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Economic Impacts of Alternative Sized Dairies in South Dakota

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ECONOMIC IMPACTS OF ALTERNATIVE SIZED DAIRIES IN SOUTH DAKOTA

BY

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This thesis is approved as a creditable and independent investigation by a candidate for the Master of Science degree and is acceptable for meeting the thesis requirements for this degree. Acceptance of this does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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ABSTRACT

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South Dakota dairy production is declining in terms of number of dairy farms, number of dairy cows, and volume of milk production. To reverse the decline, state policy makers and local action groups have worked to encourage dairy development, which has emerged primarily in South Dakota's Interstate-29 (I-29) corridor. The milk production industry is trending towards larger units leading to a struggle between producers, local policy makers, and residents regarding locating larger dairy operations in eastern South Dakota. Therefore, it is important to know the economic impact of the dairy industry within South Dakota so informed decisions regarding the future of dairy within the state are made.

Separate production functions were developed for a "representative" 150 head dairy farm and 1000 head dairy farm in eastern South Dakota from farm data collected from both primary and secondary sources. The IMPLAN, Input-Output Model for Planning, was used to evaluate dairy expansion and contraction scenarios for a local, six-county study area as well as the state of South Dakota.

The economic impact of both the 150 head and 1000 head dairy model was positive. The 1000 head dairy generally had higher multipliers resulting from increased feed and wholesale purchases. The 150 head dairy model, which internalized the production of feedstuffs, demonstrated higher value-added multipliers than the 1000 head dairy model.

Output, employment, and value-added multipliers were developed for the cheese manufacturing industry, a forward linked industry of dairy production, to determine the impact of a hypothetical increase in cheese production associated with an increase in dairy production. The cheese manufacturing multipliers were higher than that of either dairy model, suggesting the need to maintain a certain level of dairy production within the state, which will in turn maintain processing capacity.

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

LIST OF APPENDIX TABLES

Page

Chapter 1

Introduction and Background

1.1 Introduction

South Dakota dairy production is declining in terms of number of dairy farms, number of dairy cows, and volume of milk production. To reverse the decline, state policy makers and local action groups have worked to encourage dairy development, which has emerged primarily in South Dakota's Interstate-29 (I-29) corridor. The milk production industry is trending towards larger units leading to a struggle between producers, local policy makers, and residents regarding locating larger dairy operations in the local area. Decisions in the I-29 corridor of eastern South Dakota will need to be factually based on the environmental, social, and economic consequences of dairy development. This research will focus on the regional economic impact of a shift from smaller to larger sized dairy operations.

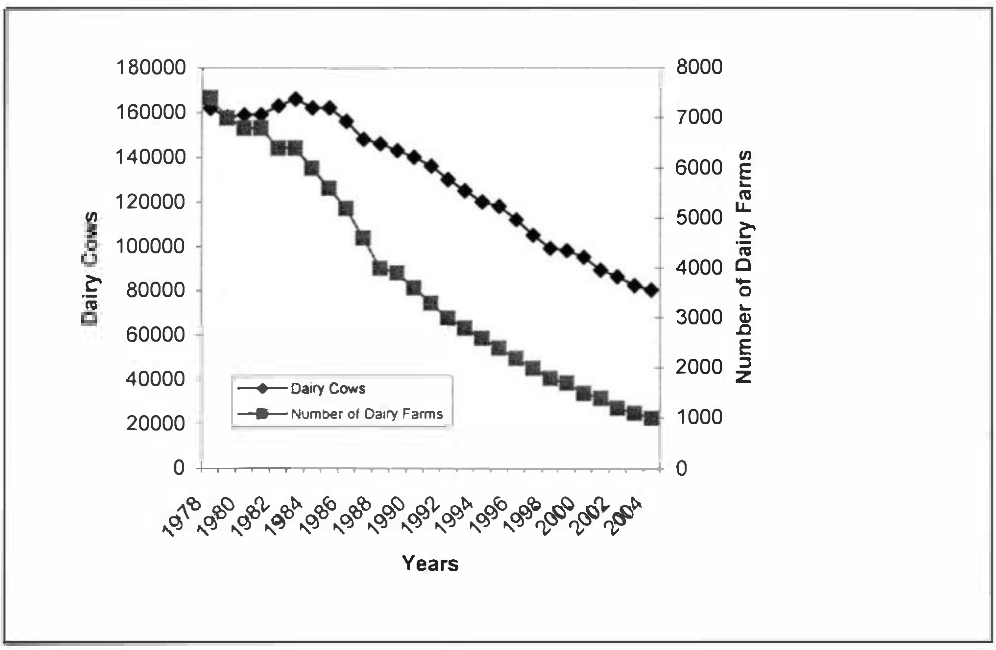
1.2 Dairy Structure Overview

The structure of milk production is changing for U.S. and South Dakota dairy producers. This section describes the changes in some key features of milk production including the number and size of dairy operations, location of dairy operations, and dairy production costs.

1.2.1 Number and Size of Dairy Operations

The total number of dairy cows in the U.S. and South Dakota has declined steadily over the past 30 years. The average number of dairy cows in the U.S. fell from 11.1 million in 1975 to 9.2 million in 2000, an 18 percent decline. (Blayney) The number of dairy cows in South Dakota declined from 174,000 to 95,000 cows, a 45 percent decline, over the same period. The number of dairy cows in South Dakota declined 88 percent from an all-time high of 675,000 cows in 1934 to the 2004 level of 79,000. (NASS)

The number of U.S. and South Dakota dairy operations has declined as well. In 1990, the U.S. had an estimated 192,660 dairy operations. By 2003, total U. S. dairy operations were estimated at 86, 310. Figure 1.1 illustrates an 86 percent decline in the total number of dairy operations in South Dakota dropping from 7400 farms in 1978 to the present level (2005) of 1000.



Source: S.D. Agricultural Statistics, Annual Bulletin 1978-2004
Figure 1.1: Number of South Dakota Dairy Cows and Dairy Farms (1978-2004)

Dairy operations became larger as total operation numbers fell. In 1992, the average U.S. dairy herd size was 57 cows. In 1997, the average herd size increased to 75 cows and is estimated at 105 cows for 2003. In 2003, U.S. dairy farms of 500 cows or more accounted for 3.4 percent of dairy operations, 40.7 percent of the total dairy cow inventory and 45.7 percent of the total production.

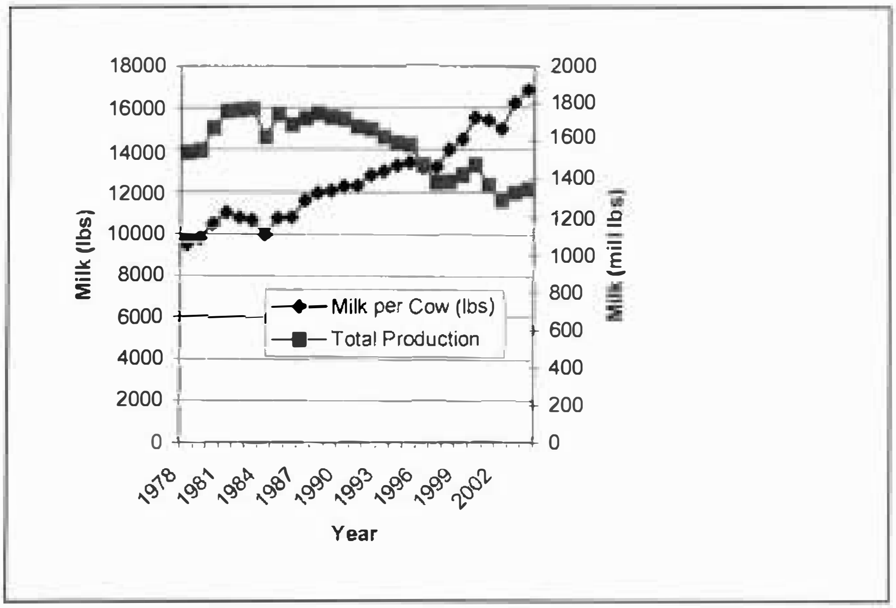
South Dakota dairy farms averaged nearly 22 dairy cows per farm in 1978. In 2004, the average number of cows per farm is nearly 80. In 2004, dairies of 100 head or more made up 21 percent of the dairy operations in South Dakota and accounted for 70 percent of the year's total production.

Despite the declines in dairy cow and farm numbers, U.S. milk production has steadily increased as the amount of milk per cow has increased. Total U.S. milk production in 1975 was 115.4 billion pounds. In 2000, U.S. dairies produced almost 167.7 billion pounds of milk, an increase of 45 percent over the 1975 figure. Production grew at an average of 1.8 percent per year over the time period. (Blayney)

Milk production per cow in South Dakota increased 77 percent from 9,506 lbs per cow in 1978 to 16,838 lbs per cow in 2004 (Figure 1.2). Total milk production in South Dakota has declined, however, despite the gains in production per cow. Total production in South Dakota for 2004 was 1.35 billion pounds, down from a 27 year high of 1.77 billion pounds in 1983.

1.2.2 Location of Dairy Operations

Dairy farm location has been affected. While the top five dairy producing states—California, Wisconsin, New York, Pennsylvania, and Minnesota have not changed in the last fifteen to twenty years; new, non-traditional areas in the western United States have moved ahead of more traditional dairy producing states. Between 1975 and 2000, Idaho, New Mexico,



Source: S.D. Ag Statistics, Annual Bulletin 1978-2004
Figure 1.2: S.D. Total Milk Production and Milk Production per Cow (1978-2004)

and the state of Washington replaced Iowa, Ohio, and Missouri in the top ten list of dairy producing states (Blayney). Between 1997 and 2002, Kansas and Arizona had dairy cow increases of 26, 887 and 31,169 respectively (2002 Census of Agriculture).

