the historical and projected returns, springer heifers, *P_MOAUCF*, receive twice the weight as replacement cow prices:

$$P\_REPF_t = 3.0 * P\_MOAUCF_t + 0.2 * P\_NMREPF_t + 0.2 * P\_OKREPF_t + 0.2 * P\_COREPF_t + 0.2 * P\_KSREPF_t + 0.2 * P\_TXREPF_t + 0.5 * P\_USREPF_t \,. \quad \textbf{(22)}$$

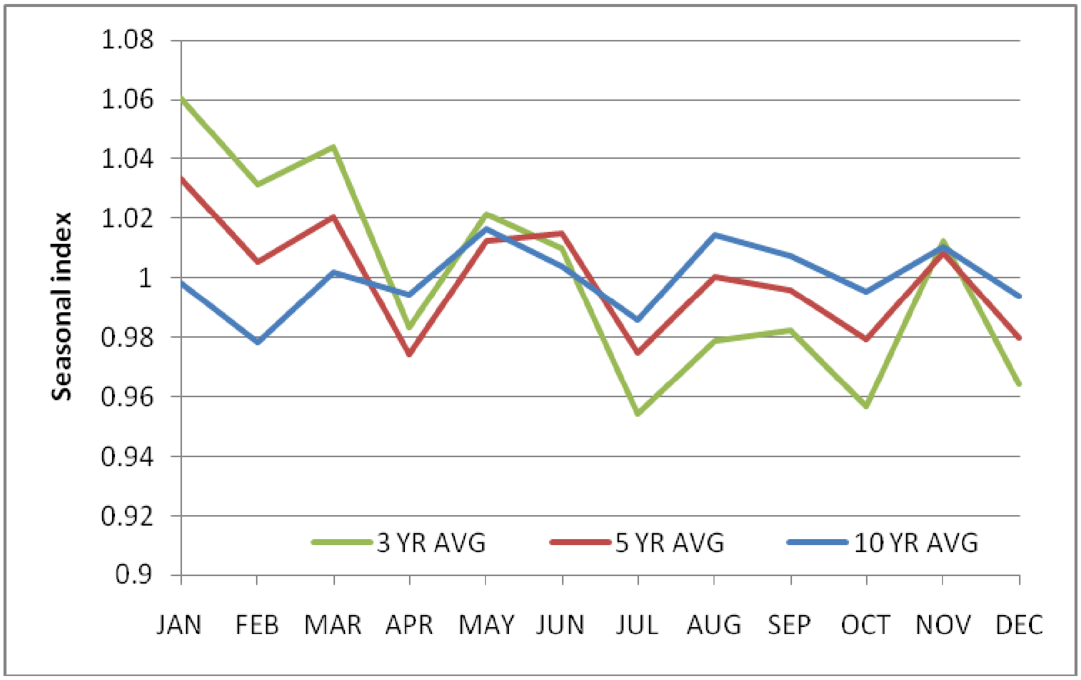
Replacement female price has been highly variable due to correlation with milk price over time; however, the average price over the past five, ten, and 20 years has been consistent at $1,514, $1,598, and $1,446, respectively, with a standard deviation of approximately $250 for all three periods. Monthly weighted average prices will be used in the historical model, and user input data, prior month data, and a five-year seasonal average price pattern will be used to calculate projected monthly prices for the projection year.

In the projection model, the user can input replacement heifer weight and price per head to customize the data output or depend on estimated price per head based on recent prices and historical monthly patterns. The estimated price per head, P_REPF_t, uses the previous month's replacement female price, P_REPF_{t-1}, and adjusts it based on the five-year average seasonal index of corresponding change per month, $[A]_{repf}$ as outlined in equation 7:

$$P\_REPF_t = P\_REPF_{t-1} * [A]_{repf} \,. \quad \textbf{(23)}$$

The monthly indexes for the past three, five, and ten years for replacement females are displayed in Figure 4-17 where prices vary between months and trend down over the year.

Figure 4-17 Replacement Female Price Paid Index

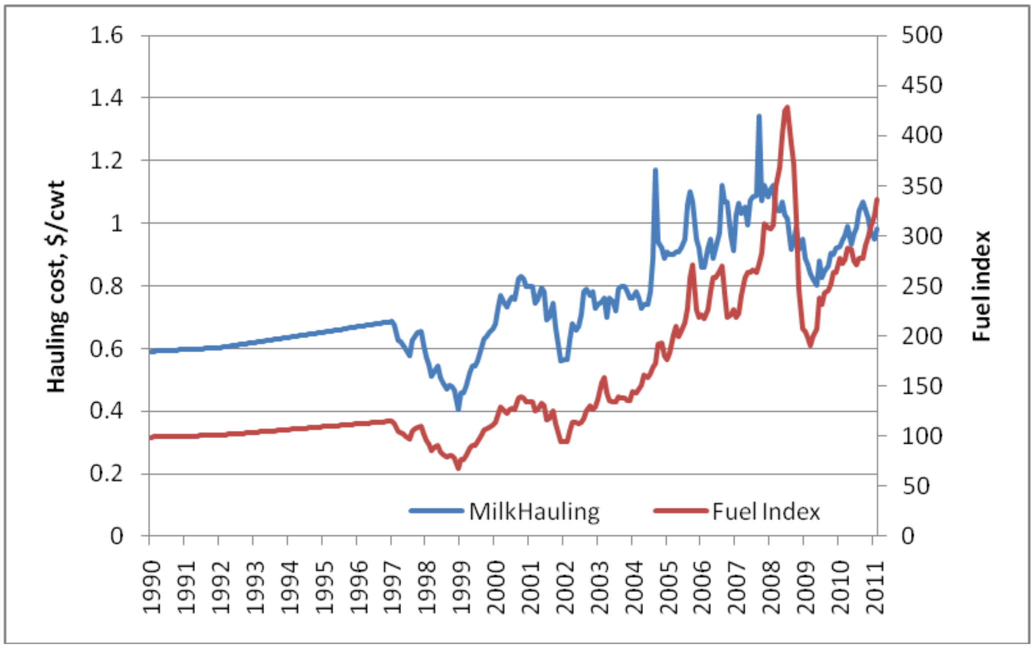


4.2.4 Other Operating Costs

Based on cost categories included in budgets reviewed in Chapter 3 and those reported by accounting firms, 10 additional operating cost categories are included to approximate cost for a dairy operation. These costs include milk hauling and promotion; livestock insurance; building and equipment repairs; marketing; breeding; supplies and veterinary; gas, fuel, and oil; professional fees; utilities and water; and other.

Milk hauling and promotion cost includes hauling, advertising, and state dairy commission deductions. Milk hauling and promotion is priced per cwt of milk shipped and is deducted directly from the milk check. Advertising and dairy commission deductions are assumed to be constant over time at $0.15 and $0.01 per cwt, respectively. Milk hauling deduction data representative of Western Kansas were provided by Jason Ables, Coordinator of Member Services in the Southwest Area for DFA. Monthly data were provided for April 2002 forward. With the exception of 2008, the milk hauling costs follow a similar pattern to the fuel price index. Therefore, the fuel price index was used to calculate milk hauling cost back to 1990. The milk hauling cost per cwt and fuel index over time are graphed in Figure 4-18**.** Hauling deduction varies over time; the five-year average is $0.98 with a standard deviation of $0.099. As shown in Figure 4-18 hauling cost is highly variable due to it tracking closely with fuel prices. However, there are some inconsistencies occurring in 2004 and 2007 where milk hauling increases to a greater degree compared with the fuel index and in 2008 when cost decreases as fuel index spikes. The projection model uses the fuel index to project hauling cost into the future, and $0.15 and $0.01 for advertising and dairy commission fees, respectively, will be added to obtain total hauling and promotion cost.

Figure 4-18 Monthly Hauling Cost, January 1990 – March 2011



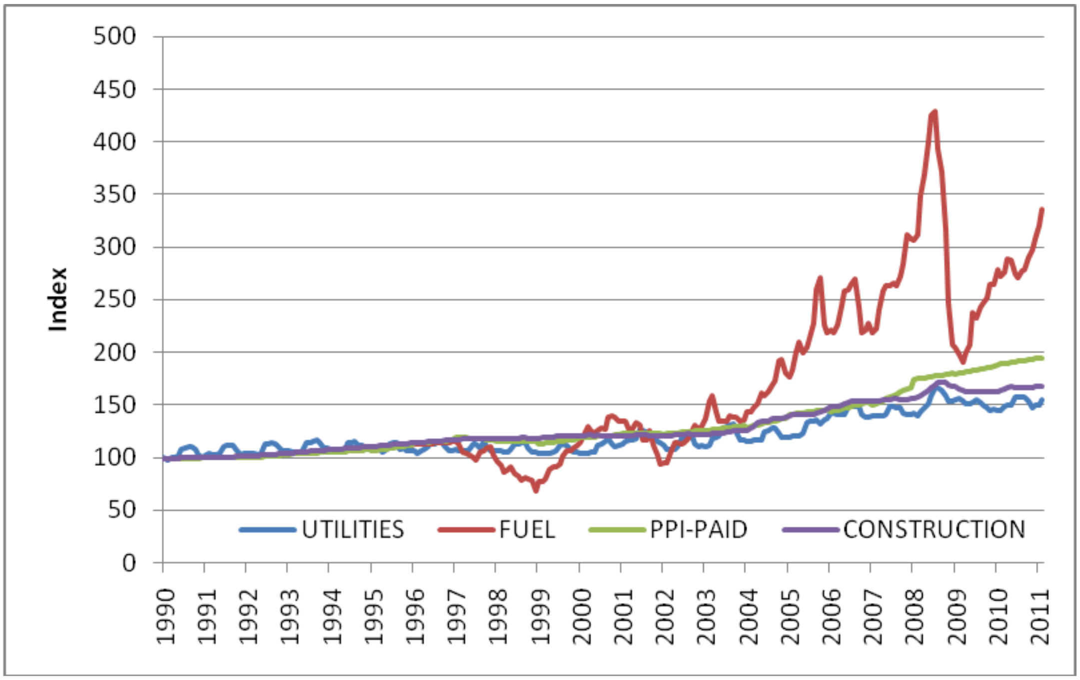
Insurance cost for livestock is calculated based on value of female and insurance rate. Current insurance rates are at one percent for mature dairy cattle. Dairy female value will be represented by the calculated replacement female price outlined above less value lost from death loss. Building and equipment repairs is calculated as a percentage of investment asset value. Repairs are estimated to be 2.5 percent of investment asset value which is outlined in the next section, both values used are taken from the K-State Enterprise Budget for a 2,400 dry lot dairy. Estimates for the remaining cost categories on a per cow basis for the year 2009 are based on 2010 K-State Dairy Enterprise Budget and real farm data for Texas and New Mexico from two private accounting firms. The 2009 estimates are divided by 12 to obtain a monthly cost per cow then entered in the historical model for June 2009. Producer price paid indexes outlined in Table

4-11 are utilized to project costs back to 1990 and forward through 2011. All producer price indexes were obtained from NASS, fuel, construction, and PPI-paid were obtained for 1997 forward, the 1990 through 1996 data were estimated through a linear trend. The monthly price indexes are graphed in Figure 4-19, which shows producer prices paid and utilities increase over time with limited volatility where as fuel has shown increased volatility in the past 10 years with a spike in 2008 and the upward trend starting again in 2009.

Table 4-11 Operating Costs

Cost category	***Estimated June 2009 cost ($ per cow)***	***Index used***
Marketing	30.00	Producer Price Paid
Breeding	65.57	Producer Price Paid
Supplies and veterinary	130.13	Producer Price Paid
Gas, fuel, and oil	55.87	Fuel
Professional fees	10.90	Producer Price Paid
Utilities and water	66.78	Utility
Other	30.00	Producer Price Paid

Figure 4-19 Index for Price Paid, 1990-1992 Base Years

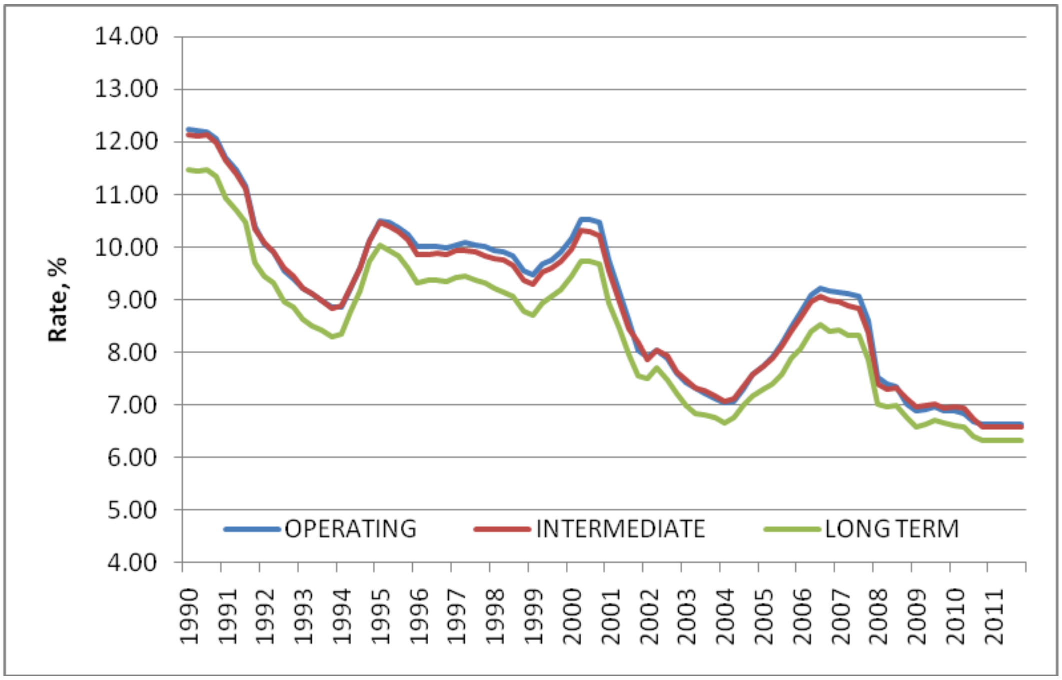


4.2.5 Depreciation, Interest, Insurance, and Taxes

Other operating costs outlined in this model are depreciation, interest, insurance, and taxes on operating expenses, livestock, land, buildings and rolling equipment. Unlike the operating expenses outlined above, these costs represent additional cost of owning assets. These costs are calculated based on predetermined rates for each category and value of asset held.