The location of dairy production within South Dakota has not changed. Dairy production in South Dakota is located primarily in the eastern part of the state. Data in Table 1.1 shows the top five counties by milk cow inventory from the 1997 and 2002

Table 1.1 South Dakota Dairy Cow Numbers 1997 and 2002

1997		2002	
Grant	5,938	Grant	8,294
Codington	5,918	Brookings	6,405
Deuel	5,442	Turner	5,919
Brookings	4,953	Deuel	5,715
Minnehaha	4,508	Codington	4,628

Source: U.S. Census of Agriculture, 1997 and 2002.

Census of Agriculture. While their order may have changed, four of the top five counties from 1997 remained in the top 5 counties in 2002.

1.2.3 Dairy Production Costs

Larger dairy operations (500 or more milk cows) take advantage of economies of scale to lower costs. Larger operations require less feed and labor hours per hundredweight of milk than do their smaller counterparts. Larger operations make better use of capital by operating their milking systems more hours per day, and achieve increased production per cow through professionally determined feed rations and employing preventative medications in the herd (Short). Based on the 2000 Agricultural Resource Management Survey (ARMS) of milk producers total operating and ownership costs were estimated to be $11.60 per cwt milk sold for dairies of 500 or more cows. Dairies with 50-199 cows had operating and ownership costs of $15.16 per cwt milk sold. Those economies of scale are reflected in the regional differences in cost of production. Milk production costs are $9 to $10 dollars lower per hundredweight in the West where large dairies are more numerous, than in the Heartland where dairies are traditionally smaller (Table 1.2).

Table 1.2 Milk Production Costs and Returns, 2000-2003

	United States			
	2000	2001	2002	2003
Item				
Total Operating Cost [a]	9.38	9.58	9.74	9.99
Total Allocated Overhead [b]	8.64	8.92	9.13	9.23
Total Costs Listed ($/cwt of milk)	18.02	18.5	18.87	19.22
	Heartland/1			
	2000	2001	2002	2003
Total Operating Cost	10.82	10.95	11.46	11.44
Total Allocated Overhead	11.87	12.01	12.24	12.36
Total Costs Listed ($/cwt of milk)	22.69	22.96	23.70	23.80
	Fruitful Rim/2			
	2000	2001	2002	2003
Total Operating Cost	8.47	8.91	8.85	8.97
Total Allocated Overhead	4.57	5.03	4.91	4.9
Total Costs Listed ($/cwt of milk)	13.04	13.94	13.76	13.87

Source: USDA/ERS *Costs and Returns Survey 2000-2003*

1/Western Ohio, Illinois, Missouri, Iowa, S.W. Minnesota, and N.E. Nebraska, and S.E. South Dakota.

2/ Arizona, California, Southern Idaho, Western Oregon, and Washington.

a/ Feed, veterinary, bedding, marketing, custom services, repairs, labor, and other costs.

b/ Capital recovery costs associated with facilities, machinery, and breeding herd.

1.3 Research Objectives

The primary objective of the proposed research is to determine the major economic impacts on South Dakota of alternative dairy expansion decisions. There are two main objectives.

Objective 1. To determine the production functions of a small (150 head) and large (1000 head) dairy in eastern South Dakota.

Objective 2. To determine the economic impact of alternative dairy farm expansion scenarios on different sectors of the regional and state economy.

1.4 Justification and Practical Utility

As previously indicated, dairy cow numbers in South Dakota have been steadily dropping for some time. Total milk production has declined as well, but the decline has been more modest due in part to growth in the average milk production per cow. However, while overall cow and farm numbers and milk production have been declining, both cow numbers and total milk production rose for dairies with 100 or more cows.

Data in Table 1.3 presents the trends of milk cow numbers, milk per cow, and total production for small (less than 50 cows), moderate (50-99 cows), and large (100 or more cows) dairies in South Dakota. Based on this data, large dairies do not appear to be following the same trend as the small and moderate sized dairy farms.

The historical data used to estimate milk production trends is from 1998-2004.[1] During that time, total milk production of both small and moderate sized dairy farms

[1] 1998 was the first year NASS data were available for dairies by size in S.D.

dropped. The total milk production of small dairy farms fell from 263 million pounds to 135 million pounds. Total production dropped from 430 million pounds to 269 million pounds for moderate sized dairies. Total milk production of large dairies increased 250 million pounds from 693 million pounds in 1998 to 943 million pounds in 2004. Dairies of more than 100 milk cows produced 70% of milk in South Dakota in 2004 compared to 50% of all milk produced in 1998.

Growth rates for the milk per cow and cow numbers of small, moderate, and large sized dairies (Table 1.3) were estimated using ordinary least squares regression techniques and the following linear regression model: $\ln Y_1 = B_1 + B_t\ (t) + u_t$ where the logarithm of Y is the number of cows or the milk produced per cow and *(t)* is time, which takes values of 1, 2, 3, etc. B_t multiplied by 100 will yield the growth rate in Y.

The estimated growth rates for the amount of milk per cow and cow numbers of the various sized dairies are presented in Table 1.4. The trend variable in the growth model, B_2, give the instantaneous rate of growth and not the compound (over a period of time) rate of growth. The compound rate of growth is found by taking the antilog of the estimated B_2, subtracting from one, and multiplying by 100.

The growth rates for milk per cow are positive for all three farm groups, however cow number growth rates are not. The estimated annual growth rates for cow numbers in small and moderate sized South Dakota dairies are –14.46 percent and –10.43 percent, respectively. A positive annual growth rate of 3.17 percent is estimated for large dairies.

Table 1.3 South Dakota Dairy Industry Production Trends (1998-2004)

	1998	1999	2000	2001	2002	2003	2004
Herds of less than 50 cows							
Number of Cows	22770	20090	16625	14685	12900	10660	8800
Total Milk Production (Million lbs.)	263	240	210	180	160	140	135
Milk per cow (lbs)	11565	12007	12413	12128	12490	13100	15341
Herds of 50 to 99 cows							
Number of Cows	32175	32340	28975	25365	21930	19680	17600
Total Milk Production (Million lbs.)	430	440	398	356	296	293	269
Milk per cow (lbs)	13354	13602	13735	14043	13519	14868	15284
Herds of 100 cows or more							
Number of Cows	44055	45570	49400	48950	51170	51660	53600
Total Milk Production (Million lbs.)	693	738	870	836	831	898	943
Milk per cow (lbs)	15730	16192	17604	17073	16248	17378	17591
All Herds							
Number of Cows	99000	98000	95000	89000	86000	82000	80000
Total Milk Production (Billion lbs.)	1.386	1.419	1.474	1.37	1.289	1.33	1.347
Milk per cow (lbs)	14000	14480	15516	15393	14988	16220	16838

Source: NASS/Quick Stats accessed February 2005.

The forecasted cow numbers, milk per cow, and total milk production for 2010, assuming the recently observed growth continues, are presented in Table 1.5. The forecasts show that in 2010, a majority of the state's milk cows will be located on and milk production will come from large dairies. Forecasts were made using the following formula: $Y_{2010} = Y_{2004} (I + r)^{6}$

The high and low forecasts were obtained by determining the confidence interval for B_2, at the 95 percent confidence level. The t-statistic for 5 degrees of freedom is 2.571. The high and low estimates for B_2 were converted to compound growth rates and applied in the growth formula above.

$$B_2 \pm (2.571)(\text{se } B_2)$$

The trend analysis assumes that the current economic, policy, and technological forces facing the dairy industry will continue. Experts within the industry suggest that dramatic changes in those trends are not likely, and that dairy farms will continue to expand and further specialize in producing milk. (Blayney)

It is not clear whether South Dakota dairy producers or outside dairy producers will choose to expand at the rates forecasted above. However, the recent trends do justify a closer examination of the economic impacts of the forecasts presented above. The proposed research will be beneficial to county decision makers considering zoning and livestock permit issues by quantifying the economic impact of different levels of expansion or contraction by size.

Table 1.4 Estimated Annual Growth Functions for Various Sized S.D. Dairies

Herds of less than 50 cows:

$\ln Y_{\text{number of cows}} = 10.2071 - .1562t$ $R^2 = .9948$

se = (.0225) (.0050) Growth rate: -14.46%

$\ln Y_{\text{milk per cow}} = 9.3001 + .0365t$ $R^2 = .7362$

se = (.0437) (.0098) Growth rate: 3.72%

Herds of 50-99 cows:

$\ln Y_{\text{number of cows}} = 10.5598 - .1101t$ $R^2 = .9715$

se = (.0377) (.0084) Growth rate: -10.43%

$\ln Y_{\text{milk per cow}} = 9.4684 + .0204t$ $R^2 = .7215$

se = (.0437) (.0098) Growth rate: 2.06%

Herds of 100 cows or more:

$\ln Y_{\text{number of cows}} = 10.6767 + .0312t$ $R^2 = .9305$

se = (.0171) (.0038) Growth rate: 3.17%

$\ln Y_{\text{milk per cow}} = 9.6734 + .0142t$ $R^2 = .4492$

se = (.0314) (.0070) Growth rate: 1.43%

Table 1.5 Forecasts of Cow Numbers, Milk per Cow and Total Milk Production in 2010

Factors	Forecast	Range at 95% confidence level Low	High
Herds of less than 50 cows			
Number of Cows	3447	3192	3725
Milk per cow	19057	16384	22160
Total Milk Production* (Billion lbs.)	0.07	0.05	0.08
Herds of 50 to 99 cows			
Number of Cows	9088	7986	10349
Milk per cow	17299	15847	18893
Total Milk Production* (Billion lbs.)	0.16	0.13	0.20
Herds of 100 cows or more			
Number of Cows	64638	60968	68528
Milk per cow	19155	17183	21337
Total Milk Production* (Billion lbs.)	1.24	1.05	1.46
All Herds			
Number of Cows	77173	72146	82602
Milk per cow	18932	17000	21068
Total Milk Production* (Billion lbs.)	1.47	1.23	1.74

*Based on estimated cow numbers and milk per cow

1.5 Organization of Thesis

This research will consist of five chapters. This first chapter contains background information regarding South Dakota's dairy production industry as well as the objectives and justification for the research.