Interest rates for the agriculture sector are obtained from Federal Reserve Bank of Kansas City for the loan types of operating, intermediate, and real estate. These data are reported per quarter for the tenth district of the Federal Reserve which includes the states of Colorado, Kansas, Oklahoma, and New Mexico. Interest rates have changed over the past 21 years to reflect a variety of national and global factors including strength of the U.S. economy and monetary policies. Figure 4-20 displays the trend over time for the three types of agriculture interest rates with 1990 having the highest rate and 2010 having the lowest rate. Operating and intermediate term interest rates trend together with real estate rates slightly lower but following the same trend over time. The real estate rate is used to calculate interest on buildings, intermediate rate is used for cattle and equipment, and the operating rate on operating expense. The rates for the last quarter in 2010 are used for 2011 in the projection model.

Figure 4-20 Agricultural Interest Rates, Federal Reserve Bank of Kansas City



Interest on operating expenses measures the interest or opportunity cost in the short term on monthly operating expenses. The model assumes all expenses are incurred at the beginning of the month and revenue is received at the end of the month. Interest on breeding livestock was also taken to measure the associated opportunity cost. The value per replacement female less percent death loss to accommodate for loss not recovered for the corresponding time period was used for the asset value. Breeding livestock are classified as intermediate assets and therefore the intermediate, machinery/intermediate, interest rate was used.

Current investment, amount equivalent to build all facilities and purchase equipment, excluding land expense, is entered for building and equipment asset valuation where 88 and 12 percent of the total is allocated for building and equipment asset values, respectively. A monthly building and construction index, included in Figure 4-19, outlined for agriculture producers by NASS is used to index total investment value back to 1990 and forward through 2011. The interest, depreciation, and insurance percentages are used to calculate the non-cash costs.

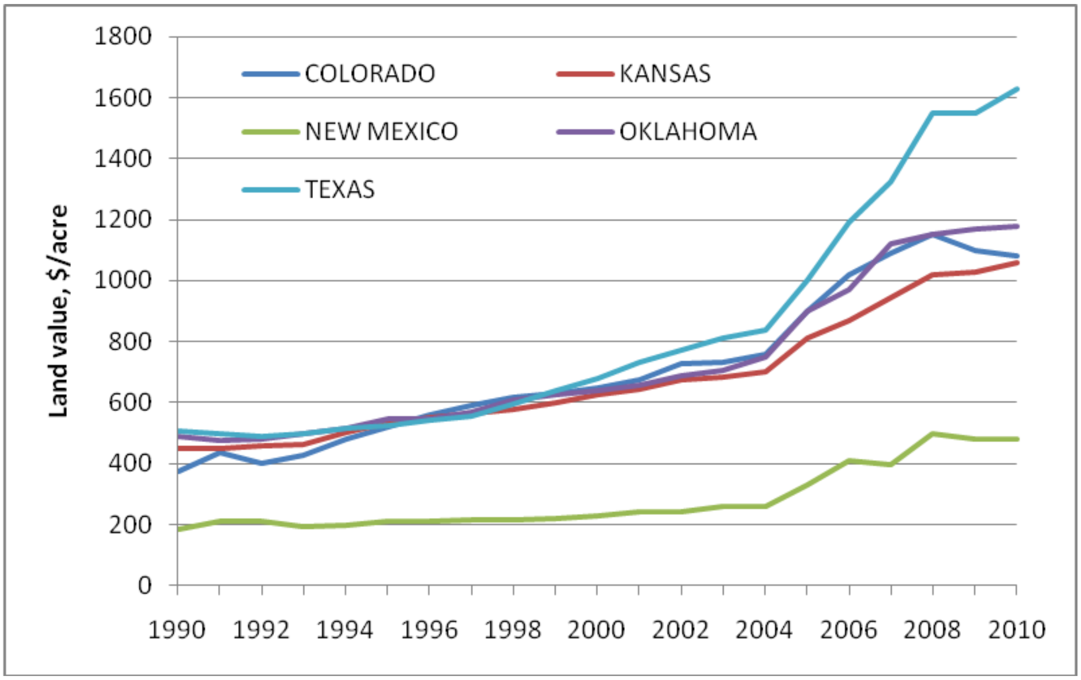
Depreciation and insurance percentages are held constant over time; buildings have salvage value equivalent to 10 percent of investment value and an assumed useful life of 20 years. Rolling equipment has a salvage value based of 20 percent of investment value and a seven year useful life. Insurance and taxes on buildings and equipment, based on values in the K-State Dairy Enterprise Budget, are 1.75 and 0.25 percent, respectively. Depreciation values are based on standard taxation guidelines, and the investment asset value insurance and tax values obtained from the K-State Dairy Enterprise Budget.

Annual land values for states in the Southern High Plains region were obtained from NASS and are displayed in Figure 4-21. Monthly land values were obtained by assigning the annual values across the corresponding months; an average across the five states represented from 1990 forward was also taken. With the exception of 1992 and 2009, land values have increased over time. From 1990 to 2004 growth occurred between three and six percent per year; rapid growth occurred from 2005 to 2009 at over nine percent per year. Projected land value, P_LAND_t, based on the five-year average increase in value per year, *LAND_pchange*, applied to the prior time period price, P_LAND_{t-1}, where t is month:

$$P\_LAND_t = P\_LAND_{t-1} * LAND\_pchange_t \ . \qquad \textbf{(24)}$$

Land values are used to calculate associated interest and taxes. Land values and required acres for a large dairy are used to find a land cost per cow. Based on the K-State Enterprise budget, a 2,400 lactating cow dry lot dairy required 130 acres of land. Adjusted for a dairy inventory of 2,500 lactating cows, 135 acres are required for the current model. Land cost per cow is then used in conjunction with a rent-to-value ratio (i.e., opportunity cost of land ownership) and tax rate to calculate associated costs. Land does not appreciate so the salvage value is 100 percent of the initial value with a life of 50 years, and therefore no depreciation is realized. Rent-to-value is five percent which is used to calculate interest and tax rate is 0.35 percent. (Dhuyvetter et. al)

Figure 4-21 Agriculture Land Value per Acre, Including Buildings



Chapter 5 - Profit Projection Model

A model was built using historic and projected data as outlined in Chapter 4. The historic model calculates monthly net returns per cow since 1990, which is summarized on an annual basis. In addition to the estimated historical returns, the model can be used to project net returns for the projected 12 months per cow of milk produced. This chapter will further explain the supporting data and equations behind the historic and projection profit models.

The historical model is a closed model with predetermined input data based on market reports, prior research, industry standards, and reported data. Though the total number of lactating cows per month can be changed in the model; a default of 2,500 is used as an average herd size for the Southern High Plains region. The projection model is developed from historical and futures market data along with management measures and user input farm data. Revenue is a total of sales generated from milk produced, cull cows, and calves. Total cost is a sum of feed, labor, replacement female, other operating, and opportunity costs.

5.1 Revenue

Dairy operations receive the bulk of their revenue from the sale of milk with some additional revenue generated through sale of cull cows and young stock.

Total revenue from milk production is calculated from volume of milk shipped time milk price received, which is a function of component levels in the milk. Milk production is measured on a monthly basis using NASS production per cow and adjusted on a monthly basis. Milk price is an average of reported and calculated mailbox prices for the Southern High Plains. The equation for revenue from milk sales per month, $Sales\_Milk_t$, is outlined in equation 25 as a function of pounds of milk per cow per day, $prod\_day_t$, times days per month all divided by 100 to adjust to a cwt basis then multiplied by mailbox price of dollars per cwt all at time t (month):

$$Sales\_Milk_t = (prod\_day_t * daysmon)/100 * P\_MILK_t . \qquad \textbf{(25)}$$

In the historical summary, typically yearly milk production is adjusted to a 305 day lactation cycle (305 days in lactation and 60 days dry); however, this model uses rolling herd average production adjusted to a monthly basis. As outlined in Equation 26, annual milk sales per cow is the sum of monthly milk sales:

$$Sales\_Milk_y = \sum_{1}^{12} Sales\_Milk_t \,. \qquad t\text{=1,2,….12} \quad y\text{=1990, 1991,……} \qquad \textbf{(26)}$$

Cull cow sales are calculated using the given cull rate of 34 percent as used in prior dairy budgets reviewed in Chapter 3. Additionally, the equation uses average price received per cwt as reported by the Wisconsin Extension DMRMP for the five states in the Southern High Plains region. Cull cow sales is a function of price per cwt for cull cows (*P_cullcwt)*, cull rate (*cull%*), cull cow weight (*CullCowWeight*) as calculated Equation 5, and number of lactating cows (*CowsLact*) adjusted on a per month and cow basis:

$$Sales\_Cull_t = P\_cullcwt_t * (CullCowWeight_t / 100) * cullrate / 12 \,. \qquad \textbf{(27)}$$

Yearly cull sales, Equation 28, is calculated by adding the cull cow sales, $Sales\_Cull_t$, for the 12 months, *t*, per year,

$$Sales\_Cull_y = \sum_{1}^{12} Sales\_Cull_t \,. \qquad t\text{=1,2,….12} \quad y\text{=1990, 1991,……} \qquad \textbf{(28)}$$

In the historical model, all calves are sold either as replacement heifers or non-replacement calves to simplify the model and reduce potential cost variability in facility and feed costs from heifer raising between farms. Calving percentage, 95 percent, is the percentage of the herd expected to calve back within a year; 95 percent is an industry standard and used in the budgets reviewed in Chapter 3. Offspring replacement percentage is the percentage of offspring which are eligible to sell as replacement heifers which can be affected between farms and across time by improved reproduction protocols and rates and sexed semen. Fifty percent was selected based on a 50:50 chance of getting a heifer or bull. Calves are assumed to be sold as wet calves, 2-14 days of age. Returns from sale of replacement and non-replacement calves is a function of calving percentage, replacement heifer percent, weight of calf, and price per cwt. The weight of heifer, *hweight*, and bull, *bweight*, calves is defined in the model as 100 and 105 pounds, respectively. Price for wet calves is based on the average of reported and calculated prices from Wisconsin and Missouri markets for calves at the average weight of 100 lbs. The number of replacement heifers per month is calculated by lactating herd inventory, *CowsLact*, multiplied by calving percentage (*calving%*) and replacement heifer percentage (*replace%*). Replacement heifer sales, *Sales_RC*, is calculated using number of replacement heifers per month, calf weight divided by 100, price per cwt received, *P_hrcalf*, and lactating cow inventory for time period *t* (month):

$$Sales\_RC_t = (calving\% * replace\% / 12) * (hweight_t / 100) * Phrcalf_t) \quad \textbf{(29)}$$

Non-replacement calf sales, *Sales_NRC*, is calculated similar to replacement heifer calf sales in Equation 29, bull calf weight, *bweight*, and calf price, *Pbcalf*, are used in place of replacement heifer calf variables and number of bull calves is found by taking one less the replacement heifer percentage:

$$Sales\_NRC_t = (calving\% * (1 - replace\%)) / 12$$

$$* (bweight \ \ / 100) * Pbcalf_t) . \quad \textbf{(30)}$$

Yearly calf sales are formulated with Equations 31 and 32 where the sum of the months per year is calculated where subscripts *y* (year) and *t* (month) represent the time period:

$$Sales\_RC_y = \sum_{1}^{12} Sales\_RC_t \qquad t{=}1,2,\ldots.12 \quad y{=}1990, 1991,\ldots\ldots \quad \textbf{(31)}$$

$$Sales\_NRC_y = \sum_{1}^{12} Sales\_NRC_t . \qquad t{=}1,2,\ldots.12 \quad y{=}1990, 1991,\ldots\ldots \quad \textbf{(32)}$$

Total revenue per cow, *TR*, is calculated as the sum of all milk or livestock sales for designated time period, *t (month) and y (year)*, as outlined in the below equations:

$$TR_t = Sales\_Milk_t + Sales\_Cull_t + Sales\_RC_t + Sales\_NRC_t \quad \textbf{(33)}$$

$$TR_y = \sum_{m=1}^{n=12} Sales\_Milk_t + Sales\_Cull_t + Sales\_RC_t + Sales\_NRC_t .$$

$$t = 1, 2, \ldots.12 \quad \textbf{(34)}$$

5.2 Costs

Major costs outlined by the model with market data are feed, labor, replacement female, and capital fixed costs. The remaining cost categories are other operating costs. This section will outline the equations used to calculate each of the costs per cow.

The largest cost component is feed. Feed is valued at market prices based on total pounds fed after accounting for shrink. Feed cost is calculated for both dry and lactating cows. Pounds fed to cows are based on rations which are formulated based on milk production levels. As milk production increases, feed intake is higher and includes a greater level of by-products. Rations were developed by Dr. Mike Brouk, K-State Dairy Extension Specialist, who also provided the percent shrink values. Each ration is comprised of eight feed ingredients, corn silage, alfalfa hay, grass hay, corn, DDG, soybean meal, whole cottonseed, and mineral. Total pounds per cow per day, $lbs_{f,t}$, used to calculate feed cost accounts for shrink (*shrink%*), amount lost due to weather, transportation, or spoilage. The shrink adjusted amount of total feed is then multiplied by the price per ton paid per ingredient, $P\_ton_{f,t}$, based on historical market prices for the Southern High Plains region. Feed cost, $Cost\_FeedDay_{d,t}$, for both lactating and dry cows is calculated per cow per day using the following equation where subcript *d* is dry or lactating diet, *f* is the feed ingredient and *t* is the time period:

$$Cost\_FeedDay_{d,t} = \sum_{f=1}^{n=8} lbs_{f,t} * (1 + skrink\%_{f,t}) * (P\_ton_{f,t}) / 2000 \; .f = 1,2,\ldots 8 \quad \textbf{(35)}$$

Total feed cost per day is the adjusted feed cost for both lactating and dry periods of the lactation cycle as outlined in Equation 14.

Labor cost is calculated based on cwt of milk produced and efficiency measure based on NASS survey data (Short, 2004). Quarterly agriculture wage rate data for livestock operations was obtained from NASS. Wage rate per hour, *wage*, along with milk production, *prod_day*, and the labor multiplier, 0.12 hours per cwt milk produced are used to calculate labor cost, *Cost_Labor*, for time *t* (month):

$$Cost\_Labor_t = (prod\_day_t * daysmon) / 100 * 0.12 * wage_t \, . \quad \textbf{(36)}$$

The last notable cash cost producers are subject to if they do not raise their own replacement stock is replacement female cost. Replacement cost is driven by the replacement rate assigned to the herd. If the herd is maintaining herd size then replacement rate will equal cull rate, but if the herd is expanding then the replacement rate will be greater than the cull rate by the desired growth rate. Cost per head for replacement females is a weighted average of Missouri auction market data and reported market data for the Southern High Plains region from NASS. Replacement cost, *Cost_Purrepf*, is a function of price per head (*P_repf*), number of lactating cows (*CowsLact*), and replacement rate (*replace%*) during time period *t* (month):

$$Cost\_Purrepf_t = replace\% / 12 * P\_repf_t \, . \quad \textbf{(37)}$$

Milk hauling and promotion is deducted from a producers milk check and is based on the amount of milk sold. For this model the pounds of milk produced per cow per day is equivalent to milk shipped. Cost per cwt is representative of actual costs for milk hauling, promotion, and Kansas Dairy Commission deduction endured by producers in Kansas and is used to estimate cost for the Southern High Plains region. Milk hauling and promotion cost measured in dollars per cwt milk produced, *Cost_Haulprom*, is a function of milk production, *prod_day*, adjusted to a cwt basis and cost per cwt, *P_Haulprom* where subscript t represents time period, month:

$$Cost\_Haulprom_t = (prod\_day_t * daysmon)/100 * P\_Haulprom_t . \quad \textbf{(38)}$$

Livestock insurance is based on the rate of insurance on mature dairy cattle and the corresponding value per head. Weighted average price per head as used in purchase of replacement female cost, *P_repf*, is used less value lost from death loss to value mature dairy cattle for insurance purposes. As outlined in equation 39, this calculated cow value and monthly adjusted insurance rate, *lvins%*, determine livestock insurance cost per month, t:

$$Cost\_lvins_t = P\_repf_t(1 - death\%) * lvins\% / 12 . \quad \textbf{(39)}$$

Repairs on buildings and equipment can be derived as an estimate of actual farm data or as a percent of investment asset value. Investment asset value is the amount assigned to purchase value of all buildings and equipment. Repairs cost, *Cost_repairs*, is valued at 2.5 percent, *repairs%*, of initial investment asset value (*invest)*, this rate is divided by 12 to adjust to a monthly repairs on buildings and equipment cost for time period t (month):

$$Cost\_repairs_t = invest_t * repairs\% / 12 . \quad \textbf{(40)}$$

All other operating expenses are based on estimates derived from actual farm data and dairy enterprise budgets for 2009. These costs are adjusted to a monthly value and then back calculated to 1990 based on corresponding monthly indexes. Utilities cost uses a utility index, gas, fuel and oil uses a fuel index, and all other cost categories use a producer price paid (PPI) index. The utility index is published by the Bureau of Labor and Statistics, and the fuel and PPI are both representative of agriculture and published by NASS.

Other ownership costs associated with assets include depreciation, interest, insurance, and taxes. These costs are based on the investment asset value of buildings and equipment and land value. Land value is based on historical value per acre and number of acres required for a large dry lot dairy (footprint of dairy only).

Interest rates are based on agriculture interest rates announced by the Federal Reserve Bank in Kansas City. The interest rate represents Federal Reserve district 10 which includes the states of Kansas, Colorado, Oklahoma, and New Mexico. Quarterly rates were obtained for operating, intermediate, and real estate sectors and used to calculate interest. Real estate rate was used to calculate interest on buildings, intermediate rate for equipment, and a rent-to-own value to calculate interest on land. Depreciation is a function of initial value (*initialvalue*), salvage value (*salvage%*), and useful life (*life*):

$$Depreciation_t = ((initialvalue_t - (initialvalue_t * salvage\%)) / life) / 12 . \quad \textbf{(41)}$$

Subscript *t* for depreciation, interest, taxes, and interest represents time period, month. Interest is calculated using the same variables as in depreciation but multiplying average value of the asset type by the corresponding interest rate.

$$Interest_{c,t} = (initialvalue_t + (initialvalue_t * salvage\%) / 2) * intrate_t / 12 . \quad \textbf{(42)}$$

Insurance and taxes is calculated as a function of the investment value, *initialvalue,* and combined insurance, *ins%,* and tax, *tax%,* rate:

$$InsTax_t = initialvalue_t * (ins\% + tax\%) / 12 . \quad \textbf{(43)}$$

Interest cost on breeding livestock was calculated to measure the associated ownership cost. At time period *t*, the corresponding replacement female value, *P_repf*, less death loss, *death%,* value lost represents the investment value and the intermediate interest rate was used to calculate interest on livestock:

$$Int\_lvst_t = P\_repf_t * (1 - death\%) * int\_intmd_t / 12 . \quad \textbf{(43)}$$

Finally, interest was calculated on operating expenses to measure opportunity on monthly operating investment. It was assumed that expenses were incurred at the beginning of the month and revenue was received at the end of the month for a dairy operation. For time period *t* operating expenses, *cost_oprtg*, are multiplied by the operating interest rate, *int_oprtg*:

$$Int\_oprtg_t = \sum cost\_oprtg_t * int\_oprtg_t / 12 . \quad \textbf{(44)}$$

Total operating cost is the sum of feed, labor, replacement, other operating costs, and interest on livestock and operating expenses. Whereas total costs includes depreciation, insurance, taxes, and interest on land, buildings, and equipment.

5.3 Data Analysis

Aggregate calculations of sales and cost categories were completed for total revenue and total cost; these items were then used to calculate revenue over cost less operating and livestock interest. Income over feed cost was derived by deducting feed cost from milk income for each month, additionally a breakeven milk price was calculated. Monthly results are summarized by year from 1990 to 2011. Statistical analysis is built into the model to allow the user to view average, max, and min for all of the historical and projected years. In addition a selected average was included to allow the user to select years they desire to take an average from for all production, revenue, cost, and return categories.

Chapter 6 - Results

Estimated returns over total costs for large-scale dairy operations located in the Southern High Plains for the past 21 years (1990-2010) have been highly variable, and have been positive only 43 percent of the time on a monthly basis. Monthly net returns somewhat follow a normal distribution, but are slightly skewed to the right. Projected returns for 2011 are negative and below average returns for the 21 years (1990-2010) reviewed. Average monthly results for the most recent 21- and 5-year periods as well as for 2011 are included in Appendix D. Results for the historical model, 1990-2010, and the projected model, 2011, are reported in this chapter with aggregate results reported first followed by analysis on revenue and cost components.

6.1 Aggregate Results

Estimated returns over total costs for the Southern High Plains region have been positive for 108 of 252 months with negative annual returns in 13 of the 22 years reviewed. Figure 6-1 presents the annual returns which can be seen to be highly variable over time with the year-to-year change in returns ranging from $38 to $924. This model does not account for risk management pricing strategies with marketing of milk and feed commodities a producer may participate in (i.e., the model is based on cash sales and purchases). Utilizing futures or options markets (or other forward contracting strategies) would reduce the variability in the markets, but the expected returns would be similar if markets are efficient. Dairy operations incurred a loss per cow of $622 in 2009, but had a positive record return of $580 per cow just two years earlier (2007). The years of 2007 and 2004 proved to be good years for the dairy industry while in 2009, 2006, and 1997 operations were operating at a loss greater than $340 per cow. On an annual basis, operations received net returns above total cost in 10 years. Twelve years resulted in negative net return with revenue greater than operating costs; in 2009 dairy operations saw negative returns and were unable to cover operating expense (Figure 6-2). The projected model shows operations generating a loss of $4 per cow in 2011.

Figure 6-1 Annual Returns per Cow

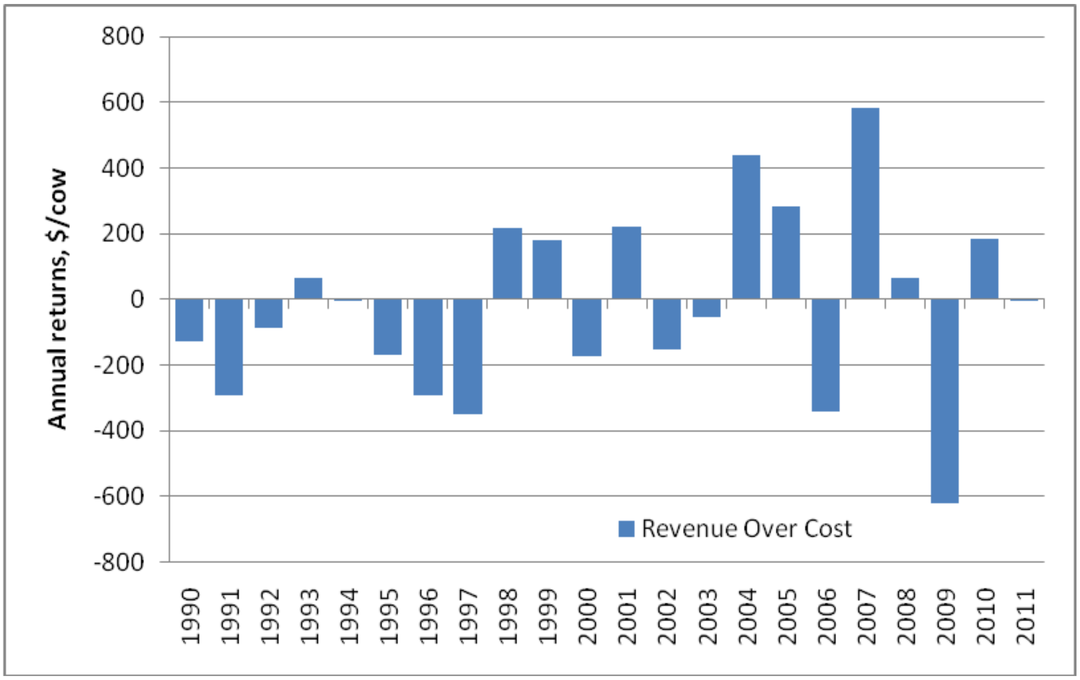
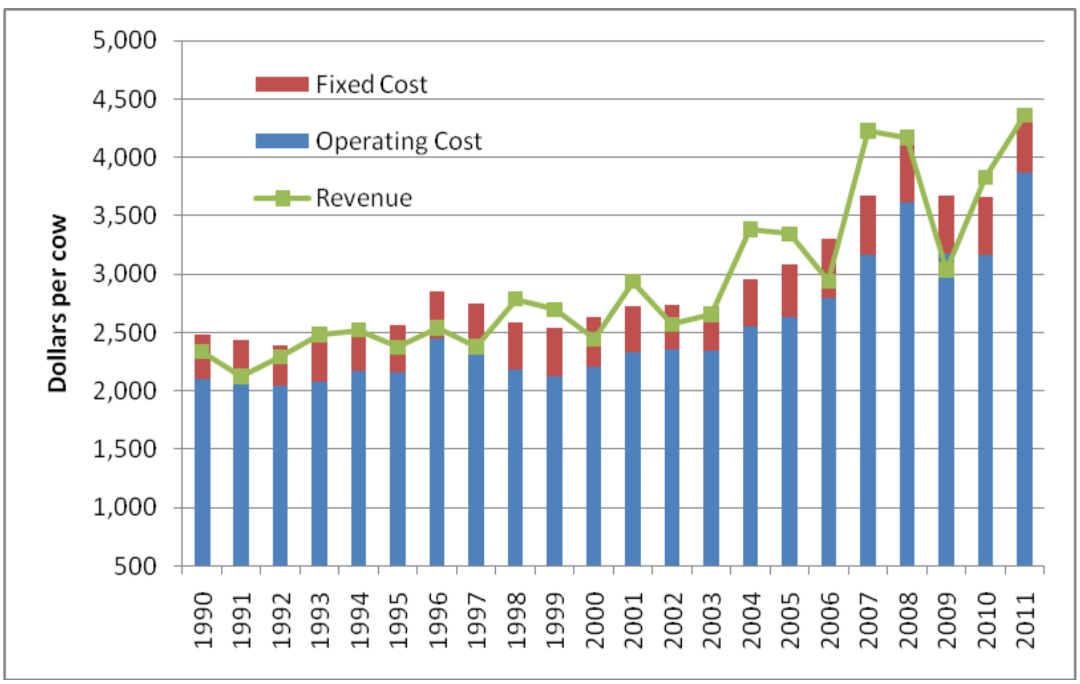