Chapter two contains a literature review of dairy impact studies and their associated analyses techniques. Techniques specific to this research are outlined in chapter three. Chapter four contains the results of the economic impact analyses. A summary and discussion follows in chapter five.

Chapter 2

Review of Literature

This section contains a review of literature related to the economic impacts of the dairy production industry. Topics specifically reviewed include: (1) input-output analysis; (2) dairy sector impact studies; and (3) financial simulation modeling.

2.1 Input-Output Analysis

The economic impact analysis is performed using the IMPLAN input/output model. The economic relationship between business-to-business and business to consumer can be examined through input-output analysis by capturing all monetary transactions related to consumption and using the resulting multipliers to examine the effect of change in one or more economic activities within the economy (IMPLAN, 2000).

Early input-output analysis is discussed in a book by Richardson (1972). The first empirical application of input-output modeling dates back to the work of Wassily Leontief on an input-output system of the United States economy in 1936, although the origins of input-output analysis may be traced back to concepts introduced by Francois Quesnay's Tableau Economicque in 1758.

Richardson describes a simple input-output model. Consider the following equation:

$$X_1 - a_{11} X_1 - a_{12} X_2 - a_{13} X_3 = Y_1 \quad (1)$$

where final demand (Y_1) is the difference between the gross output of X_1 and the output of purchasing industries ($X_{1\text{-}3}$) multiplied by their direct input coefficients (*a*s). For example, consider demand for corn from three sectors. The final demand for corn would result from the direct input coefficients of the dairy, ethanol, and swine sectors times their respective gross outputs.

Equation 1 would represent the direct effects from a change in final demand, but input-output analysis seeks to determine indirect effects as well. In our example, a change in the output of ethanol would cause a direct effect in the final demand for corn *and* an indirect effect in the demand, for example, of nitrogen. The fertilizer sector would have an equation 1 made up of output and purchasing industries of its own.

Matrix algebra must be used to analyze first, second, and third order effects all at once. Three matrices are used: a single column matrix for $X_{1...n}$ and $Y_{1...n}$ and a *nxn* matrix for the direct purchase coefficients (A). The multiplier effect is then described as:

$$\triangle X=(I-A)^{-1} \triangle Y.$$

It shows how X will change with a change in the final demand of Y. X is a matrix of outputs so a change will be reported for each sector within the economy. The inverse of matrix A (direct purchase coefficients) subtracted from its identity matrix is often called the *Leontief inverse matrix.* (Richardson, IMPLAN 2000)

The model will not hold, however, without the following assumptions:

1. *No substitution between inputs is allowed*. A change in the economy may affect output but not the mix of inputs used in production. Input price changes do not cause firms to purchase substitute goods.
2. *Output level determines amount of input purchases*. There are constant returns to scale.

3. *Output is limited only by demand*. Firms have an unlimited supply of raw materials. (IMPLAN, 2000)

Many input/output studies have been done in the agricultural sector to determine the potential economic gains/losses from industry entrance, exit, or expansion in a given region. Venhuizen (1996) used IMPLAN to analyze the effects of different policy options relating to the treatment of Conservation Reserve Program land (CRP) in South Dakota.

Iowa State University Extension economists John Lawrence and Daniel Otto estimated the impacts of the United States beef cattle industry as well as the beef cattle industries impacts for some selected states using IMPLAN. In the United States, an estimated $38 billion of gross output from beef production supports an additional $115 billion of economic output. Total direct jobs in beef production, which involve farm workers and proprietors, are estimated at 186,245. Those direct jobs supports an additional 1.37 million jobs throughout the rest of the economy. Many IMPLAN studies specifically related to dairy industry impacts have been done as well.

2.2 Empirical Studies of Economic Impacts in the Dairy Industry

There have been many input/output studies done in the dairy sector. The economic impacts of production dairies have been examined in Florida, Arizona, and most recently in Texas. The goal of each study was to demonstrate the full economic impact of the dairy industry in a given area. Regulatory decisions that negatively impacted milk production had negative implications for each region well beyond the dairy producers themselves.

A study by Hussain et. al estimated the economic impact of Erath County Texas's dairy industry using the IMPLAN input/output model. Primary data was used to better calibrate the IMPLAN production to local conditions. A survey requesting five years worth of income, input expense, and capital expense information was sent to all dairy producers within the county. Income questions included revenues received from the sale of milk, heifers, cull cows, government payments, etc. Input expenses were actual expenses incurred by the individual operation. Those expenses were further broken down into inputs purchased within the county, outside the county, and outside the state. Capital expenses were those related to farm structures, equipment, vehicles, etc.

Economic impact for Erath County, Texas was measured at the county and state levels. The results at the county level estimated a total county economic impact of $294.2 million resulting from total county dairy industry expenditures of $190.9 million. Further, 5, 912 jobs within the county were attributed to operating expenses of the dairy industry. Yearly capital expenditures of $19.1 million resulted in a total impact of $26.6 million for the county. State level analysis showed that Erath County dairy production had a $228.5 million impact on the state through both operating and capital expenditures. The number of jobs in the state of Texas resulting from the dairy industry in Erath County were estimated at 10, 926.

In 1998, Ronald Hemmer conducted an economic impact analysis for the dairy industry in Maricopa County, Arizona. Hemmer's purpose was to provide justification for technical and financial assistance for dairy producers within the West Maricopa Watershed to meet the permit requirements within the watershed. In this study, farm enterprise budgets compiled from a 1993 survey of California dairies conducted by the California State Dept. of Food and Agriculture were used to analyze the impacts of a decrease in purchases by the dairy industry. The study assumed a shut down of a 1000 head dairy for failure or inability to comply with the general permit requirements within the watershed.

The study analyzed the hypothetical shutdown from both a short-run (fixed economy) and long-run (flexible economy) viewpoint. Short term impacts from the closure of a 1000 head dairy included 50 full and part time jobs, $1.4 million in local sales and $550,000 less in regional wages. The long run impact of the closure was estimated to be less severe as new industries may take over or other dairies not effected by the watershed expanded, however no estimates were attempted based on the sheer volume and magnitude of assumptions that would have to be made.

Hemmer's study balanced the costs of technical and financial assistance against the estimated benefits gained by keeping a dairy in business. The benefit cost ratio was positive for all scenarios included in the study.

Boggess et.al estimated the economic impacts of three water quality programs in Okeechobee County, Florida and regional area from 1987 to 1993. Data included publicly available sources and surveys. Multipliers were obtained from IMPLAN to estimate the impact from changes in the Okeechobee dairy industry. Direct economic impacts of the water quality programs in the study area ranged from $7 to $19 million. Direct job losses on dairy farms ranged from 170 to 430 full-time and part-time jobs. Indirect losses in the income of businesses that supplied goods and services to the dairy industry ranged from

$1.3 million to $3.4 million over the course of the study. There were 60 to 152 less jobs in the support industries as a result of dairy decline.

A similar study regarding the effect of regulation in Okeechobee County, Florida was conducted in 1989 by Clouser, et. al. This study used a Regional Input-Output Modeling System (RIMSII) of the US Department of Commerce to obtain its multipliers. The study concluded that economic activity was reduced by over $47 million and employment reduced by 465 people resulting from the buyout or closure of 19 dairies in 1989.

In a 2003 SDSU Economics Commentator, Dr. Gary Taylor analyzed the regional impacts of expanding dairy production in South Dakota's I-29 corridor. Using the IMPLAN model, Taylor found positive multipliers that varied by region within the corridor. The analysis was based on four different sized operations: 100, 300, 1000, and 2500 cows. The economic impacts of the construction phase and continued operation phase were analyzed. The default IMPLAN production functions and Regional Purchase Coefficients (RPCs) were used in the study to analyze the potential economic impacts of a change in output. The RPCs specify the level of input purchased within the region by a given industry versus purchases from outside the region.

Lazarus, et. al. study on the economic impacts of the swine industry in Minnesota provides a major basis for this research. The study examined two sizes of farrow to finish and finishing only operations. Average costs and returns from a Minnesota State farm business management program were used to calibrate the production functions in IMPLAN by size and type. Regional Purchase Coefficient data was gathered from a survey of producers in four different Minnesota counties. The researchers found the economic impact of smaller units to be greater for the local area, however the attrition of smaller units would likely offset the gains from having smaller production units.

The variance in costs, input use, and operation performance of large and small dairies suggests that alternative production functions should be obtained. Larger dairies milk three times per day to achieve more pounds of milk per year. Larger operations also employ more advanced breeding programs and preventive veterinary vaccinations to cut feed costs and maintain herd health. The National Agricultural Statistics Service provides costs data for dairies through its Agricultural Resource Management Survey (ARMS). Total operating costs for medium sized dairies (50-199 milking cows) were estimated at $10.76 per cwt of milk sold compared to $10.03 for dairies of 500 or more milking cows. The most significant difference in costs however, are ownership costs. Ownership costs for dairies of 500 or more cows were estimated at $1.57 per cwt of milk sold compared to $4.40 for medium sized dairies (Short, 2004).

Ruwali (2000) further demonstrates the different cost structures of alternative sized dairies. Ruwali prepared enterprise budgets based on dairy budgets from the University of Illinois, Kansas State University, and the Ohio State University for traditional and larger, confinement style operations. The budgets were developed for IMPLAN analysis. Ruwali's IMPLAN budget for a 500 head confinement system purchasing all inputs showed 73.1 percent of total income was consumed in the various IMPLAN sectors compared to 42.2 percent for a traditional system growing all the feed.

2.3 Whole Farm Simulation Modeling

Feuz and Skold (1990) discuss the history, methods, and limitations of using typical farms for whole-farm impact analysis. Key issues of typical farm theory include selection /classification problems and aggregation error.

Early work on typical farms tended to be more product oriented in their classification schemes. Major outputs of the typical farm were identified first followed by further data on cost of production, size, location, etc. Other work was more resource based. Resource classifications include tillable cropland, labor availability, annual rainfall, etc. Ultimately, the major problems being studied will need to provide the basis for selecting and classifying a typical farm.

The authors further caution that typical and average are not the same. Using aggregate national, state, or regional data at the farm level can distort results by averaging over different production levels, types of technology, management ability, etc.

Specification and aggregation errors can be avoided or minimized by developing sets of typical farms where the resource base and technologies employed are typical and not a group average. Typical farm "building" can result in an optimal and not typical farm, therefore care needs to be taken that the resulting typical farm represents "what is" and not "what should be."

2.4 Financial Simulation of Alternative Sized Dairies

Bailey, et. al used CADSIM (Commercial Agriculture Dairy Simulation Model) to calculate the financial feasibility of start-up dairy operations in the Midwest.

CADSIM was developed by the University of Missouri Extension to evaluate expansion or management changes in the dairy industry. The model consists of five different modules—production, feed, labor, loan, and expense—which are used to create financial statements and financial benchmarks used by lenders. The model simulates the information over a 5 year period.

Model and production plans were developed by a team of dairy scientists, economists, engineers, and veterinarians for 150-, 300-, 500-, and 1000-cow units and evaluated over 5 years. CADSIM results were compared with internal guidelines recommend by AgriBank[2] for dairy expansion units over 200 cows. Only the 1000-cow unit generated sufficient revenue to come near AgriBank's financial efficiency guidelines. Further, the 150- and 300-cow units were much more sensitive to a drop in milk price, drop in milk production, or a rise in feed costs. The authors concluded, given the assumptions used, that only the 500- and 1000-cow units were viable start-up operations for the Midwest.

2.5 Summary

Input-output analysis provides a way to measure the impact of a change in demand in one economic sector on the rest the sectors in a given economy. The IMPLAN analysis software has been used extensively to conduct input-output analysis in a variety of subject areas including dairy.

Results from dairy impact studies in other states have exhibited generally positive economic impacts for the respective study area. However, several studies have noted that

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[2] AgriBank provides capital to the 7th District Farm Credit system, which includes many Midwestern states.

economic impact analysis can be improved by localizing the production functions and the regional purchase coefficients of the economic sector being examined. Production functions and regional purchase coefficients can also differ by size within the sector being examined. Drawing on representative farm analysis principles and creating production function and regional purchase coefficients for firms with like size and technology constraints can further improve impact studies.

Finally, results from financial feasibility simulations indicate that larger dairy operations (i.e. greater than 500 milking cows) may be viable in the Midwest region. The results further indicate that new dairy start-ups in 150 to 300 milking cow range may encounter more financial difficulties than their larger counterparts.

Chapter 3

Development of Model Dairy Farms

This study requires the development of a model 150 head dairy farm and 1000 head dairy farm. The two model dairy farms will be used to compare the economic impacts of an increase in demand (expansion). Development of a model dairy farm requires the specification of the individual components of the respective dairy production systems including feed demand, milking systems and associated facilities, machinery, waste storage and disposal, etc.

A farm panel approach was used to establish the current production practices and other requirements for a typical dairy farm. The panels were conducted on two separate occasions—one panel discussion with producers operating at or around the 1000 head threshold and one panel of producers operating at or around the 150 head level. The panel participants provided information on the herd dynamics and feed demands for both dairy sizes. The panels also provided insight into the cost structure of a large and small dairy, but the panels were not sufficiently large or prepared to give complete, reliable expenditure amounts without essentially duplicating the expenses incurred by their own specific dairy.

Expenditure data was gathered from the Minnesota Farm Business Management Database (FINBIN) to help smooth out expense categories that varied significantly amongst the panel participants. Minnesota data used in development of the large dairy farm was made up of FINBIN participants throughout Minnesota so that a sufficient number of operations were obtained. Data used in development of the 150 head dairy was confined to southwest and west central Minnesota since dairies of that size are more numerous. The similarity in climate and agricultural production methods between western Minnesota and eastern South Dakota permits valid analysis, as does the similarity in production methods of large dairies throughout Minnesota and South Dakota.

3.1 Basic Assumptions

Several basic assumptions were made prior to conducting the farmer panels in order to properly develop model dairy farms that met the objectives of the study.

(1) The study area includes six counties in eastern South Dakota, which make up the South Dakota portion of the Brookings trade area. In addition to Brookings County, the study area includes Deuel, Hamlin, Lake, Moody, and Kingsbury counties.

(2) The large dairy would be a commercial operation, which purchased all inputs. The small dairy would obtain most of its proceeds from milk production; however, the small dairy would grow its own feed and have a sufficient number of soybean acres as a cash crop to maintain an adequate crop rotation.

(3) Both dairies are assumed to be confinement style operations.

(4) All equipment and buildings have been purchased and constructed earlier and are part of an ongoing operation.

(5) The price for milk is $13.00 per cwt. The 2005 FAPRI Agricultural Outlook forecast for all milk in South Dakota does not fall below $13.69 per cwt through 2014.

3.2 Herd Size

The estimated growth rates presented in Figure 1.1 in Chapter 1 were used to establish the number of cows for the large and small-size farm. Herd size was set at 150 cows for the small farm and 1000 cows for the large farm. The decision to select 150 cows for the small farm size was based on the assumption that herds of less than 100 would continue to exhibit negative growth rates in the future. Therefore the development of a typical farm of less than 100 would not be as useful for future work. However, 150 cows is a reasonable representation of the smaller herd size of the future. Large, commercial dairies have contributed to the positive growth rates estimated in Chapter 1. A herd size of 1000 cows represents the large size herds possible in future expansion.

3.3 Model Farms

Dairy producer panels provided a source of information to reflect current production dynamics for confinement dairy farms at the specified sizes. The panels provided the following information regarding the dynamics for a typical 150-cow and 1000-cow confinement dairy herd:

- The cows are assumed to be in milk for 305 days and dry for 60 days for both the large and small dairy, which equates to an annual dry cow percentage of 16.5%. The panel indicated that generally 15-20% of the herd is dry at any given time. So, the 1000-cow dairy will have an average of 835 cows in the milking herd at any time and the 150-cow dairy will have 125 cows in the milking herd.
- A large dairy farm using BST milking three times per day (3X milking) typically produces 22,000 to 25,000 pounds of milk per cow annually. Smaller operations

without BST milking two times a day typically produced between 18,000 to 20,000 pounds of milk per cow annually. Production growth rates for all herd sizes in recent years are positive and forecasted to be on average over 19,000 lbs/cow for all herds greater than 100 head by 2010 (see Ch 1) Therefore, annual production levels of 22,000 lbs/cow for the 1000-cow dairy and 19,000 lbs/cow for the 150-cow dairy are justifiable.

- Specific feedstuffs used in a typical Total Mixed Ration (TMR) will vary by many factors including changing costs and weather conditions. However, TMRs for both sized dairies are based on corn silage, alfalfa haylage, and alfalfa hay supplemented with energy, protein, and mineral components to complete the ration.
- The large and small dairy sell all bull calves within one week of birth. Heifer calves from the large dairy are sold to a heifer grower for repurchase as replacements at a later date. The small dairy operation raises its own heifer replacements so female calves are kept. The heifers are bred at 14 to 15 months of age to calve at 23 to 24 months of age. Excess heifers are sold as springers (bred heifers).
- Culling percentages for both herd sizes are assumed to be 30%. The large operation incurs an additional death loss of 5%. The smaller dairy is assumed to have a 2% death loss.
- An owner-operator is responsible for all management decisions. The owner-operator does not receive a specific salary, but has access to surplus cash

generated by the operation. All other labor is hired with the assumption that some unpaid family labor is utilized in the smaller operation. The panel recommended approximately 14 full time equivalents (FTE) for the large dairy including herdsmen and milkers. Total labor demand for the 150-head dairy is one full time employee in addition to the owner-operator and family labor.