Figure 6-2 Annual Revenue and Cost per Cow



As displayed in Figure 6-3, over the past 21 years monthly net returns have ranged from -$87.70 to $92.52. The mean of monthly historical net returns is -$1.72 with a standard deviation of $30.46. The projected net returns for 2011 are negative with the average monthly return per cow at $0.33. In the long run, economic profit will be $0; and this model is representative of an operation above the average U.S. dairy operation, so above breakeven net returns are expected. Additionally, over time it is expected that net returns might actually be negative for an industry with over capacity leading to operations exiting and consolidation of the industry. Dairy operation monthly net returns somewhat follow a normal distribution as 77 percent of the months fall within +/- one standard deviation of the mean (i.e., -$31.71 to $29.21). However, as can be seen in Figure 6-4 the net returns are slightly skewed to the right. Fifty-seven percent of the months from 1990 to 2010 operations received negative returns over total costs while the remaining months had positive net returns. Of the months with positive net returns, 26 percent had returns between $0 and $25 per cow while 11 and 6 percent of the months were in the ranges of $25 to $50 and greater than $50 per cow, respectively.

Figure 6-3 Monthly Returns per Cow

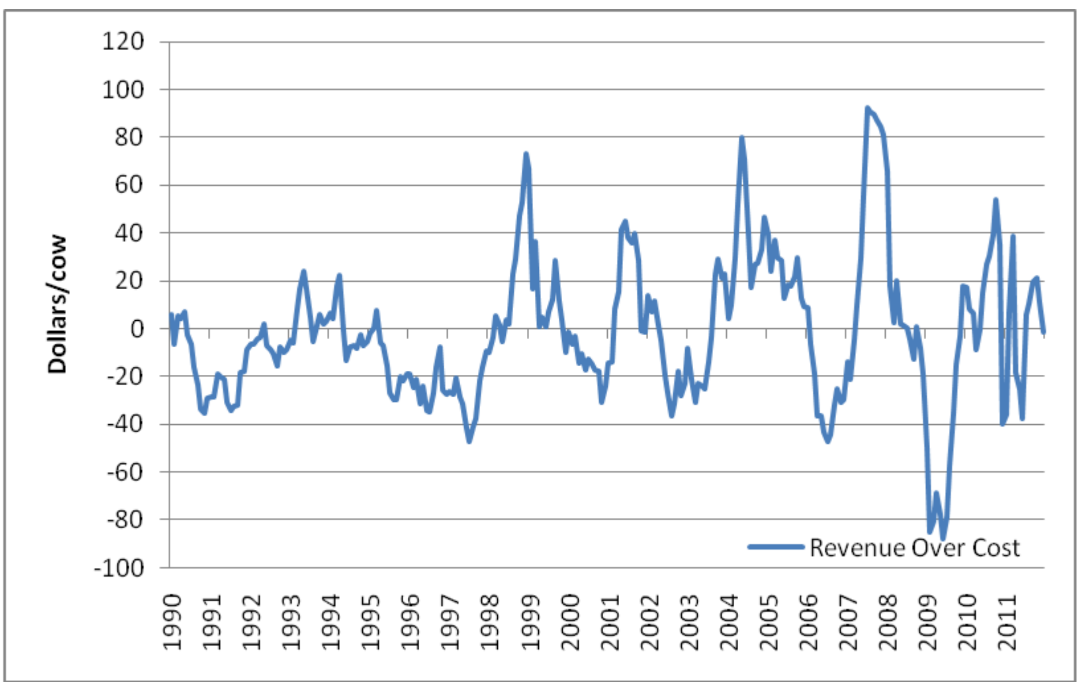
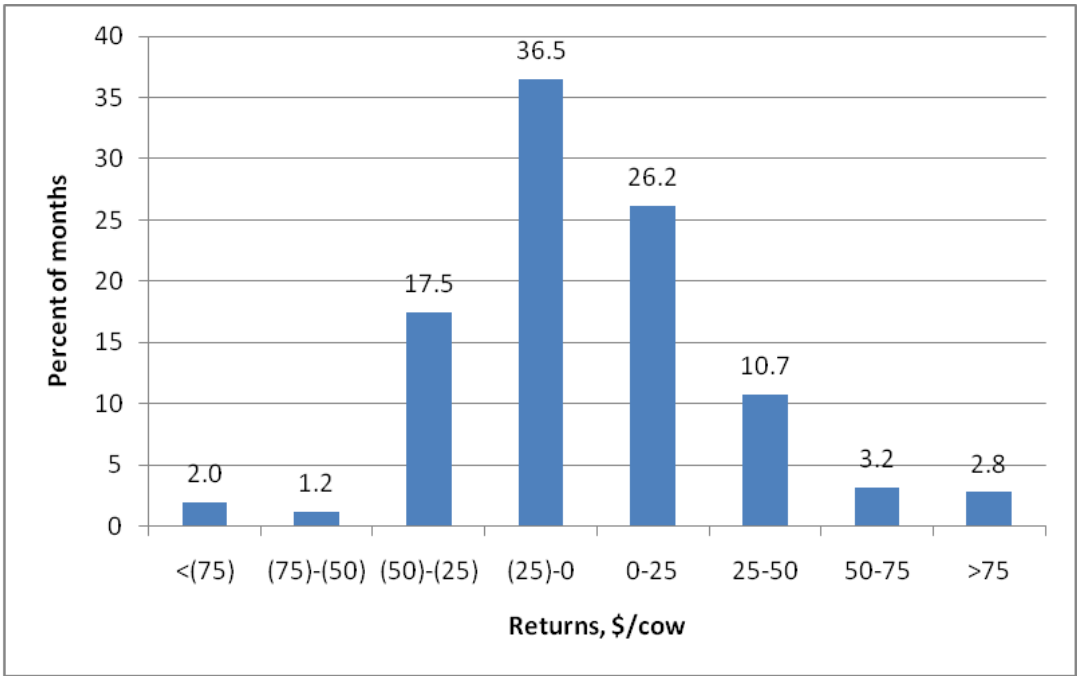
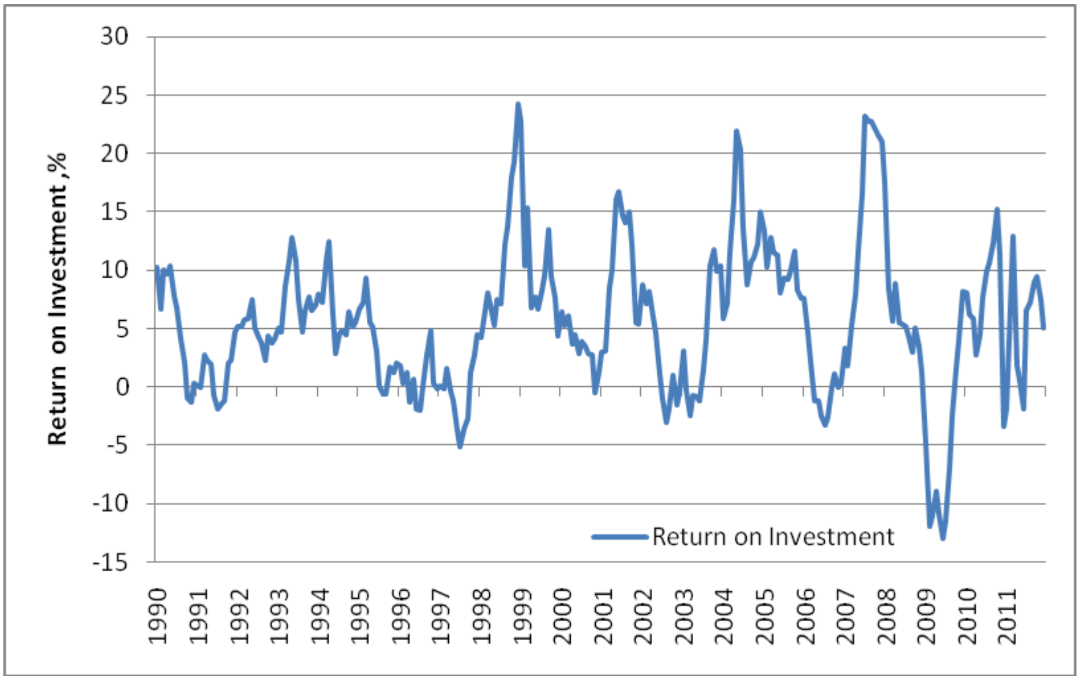


Figure 6-4 Distribution of Monthly Returns per Cow



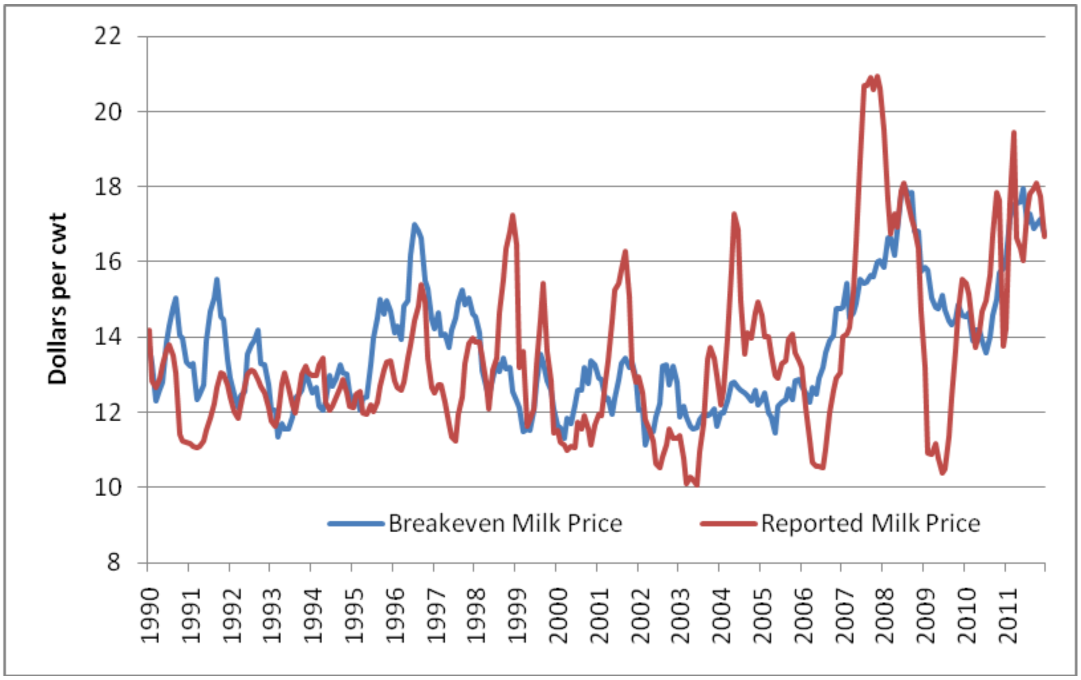
Return on investment on a per cow basis, equal to net returns plus interest divided by asset values (i.e., investment for livestock, machinery, buildings, and land), follows the net returns pattern over time. Except for 2009, when consecutive monthly net returns were below negative five percent**,** return on investment for dairy operations hs been above -5.0 percent with most months being positive. Figure 6-5 displays the return on investment on a per cow basis. The average monthly return on investment for the historical model is 5.55 percent with a standard deviation of 6.5 percent. On an annual basis, 2007 had the highest return on investment at 15.30 percent while two years later (2009) brought the lowest return at -5.62 percent. The projected return on investment in 2011 is 7.13 percent.

Figure 6-5 Monthly Return on Investment per Cow



Breakeven milk price was calculated for the historical model and, on average, the breakeven price in the past five years is higher than over the past 21 years. The 21-year average is $13.49 per cwt while the past five-year average is $14.99 per cwt. Historically, breakeven milk price has ranged from $11.12 to $18.07. Figure 6-6 shows the calculated breakeven price and the Southern High Plains region milk price over time. The breakeven milk price has a smaller range comparatively than milk price received, which results in considerable variability in milk returns. For 2011, the breakeven milk price is estimated to be $17.17 per cwt.