3.4 Production Functions and Regional Purchase Coefficients

IMPLAN contains a default set of production functions and regional purchase coefficients for each industry based on national averages. Despite IMPLAN's high level of disaggregation (528 different sectors), sectors like the dairy industry must be aggregated as a whole. That means dairies of all sizes are aggregated into the IMPLAN production functions. IMPLAN allows the analyst to make changes to the default production functions and it is clear from the review of literature that the production functions must be localized and specific to the size of dairy involved.

The Regional Purchase Coefficients (RPCs) specify the level of inputs purchased within the region by a given industry versus purchases from outside the region. IMPLAN allows for changes to be made to the RPCs, as well. Lazarus, et. al obtained primary data from a survey of 90 hog producers stratified into large and small operations. Thirty-five responded for a response rate of 38%. The survey provided a list of major inputs and services and asked respondents to estimate the percentage purchased within or outside their regions.

Lazarus (2002) examined the contribution of the new, estimated production functions and RPCs in a follow-up paper to the swine industry study. The new RPCs contributed less than 2% of the difference from the default RPCs in all but 6 sectors. The RPCs were overestimated by the survey in over half the cases meaning the results from the survey suggested that more of the item was purchased in the county than the county was capable of producing. The researchers fell back on the default RPCs in those cases. The author concluded that it was more valuable to estimate new, localized production functions than re-estimating RPCs. Thus, the RPCs will not be re-estimated in this study except for feed purchases and contracted heifer growing, which panel participants clearly indicated were purchased predominately within the study region and the state.

The data needed to estimate dairy production functions by size is limited in South Dakota. USDA-NASS publishes data from its *Costs and Returns Survey*, but these are national or, at best, regional averages. Officials with the State of South Dakota and SDSU have published budgets through university extension and for dairy promotion within the state; however, these budgets are estimates and do not necessarily reflect actual costs. The budgets are also not detailed enough to effectively modify the IMPLAN production function.

Producer panels were convened to help solve the data shortage. The panels were helpful in estimating receipts for the model farm based on the herd dynamic information provided. The Minnesota Farm Business Management database, more commonly known as FINBIN, was utilized to obtain variable expenses with some modifications based on panel discussion. Examples of each budget portion are provided below. The term value added (va) is used to represent the return to a primary input. Data in Tables 3.8 and 3.9

present the complete budgets for the respective model dairies, while specific components of these completed budgets are highlighted in Table 3.1-3.6.

3.5 Receipts

The first part of the budget (Table 3.1 and 3.2) consists of receipts obtained by both sized dairies including proceeds from the sale of milk, cull cows, bull calves, and heifers. Receipts from soybean sales are not considered for the 150-head dairy since the objective of the study is to determine the impacts the dairy enterprise has on the region. Animal weights, calving fractions, and death loss percentages were obtained from panel discussion. The treatment of heifers differs between herd sizes. The large dairy sells heifer calves shortly after birth at a set price ($120 was given by the panel) to a grower with the understanding that the calf, meeting certain conditions, will be bought back at a set price. The small dairy keeps all heifer calves and sells any not needed for replacement as springers.

Table 3.1 Receipts for 1000-head Dairy Budget

Receipts	lb/Animal	price/lb	# head	Death Loss	value/cow	1000 cows	Coefficient	IMPLAN Code
Milk	22,000	0.13	1		2860.00	2,860,000	0.918	va
Cull Cows	1,350	0.40	0.3	0.05	153.90	153,900	0.049	va
Bull Calves		85.00	0.5	0.02	41.65	41,650	0.013	va
Heifer Calves		120.00	0.5	0.02	58.80	58,800	0.019	va
	Total Receipts				3114.35	3,114,350	1.000	

Table 3.2 Receipts for 150-head Dairy Budget

Receipts	lb/Animal	price/lb	# head	Death Loss	value/cow	150 cows	Coefficient	IMPLAN Code
Milk	19,000	0.13	1		2470.00	370,500	0.857	va
Cull Cows	1,350	0.4	0.3	0.02	158.76	23,814	0.055	va
Bull Calves	1	85	0.5	0.02	41.65	6,248	0.014	va
Heifers	1	1200	0.18	0.02	211.68	31,752	0.073	va
Total Receipts					2882.09	432,314	1.000	

Note: Per head prices are used for the bull calves and heifer calves rather than price per pound.

3.6 Variable Expenses

The second part of the budget consists of variable costs incurred by the respective dairies. Feed costs and the cost of replacement heifers make up most of the model dairy farms variable costs. Other variable costs include marketing, fuel/lube, repairs, etc. National averages from the 2000 Agricultural Resource Survey are referenced in this section. It is important to note that the national per cwt averages referenced below are based on average milk production per cow of 16,157 lbs for dairies of 50-199 cows and 17, 326 lbs for dairies with 500 or more cows.

Feeding requirements for the respective herds were developed from discussion with dairy farmer panel members and from consultation with Dr. Alvaro Garcia, SDSU Extension Dairy Specialist.

The feed requirements determined the amount of feed purchased by the 1000 cow dairy and the number of acres required for the 150 head dairy. The rations for both the 1000 head and 150 head dairy model farm are shown in Tables 3.3 and 3.4

The ration uses the components specified by the panel. The required tonnages were calculated as follows: (lactating ration lbs/head) X (835 head) X 365 days plus the (dry cow ration) X (165 head) X 365 days. The lactating cows consume just over 51 lbs of dry matter per day, while the dry cows consume 24 lbs. Both dry matter consumption rates are within the ranges given by the panel members.

Table 3.3 Daily ration and total feed requirements for 1000-head dairy

Rations		**Lact. Cows**	**Dry Cows**	**Hfrs**	**Total tons/yr**
	No Head	835	165	0	
	Days Fed	365	365	0	
Alfalfa Hay	*#Hd/day*	5.43	5.43		990.98
Alfalfa Silage		17.35	0.00		2643.92
Corn Silage		40.00	10.00		6396.63
Cottonseed		3.94	0.00		600.41
Corn dstlrs wet		8.00	15.00		1670.79
Corn Grain		16.74	0.00		2550.97
SBM 48%		2.60	0.00		396.21
Concentrate		3.00	0.00		457.16
Other Hay		0.00	4.00		120.45

Note: Pounds per day are given on an *as fed* basis.

Table 3.4 Daily ration and total feed requirement for 150-head dairy

Rations		**Lact. Cows**	**Dry Cows**	**Hfrs**	**Total tons/yr**
	No Head	125	25	48	
	Days Fed	365	365	365	
Alfalfa Hay	*#Hd/day*	5.43	5.43	5.43	196.21
Alfalfa Silage		17.35	0.00	0.00	395.80
Corn Silage		40.00	10.00	10.00	1045.73
Cottonseed		3.94	0.00	0.00	89.88
Corn dstlrs wet		8.00	15.00	15.00	382.34
Corn Grain		16.74	0.00	0.00	381.88
SBM 48%		2.60	0.00	0.00	59.31
Concentrate		3.00	0.00	0.00	68.44
Other Hay		0.00	4.00	4.00	53.29

Note: Pounds per day are given on an *as fed* basis.

The 150 head dairy operates under the same ration, but feeds an additional 48 head for 365 days with a ration similar to the dry cow ration. The 48 additional head represent dairy heifers at 12-24 months of age.

The partial feed costs budgets for both sized dairies are presented in Tables 3.5 and 3.6. Feed costs for the small dairy are valued at market costs, but the cost structure will differ in the whole farm budget since some feed inputs are grown rather than purchased.

Based on the assumed rations and market prices, the 150-head model dairy's feed costs were $5.82 per cwt of milk sold compared to $4.64 for the 1000-head model dairy. Nationally, total purchased feed costs for dairy enterprises of 500 milk cows or more was estimated at $6.17 per cwt of milk sold compared to $6.54 for dairies of 50-199 milk cows based on an average milk production per cow of 17,326 lbs. and 16,157 lbs. respectively. Industrial-scale operations tend to have higher feed efficiency than other size groups due to improved genetics and professionally determined rations (Short, 2000). The 1000-head model dairy does not feed heifer calves, which also contributes to lower feed costs than shown for the 150-head dairy farm. Feed costs per cwt of milk sold are lower in South Dakota budgets due to lower unit costs for corn and forages raised locally, compared to national studies cited.

The online Minnesota Farm business Management Database has information for dairy operations with greater than 500 head and operations from 101-200 head. The information available was further limited to exclude the top 20 percent and bottom 20

Table 3.5 Feed Costs for 1000-head dairy (market price)

Feed	as fed/yr	units	Price	units	Total Cost	$/cwt milk sold	Coefficient
Alfalfa Hay	990.98	tons	100	ton	99,098	0.45	0.03
Alfalfa Silage	2643.92	tons	47	ton	124,264	0.56	0.04
Corn Silage	6396.63	tons	25	ton	159,916	0.73	0.05
Cottonseed	600.41	tons	260	ton	156,107	0.71	0.05
Corn Dstlrs Wet	1670.79	tons	30	ton	50,124	0.23	0.02
Corn grn (rolled)	91106.07	bu	2.05	bu	186,767	0.85	0.06
SBM 48%	396.21	tons	247	ton	97,864	0.44	0.03
Concentrate	457.16	tons	305	ton	139,434	0.63	0.04
Other Hay	120.45	tons	60	ton	7,227	0.03	0.00
	Total Feed Costs				1,020,800	4.64	0.33

Note: Assumes 22,000 lbs/cow/yr

Table 3.6 Feed Costs for 150-head dairy (market price)

Feed	as fed/yr	units	Price	units	Total Cost	$/cwt milk sold	Coefficient
Alfalfa Hay	196.21	tons	100.00	ton	19,621	0.69	0.05
Alfalfa Silage	395.80	tons	47.00	ton	18,603	0.65	0.04
Corn Silage	1045.73	tons	25.00	ton	26,143	0.92	0.06
Cottonseed	89.88	tons	260.00	ton	23,369	0.82	0.05
Corn Dstlrs Wet	382.34	tons	30.00	ton	11,470	0.40	0.03
Corn grn (rolled)	13638.57	bu	2.05	ton	27,959	0.98	0.06
SBM 48%	59.31	tons	247.00	ton	14,650	0.51	0.03
Concentrate	68.44	tons	305.00	ton	20,874	0.73	0.05
Other Hay	53.29	tons	60.00	ton	3,197	0.11	0.01
	Total Feed Costs				165,886	5.82	0.38

Note: Assumes 19,000 lbs/cow/yr

percent of producers for both operation sizes and to select operations only from Southwest and West Central Minnesota for the small operations.