Figure 6-6 Milk Price, Breakeven vs. Southern High Plains



Net returns are comprised of revenue less costs, specific categories of revenue or costs can influence the level of returns obtained. An OLS regression was estimated to quantify the relationship between monthly net return, (*NetReturn*) per cow as a function of production (*prod_day)*, milk price (*P_milk)*, feed cost (*FeedCost_Month)*, replacement female cost (*P_repf)*, labor cost (*wage)*, and interest rate (*int_avg)*:

$$NetReturn = b + \beta_1 * prod\_day + \beta_2 * P\_milk + \beta_3 * P\_Corn + \beta_4 * P\_AlfHay + \beta_5 * P\_repf + \beta_6 * wage + \beta_7 * int\_avg. \quad \textbf{(46)}$$

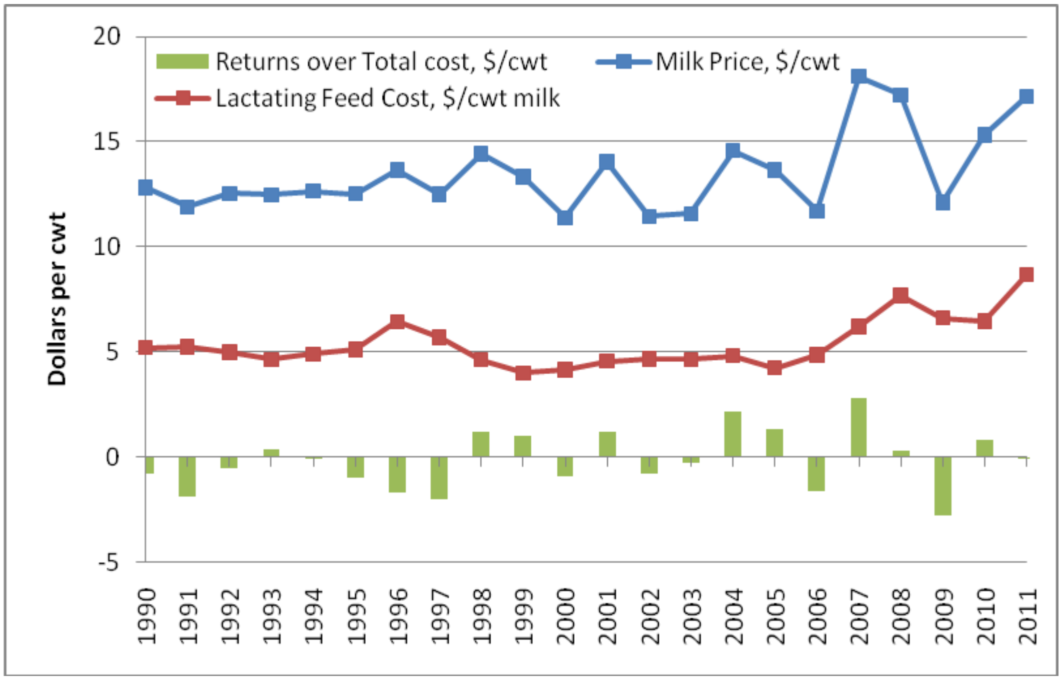
The model coefficients for estimating net return on independent variables are included in Table 6-1 where all variables except for replacement female value are significant at the one percent level. A one dollar change in milk price will decrease net returns by $15.84, a one dollar increase in corn price per bushel will decrease returns by $17.02, a one dollar increase in wage per hour will decrease returns by $6.39 and a one percent increase in average interest rate will decrease net returns by $3.77.

Table 6-1 Coefficients and Estimates for Net Returns

Characteristic	***Variable description***	***Coefficient***	***P-Value (P>|t|)***
B	Intercept	-169.34	<0.00001
prod_day	Production per cow per day	2.758	<0.00001
P_Milk	Calculated milk price for Southern High Plains region	15.840	<0.00001
P_Corn	Corn price per bushel	-17.020	<0.00001
P_AlfHay	Alfalfa hay price per ton	-0.336	<0.00001
P_repf	Price for replacement females	0.002	0.4675
Wage	Wage per hour for animal agriculture	-6.394	<0.00001
int_avg	Average agriculture interest rate for operating, intermediate, and real estate lending	-3.771	<0.00001
Observations = 264			
$R^2 = 0.969$			

Based on the regression on net returns results and revenue making up 90 percent of revenue and feed cost accounting for 40 percent of total cost, net returns are largely impacted by milk price and feed cost over time. Figure 6-7 displays annual net returns graphed against average milk price per cwt and average feed cost per cwt of milk produced for a lactating cow per year for 1990 through 2011. Feed cost per cwt milk produced ranges from $4 to $8 per cwt of milk produced. Milk price varies from $11 to $18 per cwt with more notable variations between consecutive years compared to feed cost. From the graph, it can be seen that when milk price increases and the margin between milk and feed cost widens, returns also increase.

Figure 6-7 Annual Net Returns vs. Milk Price vs. Feed Cost



Production is one revenue driver which the producer can control based on management protocols and practices. A sensitivity test is done on production level to measure change in revenue, cost, and net return over the past 21 years based on a 10 percent shock to milk production, results are displayed in Table 6-2. The shock on milk production only accounts for change in volume, but assumes prices are constant. Because milk production and component levels have a negative correlation prices might change slightly and thus values reported in Table 6-2 might be slightly overstated. As milk production increases (decreases) by 10 percent, milk sales and total revenue each increase (decrease) by approximately $20 per cow per month. However, as production increases (decreases), feed also increases by $5.03 (decreases by $3.31), and total cost increases by $9.20 (decrease by $4.69). After accounting for both revenue and costs, a ten percent increase (decrease) in milk production increases net returns by $14.50 (decrease by $13.88). Breakeven milk price ($13.49) increases when milk production decreases by $1.01 per cwt and decreases by $0.87 per cwt when production is 10 percent higher. This sensitivity analysis suggests that increasing milk production by 10 percent (six additional pounds of milk per day) has the potential to significantly increase returns. However, producers need to consider the costs (other than feed) that would be required to achieve this higher production.

Sensitivity analysis for 2011 is included in Table 6-3 where an increase (decrease) in production will increase (decrease) milk sales and total revenue by over $30. Additionally, as production increases (decrease) by 10 percent feed cost increases $13.53 (decreases by $12.25), total cost increases by $19.67 (decreases by $14.77), and net returns increase by $17.57 (decreases by $13.77). The affect of a 10 percent change in production has on revenue and cost is much greater for 2011 due to higher milk and commodity prices compared to the 21-year historical average. For the low and base production levels milk price breakeven was $17.97 and $17.17, respectively, but decreased to $16.34 at the high production level. We can conclude from the analysis that at expected levels of returns and costs for the projection year that it would be beneficial for producers to increase milk production as a six pound increase in milk production results in an increase of $13 in net returns per cow per month.

Table 6-2 Historical Milk Production Sensitivity Test, 1990-2010

	Production Level		
Variable	Low (90%)	Base (100%)	High (110%)
Milk production per day, lbs/cow	46.66	51.85	57.03
Milk sales, $/cwt	190.19	211.33	232.46
Total revenue, $/cow	219.73	238.30	261.99
Feed cost, $/cow	88.94	92.25	97.28
Total cost, $/cow	235.33	240.02	249.22
Net return, $/cow	-15.60	-1.72	12.78
Breakeven milk price, $/cwt	14.50	13.49	12.62

Table 6-3 Projected Milk Production Sensitivity Test, 2011

		Production Level	
Variable	Low (90%)	Standard (100%)	High (110%)
Milk production per day, lbs/cow	56.73	63.04	69.34
Milk sales, $/cwt	295.98	328.87	361.75
Total revenue, $/cow	334.83	363.36	400.61
Feed cost, $/cow	169.97	182.22	195.75
Total cost, $/cow	348.93	363.70	383.37
Net return, $/cow	-14.10	-0.33	17.24
Breakeven milk price, $/cwt	17.97	17.17	16.34

The profit model outlines returns on per cow basis based on calculated revenue and costs per month from January 1990 forward. Milk production has increased over the years; however milk price has varied and become more volatile in the past 10 years causing revenues to follow this trend. Except for 1996, feed cost and operating expenses showed minor changes across the historical time period until 2005 when both variables started a notable upward trend to 2008 where the costs leveled out to current levels. From the output it can be seen that a modern large-scale dairy operation in the Southern High Plains have endured variability in net returns with more months receiving negative returns. However, the last five years have shown great volatility as the year with highest net returns, 2007, was followed by the greatest loss per cow in 2009. From the projection model, dairy industry net returns are expected to be strong over the remainder of the 2011 with above average returns compared to historical analysis (1990 through 2010).

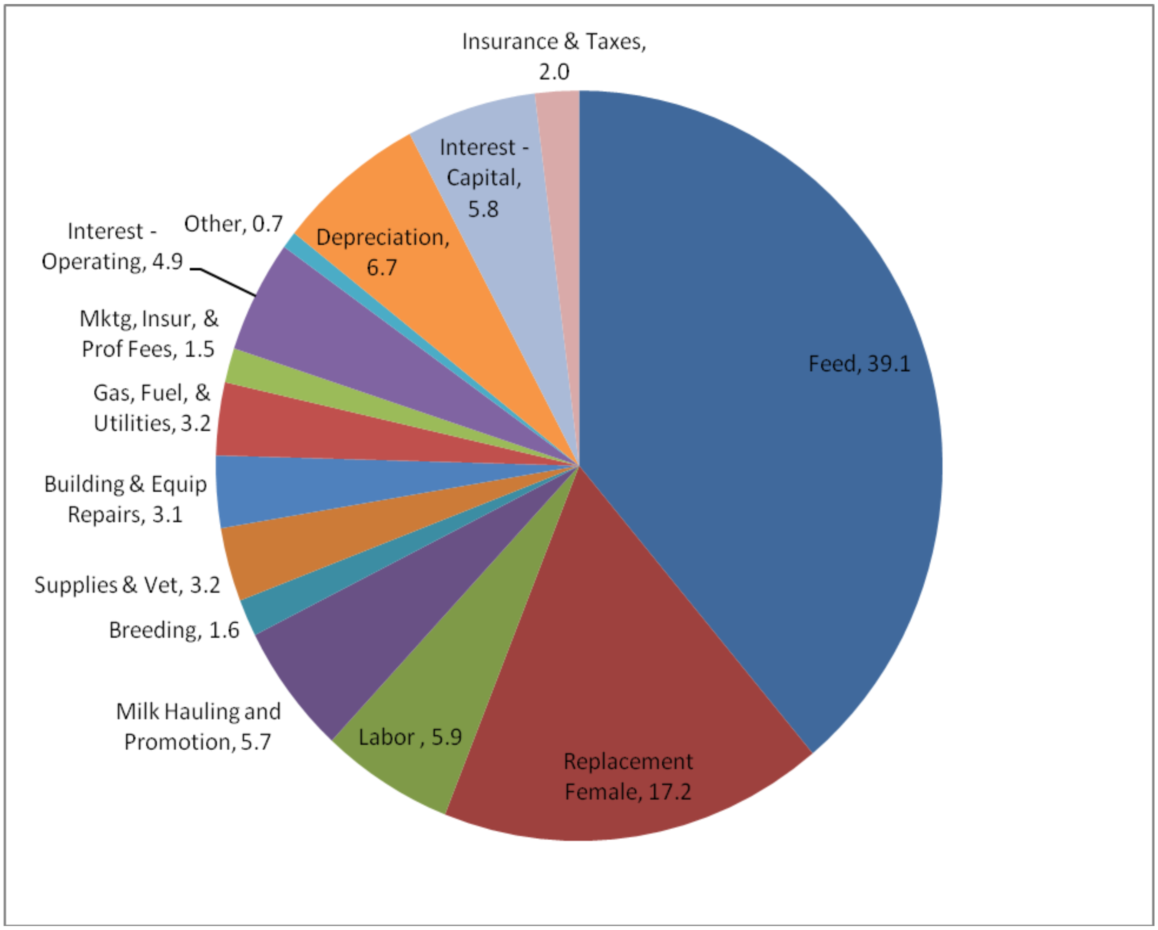
6.2 Revenue Analysis

As shown in Figure 6-2, revenue for a dairy operation is variable across time with the highest revenue recorded in 2008 and the lowest in 1991. Additionally, it can be seen from the above graphs that revenue is highly variable across time and between consecutive years. Revenue on a dairy operation is comprised of sales from milk, cull cows, and young stock. Over the 21 years analyzed, milk sales accounts for 88.8 percent of total revenue while cull cows, replacement heifers, and non-replacement calves make up 5.0, 4.6, and 1.6 of total revenue, respectively. Monthly total revenue averaged $238.30 per cow in the historical model with a range of $164.69 to $403.17. Milk sales averaged $211.33 per month with a range of $142.19 to $364.35. Milk sales are calculated from milk production and price; milk production average was 61.85 pounds per cow per day being sold at $13.33 per cwt for the historical time period. On a per cow basis, monthly revenue from cull cows, replacement heifer calf, and non-replacement calf sales were $11.93, $11.41, and $3.64, respectively. In the past five years, average revenue has been greater with total revenue at $303.28, over $75 greater than the 21-year average. The revenue generated from milk sales is $270.07 while cull cows, replacement heifer calves, and non-replacement bull calves generate $13.32, $15.24, and $4.65 per cow per month, respectively. In the projected model, production per cow is 63.04 pounds per cow being sold at $17.16 per cwt on average for 2011. Income from milk sales is estimated to be $328.87 bringing total revenue to $363.36 on average per month in the projection model. Revenue from milk sales is a key factor to total revenue and returns; therefore, milk production and milk price are key components a producer must manage to reduce risk.