Data in Appendix Tables 1 and 2 show the way the information is collected. Production coefficients were calculated for comparison purposes. The coefficients are the division of the actual amount of dollars expended per cow by the total production. A majority of the variable expenses, other than feed, available from the FINBIN database were used in the whole farm budgets.

Variable expenses, other than feed and heifer replacements, for the 1000-head model dairy were \$733.87 per cow or \$3.34 per cwt of milk sold. The 150-head model dairy had variable expenses, other than purchased feed, of \$819 per cow or \$4.31 per cwt of milk sold. Nationally, dairies of 500 head or more had variable costs, other than purchased feed, of \$3.86 per cwt of milk sold compared to dairies of 50-199 head that had variable costs, other than purchased feed, of \$4.22 per cwt of milk sold (Short, 2000).

The variable expenses between the alternative sized dairies differ categorically. The 1000- head model dairy incurs additional variable expenses related to BST use and the purchase of replacement heifers. The 150-head model dairies variable expenses include production costs of growing corn and forages for feed. Data in Appendix Table 3 shows the per acre costs for growing the respective feeds. The budget data was obtained from Lincoln, Pipestone, and Rock counties in west central and southwest Minnesota except for land rental costs, which were obtained for Brookings County from the 2005 SDSU Land Value Survey. The 150-head model dairy requires 318 acres for feed production. Total tonnage required divided by the NASS three-year average yield for Brookings County provided the acres required (Appendix Table 4).

3.7 Overhead Expenses

The third part of the budget lists the fixed costs of the model dairies. Ownership costs, which includes depreciation and interest expense, and labor are the two main fixed costs incurred by both model dairies.

Following the assumptions listed earlier in the chapter, the large dairy will employ 14 full-time workers. An average rate of $10.23 per hour for 55 hours a week ($9 for 40 hrs plus $13.50 for 15 hrs for 52 weeks yields $29,250 annually) was obtained from discussion with panel members. The 150-head model dairy will employ one full-time employee at $30,000 per year. Hired labor costs per cwt of milk sold are $1.86 for the 1000-head unit and $1.05 for the 150-head unit. Nationally, labor costs for dairy enterprises of 500 head or more are $1.41 per cwt of milk sold compared to $1.01 for dairies of 50-199 head (Short, 2000).

Overhead expenses, other than labor, for the 1000-head model dairy were $280.96 per cow or $1.28 per cwt of milk sold. The 150-head model dairy had overhead expenses, other than labor, of $520 per cow or $2.74 per cwt of milk sold. Nationally, total ownership costs for dairy enterprises of 500 cows or more are $1.57 per cwt of milk sold and $4.40 for dairies of 50-199 cows. Again, it is important to note that the national per cwt averages are based on milk production levels of 16,157 lbs per cow for dairies with 50-199 cows and 17,326 lbs per cow for dairies with 500 cows or more.

3.8 Budget Summary

The complete enterprise budgets (Tables 3.7 and 3.8) and the summary IMPLAN budgets (Tables 3.9 and 3.10) provide insight into what can be expected from the different systems and makes clear important differences in production methods:

Production: Receipts per cow differ between the systems by $232/cow, due mainly to differences in milk production. The 1000-head unit produces 3,000 pounds per cow more of milk than the 150-head unit due to three times a day milking and BST use.

Variable Expenses: The variable costs accounted for 69 percent of the receipts in the 1000-head system compared to 46 percent of receipts in the 150-head system. Variable expenses are reduced in the 150-head system primarily by growing its own feeds and raising its own heifers.

Overhead Expenses: Overhead costs make up 25 percent (7 percent labor) of the 150 head dairy's budget compared to 22 percent (13 percent labor) for the 1000 head dairy. The 1000 head unit by purchasing feed and specializing in dairy production (e.g. 3X milking) can reduce overhead costs more effectively than the 150 head units, which must maintain and insure equipment and buildings for enterprises in addition to milk production.

3.9 IMPLAN Procedures

Each cost in budget tables 3.7 and 3.8 is assigned an IMPLAN code and a coefficient. The coefficient is the division of that sectors value by the total receipts. The value-added code (va) is assigned to items including payments to labor, taxes, and other income. For the 150-head dairy cow budget the feed crops costs (e.g. fuel, oil, and repairs) are totaled in the whole farm column.

Input-Output models are driven by final demand. Industry demands are met by other goods and services industries, which in turn have demands of their own creating a cyclical effect from industry to industry. Multipliers generated within the IMPLAN system describe the cyclical effect.

Table 3.7 Whole farm budget for 1000 head dairy purchasing all feed

Receipts	lb/Animal	price/lb	# head	Death Loss	value/cow	1000 cows	Coefficient	IMPLAN
Milk	22000	0.13	1		2860	2,860,000	0.918	va
Cull Cows	1350	0.4	0.3	0.05	153.9	153,900	0.049	va
Bull Calves	1	85	0.5	0.02	41.65	41,650	0.013	va
Heifers	1	120	0.5	0.02	58.8	58,800	0.019	va
	Total Receipts				3114.35	3,114,350	1.000	
Replacements	1	1200	0.48	0.15	396	396,000	0.1272	447
Feed	as fed/yr	units	Price	units	value/cow	1000 cows	Coefficient	IMPLAN
Alfalfa Hay	990.98	tons	100.00	ton	99.10	99,098	0.0318	13
Alfalfa Silage	2643.92	tons	47.00	ton	124.26	124,264	0.0399	13
Corn Silage	6396.63	tons	25.00	ton	159.92	159,916	0.0513	12
Cottonseed	600.41	tons	260.00	ton	156.11	156,107	0.0501	78
Corn Dstlrs Wet	1670.79	tons	30.00	ton	50.12	50,124	0.0161	76
Corn grn (rolled)	91106.07	bus	2.05	bu	186.77	186,767	0.0600	12
SBM 48%	396.21	tons	247.00	ton	97.86	97,864	0.0314	21
Concentrate	457.16	tons	305.00	ton	139.43	139,434	0.0448	78
Other Hay	120.45	tons	60.00	ton	7.23	7,227	0.0023	13
	Total Feed Costs				1,020.80	1,020,800	0.3278	
		Quan.	Price	Units	value/cow	1000 cows	Coefficient	IMPLAN
Marketing		1	36.00	cow	36.00	36,000	0.012	512
Hauling & Trucking		1	33.00	cow	33.00	33,000	0.011	435
Bedding		1	48.65	cow	48.65	48,650	0.016	447
Vet & Medicines		1	134.92	cow	134.92	134,920	0.043	26
BST		1	51.24	cow	51.24	51,240	0.016	26
Fuel & Oil		1	41.48	cow	41.48	41,480	0.013	210
Building Repair		1	31.00	cow	31.00	31,000	0.010	56
Equipment Repair		1	61.00	cow	61.00	61,000	0.020	482
Breeding		1	30.00	cow	30.00	30,000	0.010	26
Custom Work		1	51.87	cow	51.87	51,870	0.017	26
Utilities		1	43.65	cow	43.65	43,650	0.014	443
Livestock Supplies		1	129.70	cow	129.70	129,700	0.042	447
Water		1	41.36	cow	41.36	41,360	0.013	445
	Total Variable Costs				2150.67	2,150,670	0.691	

Table 3.7 cont'd

Fixed Expenses						
Hired Labor		409.50cow	409.50	409,500	0.130	va
Farm Insurance		20.93 cow	20.93	20,930	0.010	459
Interest		124.00 cow	124.00	124,000	0.400	457
Mach & Building Depr.		115.22 cow	115.22	115,220	0.040	va
Taxes		10.00 cow	10.00	10,000	0.003	va
Land Rent	160 @ 65.50	10.81 cow	10.81	10,810	0.003	va
	Total Fixed Costs		690.46	690,460	0.222	
Total All Costs			**2,841.13**	**2,841,130**	**0.912**	

Table 3.8 Whole Farm Budget for 150 head dairy growing all the feed

Receipts	lb/Animal	price/lb	# head	Death Loss	value/cow	150 cows	Coefficient	IMPLA Code
Milk	19000	0.13	1		2470	370,500	0.857	va
Cull Cows	1350	0.4	0.3	0.02	159	23,814	0.055	va
Bull Calves	1	85	0.5	0.02	41	6,248	0.014	va
Heifers	1	1200	0.18	0.02	212	31,752	0.073	va
	Total Receipts				2882	432,314	1.000	

Variable Expenses	Whole Farm	Dairy	Alfalfa	Corn Silage	Corn	Other Hay		
Purchased Feed								
Cottonseed	23369	23369					0.0541	78
Corn Dstlrs Wet	11470	11470					0.0265	76
SBM 48%	14650	14650					0.0339	21
Concentrate	20874	20039					0.0483	78
Other variable costs								
Marketing	4034	4034					0.0093	512
Hauling & Trucking	3600	3600					0.0083	435
Bedding	4226	4226					0.0098	447
Vet & Medicines	15786	15786					0.0365	26
BST	0	0					0.0000	26
Fuel & Oil	10177	6450	1592	711	1203	221	0.0235	210
Building Repair	4692	4692					0.0109	56
Equipment Repair	15690	9000	3269	1416	1908	97	0.0362	482
Breeding	5400	5400					0.0125	26
Utilities	8850	8850					0.0205	443
Livestock Supplies	22418	22418					0.0519	447
Water	8250	8250					0.0191	446
Seed	7310			2627	4683		0.0169	447
Fertilizer	12268		3685	3235	5206	142	0.0284	202
Herbicides	4950		485	1621	2786	58	0.0115	204
Crop Insurance	1846		201	439	1206		0.0043	459
Total Variable Costs	199860						0.4623	

Table 3.8 cont'd

Fixed Expenses								
Hired Labor	30000						0.0694	
Interest	18068	14177	1112	1610	1068	101	0.0418	456
Mach/Bld Depr	28431	23764	1927	1274	1270	196	0.0658	
Farm Insurance	6221	4758	678	335	216		0.0144	459
Land Rent Equiv	23766		6797	6059	9355	1555	0.0550	
Taxes	1500						0.0035	
Total Fixed Costs	107986						0.2499	
Total All Costs	**307846**						**0.7122**	

Table 3.9 Whole Farm IMPLAN Budget--1000 head Dairy

IMPLAN Sector	Description	Total	Coefficeient
12	Feed Grains	346683	0.111
13	Hay & Pasture	230589	0.074
21	Oil bearing crops	97864	0.031
26	Ag Services	268030	0.086
56	Building Repair	31000	0.010
76	Wet corn milling	50124	0.016
78	Prepared Feeds	295541	0.095
202	Fertilizers	0	0.000
204	Ag Chemicals	0	0.000
210	Petroleum Refining	41480	0.013
435	Motor Freight Transport	33000	0.011
443	Utilites	43650	0.014
445	Water Supply	41360	0.013
447	Wholesale Trade	574350	0.184
456	Banking	124000	0.040
459	Insurance Carriers	20930	0.007
482	Misc. Repair Shops	61000	0.020
512	Marketing Promotion	36000	0.012
		2,295,601	0.737
va	Hired Labor	409,500	0.131
va	Land Rent Equivalent	10,810	0.003
va	Taxes	10,000	0.003
va	Management	155,717	0.050
va	Capital Recovery	115,220	0.037
va	Return above costs	117,502	0.038
			0.262
For IMPLAN			
va	Proprietary income	281,747	0.090
va	Labor	409,500	0.131
va	Taxes	10,000	0.003
va	Other Property income	117,502	0.038
			0.262

Table3.10 Whole Farm IMPLAN Budget--150 head Dairy

IMPLAN Sector	Description	Total	Coefficeient
12	Feed Grains		0.000
13	Hay & Pasture		0.000
21	Oil bearing crops	14650	0.034
26	Ag Services	21186	0.049
56	Building Repair	4692	0.011
76	Wet corn milling	11470	0.027
78	Prepared Feeds	44243	0.102
202	Fertilizers	12268	0.028
204	Ag Chemicals	4950	0.011
210	Petroleum Refining	10177	0.024
435	Motor Freight Transport	3600	0.008
443	Utilites	8850	0.020
445	Water Supply	8250	0.019
447	Wholesale Trade	33954	0.079
456	Banking	18068	0.042
459	Insurance Carriers	8067	0.019
482	Misc. Repair Shops	15690	0.036
512	Marketing Promotion	4034	0.009
		224,149	0.518
va	Hired Labor	30,000	0.069
va	Land Rent Equivalent	23,766	0.055
va	Taxes	1,500	0.003
va	Management	40,000	0.093
va	Capital Recovery	28,431	0.066
va	Return above costs	84,468	0.195
			0.482
For IMPLAN			
va	Proprietary income	73,812	0.171
va	Labor	30,000	0.069
va	Taxes	1,500	0.003
va	Other Property income	102,853	0.238
			0.482

Chapter 4

Results

The economic impact of the 150-cow and 1000-cow dairy was calculated using the IMPLAN software. Total output, employment, and value added impacts are compared at the regional level (Brookings, Deuel, Hamlin Kingsbury, Lake, and Moody counties), state (South Dakota), and national levels. Dollar amounts used in the IMPLAN program and reported within this chapter are for 2005. However, the results are the product of the economic structure contained within the 1998 IMPLAN data. Changes were made to the production function of the dairy production industry as well as the dairy production industry's regional purchase coefficients. The structural matrices, supply -demand pooling, and other economic variables are from the IMPLAN default data for 1998.

IMPLAN data for 2002 were available; however, important sectors to the research (e.g. dairy products) were aggregated with other agricultural livestock sectors so that production functions for the dairy production industry could not be adjusted and results could not be isolated to the dairy production industry. The 2002 data were utilized for forward linkage analysis involving the dairy-processing sector.

Total output is the value of production by an industry over a certain time period. Total employment impacts result from the direct, indirect, and induced impacts of the model dairy farms. Total value added is the sum of employee compensation, indirect business taxes, proprietary income, and other property income.

Multipliers for total output, employment, and value added were calculated and compared. Multipliers described an economy's response to a change in production. The output multiplier describes the total dollar change in total output from all industries given a change in final demand. For example, a total output multiplier of 1.72 suggests that for every dollar spent, $.72 of indirect and induced effects occur in related industries.

Multipliers provide a basis for policy related discussions. For eastern South Dakota, multipliers can provide a basis for discussion of the economic impact of the dairy industry and estimates of the monetary gains and losses from increases or declines in dairy cow numbers. Multipliers, however, are not perfect and do not indicate the opportunity costs of resource consumption within a particular area.

4.1 Comparison of Multipliers for a 150 head and 1000 head dairy

The 150-cow dairy system impact at the regional level had a total output of $563,508 yielding a multiplier of 1.30 (Table 4.1) when divided by the 150-cow model dairy output of $432,316. A multiplier of 1.30 indicates that for every dollar spent in the dairy industry, $.30 of indirect and induced effects occur in related industries. The total employment impact was 2.70 including the one employee assumed to be employed full-time by the 150-cow dairy. The total employment multiplier was 2.70 indicating that for every one employee employed under this model, another 1.70 jobs are supported in related industries due to direct, indirect, or induced effects. Note that neither family labor nor the managerial component provided by the owner-operator is captured in the employment impact estimation. The total value added impact was $286, 230 with a multiplier of 1.37.

The 1000-cow dairy model at the regional level had a total output impact of $4,352,623 (Table 4.2) including the $3,114,542 contributed directly by the dairy resulting in a total output impact multiplier of 1.40. The employment impact was 31.6 jobs with a multiplier of 2.26. Total value added was $1,541,749 with a multiplier of 1.88.

The multipliers for both dairy systems are small in general. The relatively small multipliers can be explained, in part, by the regional purchase coefficients developed within the IMPLAN software. The regional purchase coefficient is the proportion of regional demand for a given sector's output that is fulfilled from regional production. The IMPLAN farm industry balance sheet shows the regional purchase coefficients for each sector that supplies the dairy production industry. The default regional purchase coefficient for feed grains (sector 12) and hay and pasture (13) in the six county study area is 16.5 percent for both sectors. The low regional purchase coefficient suggests that while a sufficient amount of feedstuffs are grown in the area, the feedstuffs are being exported out of the area for processing and returning as imports. This is very important since feed costs make up a large portion of a dairy's budget. When economic activity is generated outside a given area, even when a large dairy comes into an area, the increase in the number of jobs, output, and valued added will not be proportional to the size of the dairy.