6.3 Cost Analysis

Total cost has increased over time with an upward trend starting in 1995 and peaking in 2008, total costs decreased in 2009 and 2010, but are expected to exceed the historical high in 2011 (Figure 6-2). Feed, labor, and replacement females are the primary drivers behind cost on a dairy operation. Additional categories include, milk hauling and promotion, supplies and veterinary, repairs, depreciation, interest, and insurance and taxes which each make between 3.0 and 7.5 percent of total cost. As displayed in Figure 6-8 feed cost is 39 percent of total cost while replacement female purchases and labor cost are 17 and 6 percent, respectively. Depreciation and total interest each make up 6.6 and 10.7 percent of total cost, respectively.

Figure 6-8 Cost Categories as Percent of Total Cost



From 1990-2010 total cost is estimated to average of $240.02 per cow per month with a range of $189.40 to $366.45 and standard deviation of $41.36. The average lactating diet cost per cow per day is $3.20 and the average cost for dry cows is $2.15 per day. These costs result in an average monthly feed cost of $92.25 per cow. On average, a 2,500 lactating cow operation will purchase 71 replacement females per month at $1,503 per head resulting in an average monthly replacement female purchase cost of $42.57 per cow. Labor and milk hauling and promotion both are just under 7.0 percent of total cost and are $14.12 and $13.61 per cow, respectively. Fixed costs including depreciation, calculated on buildings and equipment, and interest, calculated on land, buildings, and equipment, were sizable factors in determining total cost at an average of $16.08 and $14.22 per cow per month, respectively. The other two categories which were above 3.0 percent of total cost were supplies and veterinary and repairs which each had cost per cow per month just above $7.50.

The most recent five-year average (2006-2010) for total cost is $305.52 per cow per month. Feed, replacement female purchase, labor, milk hauling and promotion, and repairs increase to $127.68, $45.27, $21.37, $16.92, $10.18, and $9.51, respectively. The fixed costs increase to $20.29 and $15.79 for depreciation and interest on capital investment, respectively. In the projection model, total cost increases to an average of $354.69 per month with feed taking a larger share of total cost at 49.8 percent and replacement female purchases taking a lower share at 10.0 percent. The remaining cost categories remained within 2.0 percent of the historical model. Relative to the 5-year average, feed cost per cow per day is expected to increase in 2011 to $6.49 ($2.02 increase) for the lactating diet and $3.44 ($0.65 increase) for the dry cow diet. The increased milk production and more complex diets bring the average cost per month for feed to $182.22 per cow in the projection model.

Feed cost is almost half of total cost for a dairy operation, and has increased in total dollars and percent of total cost over the past 21 years. Sensitivity analysis was done on total feed cost per cow per day by shocking feed commodity prices. Feed ingredient prices were shocked by 10 percent. Table 6-4 outlines the percent change in total feed cost for each feed commodity over the past 21 and 5 years and in 2011. When the price of corn (including corn silage due to direct calculation) increases 10 percent, total feed price increases by 3.58, 3.62, and 4.17 percent for the 21- and 5-year averages and 2011, respectively. Alfalfa hay impacted total feed cost by 2.67, 2.61, and 1.89 percent for the 21- and 5-year average and 2011 when price was increased 10 percent. When soybean meal price was increased by 10 percent, feed cost increased by 1.07, 1.22, and 1.18 percent for the 21- and 5-year averages and 2011. Although mineral is fed in trace amounts, the high price levels cause it to impact feed price by 1.02 (21-year average) to 1.32 (2011 average) when price increases by 10 percent. Other hay and cottonseed had less than a one percent affect on total feed price. Of the feed ingredients included in the rations, corn is the biggest driver of feed price with the largest impacts on feed price over time. When corn and DDG price affects are added together, DDG price is highly correlated with corn price, the affect on price change is approximately 4.5 percent for the 21-year average and 5.0 percent for the 2011 average.

Table 6-4 Feed Price Sensitivity Analysis, Impact of a 10 percent Price Increase

	Percent Change in Feed Cost per Cow per Day		
Feed commodity	21-year average	5-year average	2011 average
Corn	3.58	3.62	4.17
Alfalfa hay	2.67	2.61	1.89
Other hay	0.78	0.74	0.55
Dried Distillers Grains	0.88	0.67	0.80
Soybean meal	1.07	1.22	1.18
Whole cottonseed	0.00	0.00	0.09
Mineral	1.02	1.14	1.32

Total cost per cow has increased over time and feed cost has become a larger factor in determining total cost. The corn market is a driving factor behind feed cost due to its influence on both corn silage price and the DDG market. Other costs such as labor, replacement female purchases, and milk hauling and promotion are sizable portions of total cost in addition to fixed costs of depreciation and interest.

Chapter 7 - Conclusion

The dairy industry has changed over the past 21 years; on average operations have increased herd size and efficiency of production. Additionally, producers have faced increased volatility in commodity markets over the past 10 years causing returns to vary significantly as well. Due to the spatial change in the industry to the Western and Southern portions of the U.S. and the opportunity for low capital input cost facilities to enter into these areas, the historical and projected returns for a representative dairy in the Southern High Plains region was evaluated. The historical and projected profit model for this region were based on market, government, and actual farm data. This model shows that when revenue and costs are analyzed per month over the 1990 to 2010 time period, dairies were profitable 43 percent of the time on a per cow basis. When returns were aggregated to an annual basis, negative returns were greater than $300 in 2006 and 2009. When analyzing profits and costs, milk price and milk production are key drivers of explaining profit variability over time. Feed cost as a percentage of total cost has increased over time with other large input costs being replacement females, labor, milk hauling, depreciation, and interest on land, buildings, and equipment. The information in this thesis can help those in the dairy industry better understand and analyze price and returns over time as well as opportunities and viability of a dairy operation over the next 12 months. Furthermore, the projection model framework can be updated such that forecasts of net returns can be generated on a regular basis in the future.

7.1 Application of Prior Research

Several key factors have been drivers of change in the dairy industry over the past 21 years. Structurally, the dairy industry has shifted geographically to different regions of the country and at the same time average herd size has increased. Regional concentration has shifted to the West and Midwest (MacDonald et al.) due to land availability and profit driving factors (Peterson and Dhuyvetter.; Miller and Blayney.). Technical changes have occurred across the dairy operation with improved milk efficiency, improved reproduction management, and increased genetics. Economically, large farms, those with greater than 500 cows, can increase efficiency of scale where costs per cwt of milk decrease as herd size increases comparative to farms with less than 50 cows (MacDonald et al.). Additional location based studies have found that dairies relocate based on population density, unemployment rate, and environmental regulations (Herath et al.; Osei and Lakshminarayan). These reasons and the opportunity for dairies in the Southern High Plains due to arid climate, availability of land, and location from high population centers were drivers of focusing on this region for this study and the corresponding model developed.

Milk price is one of the key factors in calculating milk sales which ultimately drives total revenue and net returns. An analysis of milk pricing was done to understand the variability in milk price received across regions, impact of futures markets, and government policy. Fluid milk and associated prices are determined based on class and grade qualifications and class use in the manufacturing process. Producers receive a base price for milk based on formulas outlined in Chapter 2 with additional premiums and deductions for the makeup of the milk and a producer price differential based on location and class usage. Several policies have been enacted by government and the National Milk Producers Federation (NMPF) to help producers mitigate price risk in the fluid milk market. Programs which have taken measures to protect dairy prices over the past 21 years include the Cooperatives Working Together, NMPF program, Dairy Export Incentive Program, and Commodity Credit Corporation, both government and industry developed programs. Government policy with additional measures to protect margins, spread between milk price and commodity prices, are planned for the next farm bill.

Supporting the findings of this study, several profitability studies were reviewed that also found that milk production has a large impact on profitability. As expected, other leading factors of profitability for a dairy operation were milk price, feed commodity prices, and level of capital investment required.

Finally, other profit budgets and projection tools were analyzed from Kansas, Wisconsin, and Missouri. These tools further revealed the importance of milk price and production, feed ingredient prices, and interest rate on net returns. Additionally, these models outlined additional revenue and cost categories represented on a dairy operation and how opportunity costs can influence profitability. The models reviewed provided a basis for the historical and projection models built for the Southern High Plains region.

7.2 Application of Model

The primary objective of this thesis was to develop a framework/model that could be used to estimate historical monthly returns to dairy operations in the Southern High Plains region as well as to project monthly returns up to 12 months into the future. The historical model was developed to analyze price and return pattern change over time and to develop estimates for the projection model. The goal of the model is to gain insight to the level of opportunity for a large dairy in the Southern High Plains region in the short term. This insight of the viability of the dairy industry can be an important basis of information for producers, investors, and other key decision makers for the future of an operation.

7.3 Model Limitations

The two components of the model, historical and projected returns, are built to focus on only economic returns from a dairy operation. The model is based on a representative dairy in the Southern High Plains region with the focus on dry lot dairies milking over 2,000 cows. Additionally, the model is effectively based on the average herd in the Southern High Plains that primarily consists of the Holstein breed which is characterized as having a high production and average milk components. Therefore, this model is representative of a dairy focusing on high production and minimal capital input for facilities. These limitations of the model bring forth potential opportunities for future development of this model.

One key opportunity is to allow the model to adjust based on breed type. For example, the Jersey breed typically produces less milk that is much higher in components and thus receives a higher price per cwt. Additionally, because Jersey cows are smaller framed animals and require less feed operating costs per cow are generally lower; also due to their smaller frame calf and replacement female prices are typically lower than Holstein prices. An adjusted milk pricing model with price based on futures price of cheddar cheese, butter, nonfat dry milk, and whey to account for milk sold that is higher in components would likely be more appropriate for estimating revenues. Additionally, adjustments to allow production levels, feed rations, calf sale prices, and reproduction rates to vary would need to be included in the model in addition to the component pricing to allow for adjustment according to breed type.

Within the dairy industry and Southern High Plains, each dairy operation is unique. Operations can vary based on many factors including building structure, management goals, and outside variables. Thus, adjustments to model input values, both on the revenue and cost side, can be important to adjust the model for additional capital input cost of confinement housing. Additionally difference in management goals of minimal input cost or niche marketing revenue are just a few examples of how a dairy operation can deviate from the average revenue and returns calculated in this model. Finally, within the Southern High Plains region, environmental regulations, water availability, and location to feed vary across the region. Building in revenue and cost variability as outlined above would have the potential to increase the accuracy of the model for more individual- and site-specific situations.

To create a more financially accurate picture of cash flows, another potential modification to the model would be to allow the timing of revenues and expenses to vary by reallocating respective percent of totals and timing of revenue and costs. This will allow the model to accurately reflect actual farm data and real timing of cash inflow and outflow. Monthly allocation of revenue and costs per farm can be accomplished with a user driven index where percentages, totaling to 100 percent for 12 months, are entered to assign revenue and costs to different seasons or months of the year. Although production and projected prices contain some seasonality due to calculated indexes or basis values, assigning additional cost variability could be beneficial when assigning calf sales based on seasonal breeding, feed costs based on time of harvest or forward contracting, utilities, fuel, breeding, and repairs costs based on seasonal variables.

Finally, additional sensitivity analysis on milk prices, feed input costs, total investment required, or interest rates can be added to the model. This sensitivity analysis could allow a user to evaluate how associated changes will impact their revenue and costs in the short term and what these changes would have done historically.

The model outlined in Chapters 4 and 5 is a base model for a large-scale, commercial dairy on the Southern High Plains. In order to capture estimated returns and costs with the model, assumptions were made reflecting dry lot dairies located in the Southern High Plains and industry standards. These decisions create a fixed model based on estimated averages and normalities in the industry. The model was designed to capture profitability of large dry lot dairies based on data outlined in Chapter 4; additional modifications to the model outlined in this section can customize the model to a different structure or management type.

7.4 Summary

Dairy operations are continuing to increase in herd size and increase efficiency while facing increasing volatility in profitability. Due to several factors, operations have increased their presence in the Western and Southern Midwest regions. Although milk prices typically are lower in these areas, land availability, capital input required, and weather conditions have attracted large, dry lot dairies to these areas. The model developed shows that large scale commercial dairies have seen variability in returns over the past 21 years; however, there is opportunity to enter the market and receive positive net returns. Net returns are volatile from year to year and highly sensitive to milk production and feed costs. The projection model reveals a bleak outlook for the dairy industry over the next 12 months with below breakeven net returns being estimated. However, this model is conservative in measuring net returns due to estimating interest on operating costs, livestock, land, buildings, and equipment. Depending upon capital investment and debt load, an operation may not incur these costs and net returns will be higher than calculated in this model for that operation. Individual dairies with lower than average production and/or higher than average feed costs could also have considerably different results. This points to the importance of individual dairies knowing how they stand relative to industry averages.

Chapter 8 - References

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Appendix A - Abbreviations and References

Table A-1 Abbreviations and References

Abbreviation/Reference	Description
cwt	Hundredweight
lbs	Pounds
Milk shipped	Amount of milk shipped from the farm (milk produced less on farm use)
Milk produced	Amount of milk produced on the farm
Rolling herd average	Annual pounds of milk produced per cow
Cull rate	Percentage of cows removed from the heard per year
Springer heifer	Bred replacement heifer
Southern High Plains Region	Includes states of Colorado, Kansas, Oklahoma, Texas, and New Mexico
SCC	Somatic Cell Count
USDA	United States Department of Agriculture
NASS	National Agriculture Statistics Service
AMS	Agriculture Marketing Service
ERS	Economic Research Service
NMPF	National Milk Producers Federation
CWT	Cooperatives Working Together
MILC	Milk Income Loss Contract
FMMO	Federal Milk Marketing Order

Appendix B - Dairy Enterprise Budgets

Figure B-1 Wisconsin Proforma Calculator, Profitability Results

Name: E. X. Ample   City, State: Hometown, WI

A	B	C	D	F	H
Profitability Results	Base		2000	2001	2002
INCOMES Misc.	$10,000	Print Profit Results	**$9,000**	$8,000	**$7,000**
Milk Sales	$202,437		**$207,498**	$212,559	**$217,620**
Cull Cow Sales	$10,125		**$10,125**	$10,125	**$10,125**
Replacement Sales	$3,437		**$3,437**	$3,437	**$3,437**
Calf Sales	$1,496		**$1,496**	$1,496	**$1,496**
Crop Sales	$225		**$225**	$225	**$225**
Cash Income	$227,720		$231,781	$235,842	$239,903
Estimated change in the Inventory of Raised Breeding Livestock			$0	$0	$0
TOTAL INCOME	$227,720		**$231,781**	**$235,842**	**$239,903**
VARIABLE COSTS (Go to cell **K1** for help comparing your actual costs in the base year to these estimated base year costs.)					
Crop Expenses	$14,220	Print Inputs, Profit, Cash Flow, Ratios	**$14,647**	$15,086	**$15,539**
Custom Hire	$1,500		**$1,545**	$1,591	**$1,639**
Purchased Forage	$15,604		**$15,604**	$15,604	**$15,604**
Purchased Grain, Etc.	$30,747		**$32,521**	$34,296	**$36,071**
Fuel/Oil/Gas	$3,660		**$3,770**	$3,883	**$3,999**
Labor Hired	$10,628		**$10,960**	$11,293	**$11,625**
Purchased Replacements	$0		**$0**	$0	**$0**
Rent	$0		**$0**	$0	**$0**
Supplies	$7,155	Print All Four Risk & Sensitivity Pages	**$7,408**	$7,670	**$7,941**
Utilities	$5,190		**$5,423**	$5,665	**$5,917**
Vet & Med	$6,949		**$7,351**	$7,770	**$8,208**
Breeding Fees	$2,523		**$2,599**	$2,677	**$2,757**
Other Expenses	13,273.17		**$13,807**	$14,360	**$14,934**
---TOTAL-------			2000	2001	2002
VARIABLE COSTS	$111,449		**$115,634**	**$119,895**	**$124,234**

FIXED COSTS					
ITEM:	VALUE	% Charge			
LAND	$231,000		$231,000	$231,000	$231,000
Interest	$9,240	4.00%	**$9,240**	$9,240	**$9,240**
Property Tax	$4,620	2.00%	**$4,620**	$4,620	**$4,620**
Basic Liability Insurance	$2,888	1.25%	**$2,888**	$2,888	**$2,888**
BUILDINGS	$80,000		$76,000	$72,000	$68,000
Depreciation	$4,000	5.00%	**$4,000**	$4,000	**$4,000**
Interest	$6,400	8.00%	**$6,080**	$5,760	**$5,440**
Repairs, Insurance, Tax	$4,664	5.83%	**$4,431**	$4,198	**$3,964**
MACHINERY	$130,000		$139,000	$147,800	$156,200
Depreciation	$13,000	10.00%	**$15,200**	$17,600	**$20,200**
Interest	$10,400	8.00%	**$11,120**	$11,824	**$12,496**
Repairs, Insurance	$10,179	7.83%	**$10,884**	$11,573	**$12,230**
LIVESTOCK	$128,890		$128,890	$128,890	$128,890
Depreciation	$0	20.00%	**$0**	$0	**$0**
Interest-Lst & C. Assets	$11,111	8.00%	**$11,111**	$11,111	**$11,111**
Insurance-Lst & C.A.	$458	0.33%	**$458**	$458	**$458**
LABOR	$35,000		**$37,500**	$40,000	**$42,500**
MANAGEMENT	$0	0.00%	**$0**	$0	**$0**
(as a percent of the Total Income calculated above)			2000	2001	2002
---TOTAL-------			Total Fixed Costs	Total Fixed Costs	Total Fixed Costs
FIXED COSTS	$111,960		$117,532	$123,271	$129,148
TOTAL COSTS	$223,409		**$233,166**	**$243,166**	**$253,382**
RETURN OVER Variable Costs, Cash Costs, or Total Costs					
VARIABLE COSTS	$116,271		$116,147	$115,947	$115,669
CASH COSTS*	**$77,824**		**$79,210**	**$80,251**	**$80,944**
TOTAL COSTS	$4,311		($1,384)	($7,324)	($13,479)

* Excluding the cash cost portion of the fixed labor component.

Figure B-2 Wisconsin Proforma Calculator, Cash Flow Results

Cash Flow Summaries

	January	February	March	April	May	June	July	August	September	October	November	December	Total	
Base	Estimated family living draw this year				$35,000									
Income	18,895	17,461	18,826	18,635	19,161	18,857	19,263	19,593	19,347	19,800	18,598	19,283	$227,720	
Expenses	11,725	9,415	9,415	14,650	15,179	12,950	11,333	8,944	9,102	12,713	9,415	9,415	$134,258	
Interest	1,352	1,343	1,335	1,326	1,317	1,308	1,299	1,290	1,281	1,272	1,262	1,253	$15,638	
Debt Repayment	1,111	1,120	1,128	1,137	1,146	1,155	1,164	1,173	1,182	1,191	1,201	1,210	$13,919	
Family Living	2,500	5,000	2,500	2,500	2,500	2,500	2,500	3,750	2,500	2,500	2,500	3,750	$35,000	$28,905
Credit Needed this month	0	0	0	977	982	0	0	0	0	0	0	0		
Surplus Funds this month	2,207	582	4,448	0	0	944	2,967	4,436	5,282	2,123	4,219	3,655		$0
Net Line of Credit	(2207)	(2789)	(7237)	(6260)	(5279)	(6223)	(9190)	(13625)	(18907)	(21031)	(25250)	(28905)		
Number of purchased replacements required to maintain herd size. Adjust monthly cash flow on "Expenses" Tab.										Line of Credit Required	$ -			
Replacements Required	0.0	0.0	0.0	0.0	0.0	0.0	Print Cash Flow	0.0	0.0	0.0	0.0	0.0	0.0	
The cost of these replacements is considered an operating expense.														
2000	Estimated family living draw this year				$37,500									
Income	19,232	17,762	19,161	18,963	19,504	19,193	19,609	19,948	19,696	20,156	18,927	19,630	$231,781	
Expenses	12,010	9,700	9,700	15,149	15,694	13,465	11,731	9,339	9,502	13,221	9,700	9,700	$138,914	
Interest	1,188	1,179	1,170	1,161	1,152	1,143	1,134	1,125	1,115	1,106	1,096	1,087	$13,657	
Debt Repayment	1,136	1,145	1,154	1,163	1,172	1,181	1,190	1,200	1,209	1,218	1,228	1,238	$14,235	
Family Living	2,679	5,357	2,679	2,679	2,679	2,679	2,679	4,018	2,679	2,679	2,679	4,018	$37,500	$27,475
Credit Needed this month	0	0	0	1,189	1,193	0	0	0	0	0	0	0		
Surplus Funds this month	2,219	380	4,458	0	0	725	2,876	4,266	5,191	1,932	4,224	3,587		$0
Net Line of Credit	(2219)	(2599)	(7057)	(5868)	(4675)	(5400)	(8276)	(12542)	(17732)	(19665)	(23888)	(27475)		
Number of purchased replacements required to maintain herd size.										Line of Credit Required	$ -			
Replacements Required	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
The cost of these replacements is considered an operating expense.														
2001	Estimated family living draw this year				$40,000									
Income	19,569	18,063	19,497	19,291	19,848	19,529	19,955	20,302	20,044	20,513	19,256	19,976	$235,842	
Expenses	12,301	9,991	9,991	15,654	16,216	13,987	12,131	9,738	9,905	13,736	9,991	9,991	$143,631	
Interest	1,049	1,040	1,030	1,021	1,011	1,002	992	983	973	963	953	943	$11,960	
Debt Repayment	1,186	1,195	1,204	1,214	1,223	1,233	1,242	1,252	1,262	1,272	1,281	1,291	$14,855	
Family Living	2,857	5,714	2,857	2,857	2,857	2,857	2,857	4,286	2,857	2,857	2,857	4,286	$40,000	$25,396
Credit Needed this month	0	0	0	1,456	1,460	0	0	0	0	0	0	0		
Surplus Funds	2,177	123	4,414	0	0	450	2,732	4,044	5,047	1,685	4,174	3,465		$0
Net Line of Credit	(2177)	(2300)	(6714)	(5258)	(3798)	(4248)	(6980)	(11024)	(16071)	(17757)	(21930)	(25396)		
Number of purchased replacements required to maintain herd size.										Line of Credit Required	$ -			
Replacements Required	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
The cost of these replacements is considered an operating expense.													\	

Figure B-3 Kansas 2,400 Cow Dry Lot Budget, 2009

DAIRY ENTERPRISE — 2,400 LACTATING COWS – FREESTALL MF-2540
Kevin C. Dhuyvetter, Extension Agricultural Economist
John Smith and Mike Brouk, Extension Dairy Specialists and Joe Harner, Extension Agricultural Engineer

COST-RETURN PROJECTION — 2,400 LACTATING COW DRYLOT DAIRY
(REPLACEMENTS PURCHASED /1)

	Production level (lbs milk sold)				Your Farm
	19,000		23,500		
	per cow	per cwt	per cow	per cwt	
RETURNS PER COW					
1. Milk sales @ $16.32/cwt.	$3,100.58	$16.32	$3,834.93	$16.32	____
2. Volume premium	190.00	1.00	235.00	1.00	____
3. Government payment (MILC)	0.00	0.00	0.00	0.00	____
4. Calves sold: 95% x $199/head	188.87	0.99	188.87	0.80	____
5. Cull cows sold: 1,350 lbs x 28.0% x $47.51/cwt.	179.59	0.95	179.59	0.76	____
6. Manure credit	-12.31	-0.06	-16.06	-0.07	____
A. GROSS RETURNS	$3,646.73	$19.19	$4,422.33	$18.82	____
COSTS PER COW:					
7. Feed	$1,572.89	$8.28	$1,785.94	$7.60	____
8. Labor	295.17	1.55	295.17	1.26	____
9. Supplies, drugs, and veterinary	130.00	0.68	140.00	0.60	____
10. Somatotropin (rbST)	0.00	0.00	82.93	0.35	____
11. Utilities and water	114.17	0.60	116.99	0.50	____
12. Fuel, oil, and auto expense	75.60	0.40	75.60	0.32	____
13. Milk hauling and promotion costs	209.00	1.10	258.50	1.10	____
14. Building and equipment repairs	91.25	0.48	91.25	0.39	____
15. Breeding/genetic charge:					
a. Capital replacement: 34% x $1370/head	465.80	2.45	465.80	1.98	____
b. Semen, A.I. services, and supplies	42.00	0.22	52.50	0.22	____
c. Interest	102.75	0.54	102.75	0.44	____
d. Insurance	13.70	0.07	13.70	0.06	____
16. Professional fees (legal, accounting, etc.)	12.71	0.07	12.71	0.05	____
17. Miscellaneous	17.66	0.09	22.66	0.10	____
18. Depreciation on buildings and equipment	195.43	1.03	195.43	0.83	____
19. Interest on land, buildings, and equipment	164.76	0.87	164.76	0.70	____
20. Insurance and taxes on land, buildings and equip.	57.29	0.30	57.29	0.24	____
B. SUB TOTAL	$3,560.18	$18.74	$3,933.98	$16.74	____
21. Interest on 1/2 operating costs @ 7.5%	90.84	0.48	103.00	0.44	____
C. TOTAL COSTS PER COW	$3,651.02	$19.22	$4,036.99	$17.18	____
D. RETURNS OVER TOTAL COSTS (A - C)	-$4.30	-$0.02	$385.34	$1.64	____
E. BREAKEVEN MILK PRICE, $/cwt:		$16.34		$14.68	____
22. Lactating cow feed cost, $/head/day	$4.56		$5.24		
23. Dry cow feed cost, $/head/day	$1.94		$1.94		
F. ASSET TURNOVER (A/Assets) /2	72.0%		87.3%		____
G. NET RETURN ON ASSETS					
((D + 15c + 19 + 21)/Assets) /2	6.99%		14.92%		____

/1 For cost of raising replacement heifers see MF-399.

/2 Assets equal total value of breeding herd and land, buildings, and equipment.

Figure B-4 Wisconsin Enterprise Budget Plan, User Entry

Wisconsin Dairy Enterprise Planning Budget for 2008				UW Extension	
Enter your values in the yellow cells					
Budget Inputs					
				Ownership Costs:	
Prices					
				Facilities	**Equipment**
Milk	$ 18.00	per cwt	Depreciation (Life in year	30	10
Purchased cow	$ 2,500.00	per head	Repairs (%)	5	5
Calf	$ 300.00	per head	Taxes (%)	1.5	0
Cull cow	$ 500.00	per head	Insurance (%)	0.5	0.5
Forage	$ 130.00	ton	Labor	$ 10.00	per hour
Corn	$ 6.50	bu	Management Fee	5.00	%
Soybean Meal	$ 0.12	lbs			
Dical	$ 0.13	lbs			
T.M. salt	$ 0.10	lbs	Herd Size	400	cows
Production Factors			Parlor: Double –	8	
Pounds of Milk Per Cow/Year	24,000	lbs			
Calves Per Cow/Year	0.84	head			
Percent Cows Culled Annually	33	%			
Death Loss Rate for Cows	2	%			
Livestock Costs:					
Milk Hauling	$ 0.40	per cwt			
Bedding	$ 55.00	per cow			
Vet & Medicine	$ 90.00	per cow			
Breeding Costs	$ 35.00	per cow			
Utilities, Power, & Fuel	$ 75.00	per cow			
Supplies	$ 85.00	per cow			
Marketing & Other Costs	$ 90.00	per cow			

Developed by Bruce L. Jones, Department of Agricultural and Applied Economics and Center for Dairy Profitability, University of Wisconsin-Madison and Ken Barnett, University of Wisconsin-Extension and Center for Dairy Profitability

Figure B-5 Wisconsin Enterprise Budget Plan, Results

Wisconsin Dairy Enterprise Planning Budget for 2008					
Enter values in the yellow cells					
	Quantity	Unit	Unit Value	Total per Cow	Total per cwt
Gross Returns from Milk:	240	cwt	$ 18.00	$ 4,320.00	$ 18.00
Feed Costs:					
Forage	6.35	ton	$ 130.00	$ 825.50	$ 3.44
Corn	124.00	bu	$ 6.50	$ 806.00	$ 3.36
Soybean Meal	2000.00	lbs	$ 0.12	$ 240.00	$ 1.00
Dical	195.00	lbs	$ 0.13	$ 25.35	$ 0.11
T.M. Salt	95.00	lbs	$ 0.10	$ 9.50	$ 0.04
Total Feed Costs				$ 1,906.35	$ 7.94
Livestock Costs:					
Milk Hauling	1	cwt	$0.40	$ 96.00	$ 0.40
Bedding	1	cow	$55.00	$ 55.00	$ 0.23
Vet & Medicine	1	cow	$90.00	$ 90.00	$ 0.38
Breeding Costs	1	cow	$35.00	$ 35.00	$ 0.15
Utilities, Power, & Fuel	1	cow	$75.00	$ 75.00	$ 0.31
Supplies	1	cow	$85.00	$ 85.00	$ 0.35
Marketing & Other Costs	1	cow	$90.00	$ 90.00	$ 0.38
Total Livestock Costs				$ 526.00	$ 2.19
Cow Ownership Costs (Net of Calf Sales):					
Purch. Replacement Cow	0.33	head	$ 2,500.00	$ 825.00	$ 3.44
Less: Sale of Cull Cow	0.33	head	$ 500.00	-$ 165.00	-$ 0.69
Death Loss Replacement	0.02	head	$ 2,500.00	$ 50.00	$ 0.21
Less: Sale of Calf	0.84	head	$ 300.00	-$ 252.00	-$ 1.05
Total Depreciation & Death Loss				$ 458.00	$ 1.91
Labor & Management Costs:					

Figure B-6 Missouri 3,000 Cow Enterprise Cash Flow, Annual Results

3,000-Cow Dairy Model Projected Cashflow Statement

	Year 1 2006	Year 2 2007	Year 3 2008	Year 4 2009	Year 5 2010	5-Year Average
CASH INFLOWS						
Farm cash receipts						
Milk sales	$9,622,663	$10,023,810	$10,390,124	$9,474,153	$9,474,153	$9,796,980
Livestock sales	$1,249,520	$1,249,521	$1,249,520	$1,249,520	$1,249,520	$1,249,520
Crop sales	$0	$0	$0	$0	$0	$0
Government payments	$0	$0	$0	$0	$0	$0
Other farm income	$0	$0	$0	$0	$0	$0
Patronage dividends	$0	$0	$0	$0	$0	$0
Sale of assets:						
Machinery	$0	$0	$0	$0	$0	$0
Real estate	$0	$0	$0	$0	$0	$0
Other	$0	$0	$0	$0	$0	$0
Money borrowed	$0	$0	$0	$0	$0	$0
TOTAL	$10,872,183	$11,273,331	$11,639,644	$10,723,673	$10,723,673	$11,046,501
CASH OUTFLOWS						
Cash farm expenses						
Seed expenses	$0	$0	$0	$0	$0	$0
Fertilizer and chemicals	$0	$0	$0	$0	$0	$0
Purchased feedstuffs	$3,776,354	$3,776,354	$3,776,354	$3,776,354	$3,776,354	$3,776,354
Labor (includes benefits & SS)	$1,023,149	$1,048,727	$1,074,946	$1,101,819	$1,129,365	$1,075,601
Marketing 1/	$545,284	$568,016	$588,774	$596,521	$596,521	$579,023
DHI testing	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000
Artificial insemination	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000
Veterinary, hoof trimming & BST	$589,200	$589,200	$589,200	$589,200	$589,200	$589,200
Medicine	$0	$0	$0	$0	$0	$0
Farm supplies	$184,300	$188,908	$193,630	$198,471	$203,433	$193,748
Fuel & oil	$70,300	$70,300	$70,300	$70,300	$70,300	$70,300
Utilities	$180,000	$184,500	$189,113	$193,840	$198,686	$189,228
Repairs--Buildings	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000
Repairs--Machinery & equipment	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000
Rent	$0	$0	$0	$0	$0	$0
Farm taxes (R.E. & personal prop)	$45,000	$46,125	$47,278	$48,460	$49,672	$47,307
Farm insurance	$45,000	$46,125	$47,278	$48,460	$49,672	$47,307
Interest	$0	$0	$0	$0	$0	$0
Legal & professional fees	$20,000	$20,500	$21,013	$21,538	$22,076	$21,025
Custom hire	$80,000	$82,000	$84,050	$86,151	$88,305	$84,101
Car and truck costs	$10,500	$10,500	$10,500	$10,500	$10,500	$10,500
Contract heifer rearing	$0	$0	$0	$0	$0	$0
Other expenses	$0	$0	$0	$0	$0	$0
Miscellaneous	$101,686	$102,619	$103,537	$104,274	$104,911	$103,405
Total Cash Farm Expenses	$6,880,773	$6,943,873	$7,005,971	$7,055,888	$7,098,994	$6,997,100
Capital purchases:						
Breeding livestock	$2,099,998	$2,100,004	$2,100,000	$2,100,000	$2,100,000	$2,100,000
Machinery & equipment	$0	$0	$0	$0	$0	$0
Buildings & land	$0	$0	$0	$0	$0	$0
Principal payments	$0	$0	$0	$0	$0	$0
Family living expenses	$0	$0	$0	$0	$0	$0
Personal draw	$0	$0	$0	$0	$0	$0
State & Fed income & SE taxes	$0	$0	$0	$0	$0	$0
Other	$0	$0	$0	$0	$0	$0
TOTAL	$8,980,771	$9,043,877	$9,105,971	$9,155,888	$9,198,994	$9,097,100
NET CASH FLOW	$1,891,412	$2,229,454	$2,533,673	$1,567,784	$1,524,679	$1,949,400
1/ Includes milk hauling, state and federal promotion, coop/marketing fees, and the cost of marketing beef.						

Figure B-7 Missouri Enterprise Cash Flow, 5-year Average Results

3,000-Cow Dairy Model Projected Dairy Enterprise Budget (5-year Avg.)

	Herd	Per Cow	Per CWT	Percent
INCOME FROM OPERATIONS:				
Milk sales	$9,796,980	$3,266	$14.38	93.6%
Sales of youngstock & calves	$664,520	$222	$0.98	6.4%
Other farm income	$0	$0	$0.00	0.0%
Patronage dividend	$0	$0	$0.00	0.0%
Total Gross Receipts	$10,461,501	$3,487	$15.36	100.0%
OPERATING EXPENSES:				
Feed:				
Feedstuffs	$3,776,354	$1,259	$5.54	42.2%
Less feed for heifers	$0	$0	$0.00	0.0%
Total feed	$3,776,354	$1,259	$5.54	42.2%
Herd replacement costs:				
Depreciation--dairy cows	$866,250	$289	$1.27	9.7%
Loss on sale of cows	$465,000	$155	$0.68	5.2%
Total herd replacement costs	$1,331,251	$444	$1.95	14.9%
Other operating expenses:				
Labor (includes benefits & SS)	$1,075,601	$359	$1.58	12.0%
Marketing 1/	$579,023	$193	$0.85	6.5%
DHI testing	$45,000	$15	$0.07	0.5%
Artificial insemination	$75,000	$25	$0.11	0.8%
Veterinary	$589,200	$196	$0.86	6.6%
Medicine	$0	$0	$0.00	0.0%
Supplies	$193,748	$65	$0.28	2.2%
Fuel & oil	$70,300	$23	$0.10	0.8%
Utilities	$189,228	$63	$0.28	2.1%
Repairs--Buildings	$45,000	$15	$0.07	0.5%
Repairs--Machinery & equipment	$45,000	$15	$0.07	0.5%
Rent	$0	$0	$0.00	0.0%
Farm taxes (R.E. & personal prop)	$47,307	$16	$0.07	0.5%
Farm insurance	$47,307	$16	$0.07	0.5%
Legal & professional fees	$21,025	$7	$0.03	0.2%
Custom hire	$84,101	$28	$0.12	0.9%
Car and truck costs	$10,500	$4	$0.02	0.1%
Other	$0	$0	$0.00	0.0%
Interest	$0	$0	$0.00	0.0%
Depreciation	$728,000	$243	$1.07	8.1%
Less other expenses for raising heifers	$0	$0	$0.00	0.0%
Total other operating expenses	$3,845,341	$1,282	$5.64	43.0%
TOTAL OPERATING EXPENSES	$8,952,945	$2,984	$13.14	100.0%
NET INCOME FROM OPERATIONS	$1,508,556	$503	$2.21	

1/ Includes milk hauling, state and federal promotion, coop/marketing fees, and the cost of marketing beef.

Appendix C - Feed Cost Data

Feed Rations

Table C-1 Pounds of Feed Fed, As Fed Basis

MILK PRODUCTION	***FEED INGREDIENT, LBS/COW/DAY AS FED***								***AS FED TOTAL***
LBS/COW /DAY	CORN SILAGE	ALFALFA HAY	HAY-OTHER (GRASS)	CORN	DDG	SOYBEAN MEAL	WHOLE COTTON - SEED	MINERAL	LBS/COW /DAY
< 60	55	11	0	7	4.5	3	0	1.2	81.7
60-65	60	11	0	7.5	4.5	3.5	0	1.3	87.8
66-70	63	11.5	0	8	4.5	4	0	1.4	92.4
71-75	63	12	0	8	5	4.3	0	1.5	93.8
76-80	63	12	0	9	5	4.5	2.5	1.6	97.6
> 80	58	11	0	10	4.5	4.5	4.5	1.7	94.2
DRY	15	0	28	2	2.5	0	0	1	48.5

Table C-2 Pounds of Feed Fed, DM Basis

MILK PRODUCTION	***FEED INGREDIENT, LBS/COW/DAY DRY MATTER BASIS***								***DM TOTAL***
LBS/COW /DAY	CORN SILAGE	ALFALFA HAY	HAY-OTHER (GRASS)	CORN	DDG	SOYBEAN MEAL	WHOLE COTTON - SEED	MINERAL	LBS/COW /DAY
< 60	19.50	9.35	0.00	6.16	4.05	2.70	0.00	1.14	42.65
60-65	21.00	9.35	0.00	6.60	4.05	3.15	0.00	1.24	45.39
66-70	22.05	9.78	0.00	7.04	4.05	3.60	0.00	1.33	47.85
71-75	22.05	10.20	0.00	7.04	4.50	3.83	0.00	1.43	49.04
76-80	22.05	10.20	0.00	7.92	4.50	4.05	2.25	1.52	52.49
> 80	20.30	9.35	0.00	8.80	4.05	4.05	4.05	1.62	52.22
DRY	5.25	0.00	23.80	1.76	2.25	0.00	0.00	0.95	34.01

Appendix D - Model Results

Table D-1 Profit Model Estimates, Month Averages

	Average Value per Cow, $ per Month		
Variable	21-Year	5-Year	2011
REVENUE:			
Milk sales	211.33	270.07	328.87
Cull cow sales	11.93	13.32	19.35
Replacement heifer calf sales	11.41	15.24	8.55
Non-replacement calf sales	3.64	4.65	6.58
Total revenue	238.30	303.28	363.36
COSTS:			
Feed cost	92.25	127.68	182.22
Replacement female purchase	42.57	45.27	35.35
Labor	14.12	21.37	23.34
Milk hauling and promotion	13.61	16.92	19.97
Supplies, drug, and veterinary	7.66	10.18	11.70
Breeding and genetics	3.86	5.13	5.89
Gas, fuel, and oil	3.04	5.32	7.45
Insurance, livestock	1.18	1.25	1.67
Marketing	1.77	2.35	2.70
Professional fees	0.64	0.85	0.98
Repairs, building and equipment	7.54	9.51	10.16
Utilities and water	4.43	5.45	5.86
Other	1.77	2.35	2.70
Depreciation	16.08	20.29	21.67
Interest, breeding stock	10.53	9.84	11.02
Interest, operating expense	1.40	1.60	1.77
Interest, land, buildings, and equipment	14.22	15.79	14.62
Taxes and insurance, land, buildings, and equipment	4.74	5.99	6.40
Total costs	240.02	305.52	363.70
NET RETURNS	-1.72	-2.24	-0.33