The 1000-head dairy model was rerun with the regional purchase coefficients for Feed Grains (Sector 12) and Hay and Pasture (Sector 13) set to one (Table 4.3). A regional purchase coefficient of one implies that the entire demand of the model dairy in those sectors is fulfilled by local production. Local dairy producers that participated in

Table 4.1 Regional level impacts of a 1000 head dairy system

IMPLAN	Sector Description	Output Impact (Receipts)	Employment Impact	Total Value Added Impact
1	Agriculture (AGG)	16,625	0.10	4,121
12	Feed Grains	77,469	0.60	28,546
13	Hay & Pasture	33,783	0.80	14,900
21	Oil Bearing Crops	19,921	0.20	7,304
26	Agricultural- Forestry- Fishery Services	25,914	1.10	17,214
56	Maintenance & Repair	50,649	1.00	28,525
58	Manufacturing	11,693	0.00	2,190
78	Prepared Feeds	4,412	0.00	580
128-428	Other Apparel, Parts, Electronics (AGG)	23,754	0.20	7,116
435	Transportation (AGG)	64,904	0.60	28,927
441	Communications	9,349	0.00	5,836
443	Utilities (AGG)	64,626	0.20	47,069
447	Wholesale Trade	336,384	3.80	230,249
449	Other Trade (AGG)	93,716	3.40	68,416
456	Banking & Financial Services (AGG)	103, 626	0.80	77,416
459	Insurance Carriers	8,430	0.10	4,570
462	Real Estate	48,169	0.20	35,813
463	Services (AGG)	114,600	3.00	65,624
482	Misc Repair Shops	27,220	0.50	10,064
510	Government (AGG)	20,729	0.30	9,129
512	Other State and Local Govt. Enterprises	82,106	0.60	28,856
526	1000 cow dairy	3,114,542	14.00	819,283
	Total Impact (Direct, Indirect and Induced)	4,352,623	31.6	1,541,749
	Multipliers	1.40	2.26	1.88

Table 4.2 Regional level impacts of a 150 head dairy system

IMPLAN	Sector Description	Output Impact (Receipts)	Employment Impact	Total Value Added Impact
1	Agriculture (AGG)	1,587	0.00	409
12	Feed Grains	895	0.00	330
13	Hay & Pasture	390	0.00	172
21	Oil Bearing Crops	1623	0.00	595
26	Agricultural- Forestry- Fishery Services	2,014	0.10	1,338
56	Maintainence & Repair	7,306	0.10	4,121
58	Manufacturing	1,581	0.00	293
78	Prepared Feeds	660	0.00	87
128-428	Other Apparel, Parts, Electronics (AGG)	2,881	0.00	845
435	Transportation (AGG)	6,786	0.10	3,042
441	Communications	1,091	0.00	683
443	Utilities (AGG)	11,007	0.00	8,131
447	Wholesale Trade	21,703	0.20	14,855
449	Other Trade (AGG)	12,483	0.50	9,124
456	Banking & Financial Services (AGG)	14,603	0.10	10,908
459	Insurance Carriers	1,984	0.00	1,075
462	Real Estate	6,010	0.00	4,489
463	Professional Services (AGG)	14,649	0.40	8,382
482	Misc Repair Shops	6,542	0.10	2,419
510	Government (AGG)	3,307	0.00	1,382
512	Other State and Local Govt. Enterprises	12,088	0.10	4,248
526	150 cow dairy	432,316	1.00	209,302
	Total Impact (Direct, Indirect and Induced)	563,508	2.70	286,230
	Multipliers	1.30	2.70	1.37

panel discussion for this research stated that their feed needs, especially silage and hay, were fulfilled locally if possible.

The total output impact of the 1000-head dairy was over 14 percent higher when feed needs were met locally. Meeting feed needs locally also provided for nearly 7 more jobs and over $269,000 in additional value added impacts. Since the 150-head model dairy grows its own feed, spillover effects into the feed and hay sectors do not exist, therefore a regional purchase adjustment has no effect on the economic impacts of a dairy that grows its own feed. The data are results from the IMPLAN production functions used in the regional runs with the regional purchase coefficients for feed and hay in the 1000 head dairy set to one.

The 150-head and the 1000-head dairy were also compared at a national level to see the effects of increasing regional purchase coefficients. Regional purchase coefficients at the national level are at or approaching 1.0 for all sectors, which provides an estimate of what the multipliers would be if *all* the good and services were available within the study region. The national level multipliers (Table 4.4 and Table 4.5) represent the maximum level of effect the model 150-head and 1000-head dairy may have on the study region. The national level multipliers are further compared to a study area built at the state level and the original, RPC adjusted, multipliers from the initial six county study area.

Table 4.3 Impacts of a 1000 head dairy with feed needs met locally.

IMPLAN	Sector Description	Output Impact (Receipts)	Employment Impact	Total Value Added Impact
1	Agriculture (AGG)	19,309	0.01	4,815
12	Feed Grains	415,119	3.10	152,964
13	Hay & Pasture	181,026	4.20	79,842
21	Oil Bearing Crops	22,692	0.20	8,320
26	Agricultural- Forestry- Fishery Services	29,624	1.20	19,679
56	Maintainence & Repair	58,888	1.10	33,190
58	Manufacturing	13,241	0.00	2,494
78	Prepared Feeds	4,421	0.00	582
128-428	Other Apparrel, Parts, Electronics (AGG)	30,148	0.30	8,905
435	Transportation (AGG)	81,855	0.80	36,714
441	Communications	11,173	0.10	6,988
443	Utilities (AGG)	70,895	0.30	51,074
447	Wholesale Trade	362,924	4.10	248,415
449	Trade (AGG)	107,444	3.90	78,432
456	Banking & Financial Services (AGG)	108,942	0.90	81, 421
459	Insurance Carriers	9,346	0.10	5,067
462	Real Estate	66,776	0.30	49,168
463	Services (AGG)	131,656	3.50	75,431
482	Misc Repair Shops	29,293	0.60	10,831
510	Government (AGG)	18,136	0.30	10,043
512	Other State and Local Govt. Enterprises	85,203	0.60	29,945
526	1000 cow dairy	3,114,572	14.00	819,291
	Total Impact (Direct, Indirect and Induced)	4,977,184	39.7	1,813,608
	Multipliers	1.60	2.84	2.21

The total output multiplier for the 1000-cow unit ranges from 1.60 at the regional level to 3.20 at the national level. The range shows that as more goods and services are provided locally the greater the economic impact of the industry on the region. The employment multiplier for the 1000-cow unit is 2.84 at the regional level, and 7.37 at the national level. The total value added multiplier is 2.21 at the regional level and 5.41 at the national level.

The 150-cow unit's local, state, and national multipliers are presented in Table 4.5. The 1000 head dairy system total output and total value added multipliers are higher relative to the 150 head dairy system when compared across regional, state, and national levels. The employment multiplier for the 150 head system is slightly higher than the 1000 head system at the state and national levels. The lower multiplier impact of employment could be attributed to purchases made as domestic and foreign imports; however, it is more likely due to the treatment of family or owner-operator labor in the 150 head dairy system.

The 150 cow unit requires two full time workers; however, one full time worker in this system is assumed to be the proprietor who is not treated as an employee. The total employment impact divided by two instead of one would yield a lower employment multiplier for the 150 head system.

Table 4.4 Comparison of the 1000 head dairy system at the regional, state, and national level.

Multipliers	1000 head Regional Level	1000 head State Level	1000 head National Level
Total Output	1.60	1.79	3.20
Employment	2.84	3.44	7.37
Total Value Added	2.21	2.69	5.41

Table 4.5 Comparison of the 150 head dairy system at the regional, state, and national level.

Multipliers	150 head Regional Level	150 head State Level	150 head National Level
Total Output	1.30	1.43	2.68
Employment	2.70	3.70	8.63
Total Value Added	1.37	1.53	2.83

4.2 Economic Impact of Forecasted Dairy Growth

Total milk production in South Dakota for 2004 was 1.347 billion pounds. The linear regression analysis in Chapter 1 forecasts production to be 1.47 billion pounds in 2010, a 123 million pound gain, given the current trends in milk production per cow and number of cows for the state. Despite forecasted gains in milk per cow for herds of less than 50 cows, 50-99 cows, and 100 or more cows, increases in total milk production are forecasted solely for dairy operations with 100 cows or more.

It is important to note that the 123 million pound expansion represents the net gain in total milk production forecasted for the state. Herds of 100 cows or more are forecasted to have a total milk production of 1.24 billion pounds by 2010, a 297 million pound gain over the 2004 production of 943 million pounds. Herds of 99 cows or less are forecasted to produce 230 million pounds by 2010, a 174 million pound decline from the 2004 production of 404 million pounds. The decline in milk production for dairy herds of 99 cows or less results entirely from a forecasted decline in cow numbers. The gains projected for dairies of 100 cows or more results from both gains in milk production per cow and an increase in overall dairy cow numbers.

Three separate IMPLAN models were developed to estimate the economic costs associated with production declines in dairies with 99 cows or less and the offsetting economic gains from increased production in dairies with 100 cows or more:

- Model 1: State level impact of a 174 million pound decrease in milk production using 1998 IMPLAN default production function and regional purchase coefficients. (Table 4.6)
- Model 2: State level impact of a 297 million pound increase in milk production using the 150 head dairy production function developed in Chapter 3. (Table 4.7)
- Model 3: State level impact of a 297 million pound increase in milk production using the 1000 head dairy production function developed in Chapter 3. The regional purchase coefficients for feed grains and hay/pasture are set to one. (Table 4.8)

Milk is valued at $13.00 per cwt in all three models yielding a downward shock to the dairy production industry of $22.62 million in Model 1 and an upward shock of $38.61 million in Models 2 and 3.

Larger dairies are relatively new to South Dakota therefore it is reasonable to use the default 1998 IMPLAN production functions and regional purchase coefficients to estimate the economic impacts of the projected decline in production from dairies with less than 100 cows.

The projected decline in milk production from dairy herds with less than 100 cows, without offsetting gains from dairy herds with 100 cows or more, will cost South Dakota an estimated $35.5 million in direct, indirect, and total output with over $22 million in reduced output from the dairy industry alone (Table 4.6). Employment is reduced by an estimated 229 jobs with the dairy farm products, trade, and professional services sector affected most. The estimated job reduction does not include the owner-operators of the actual dairy enterprise exiting the industry. The estimated reductions in output, employment, and value-added are gross numbers and do not take into account the reallocation of resources into alternative uses, which will in turn generate their own economic activity.

Table 4.6 State level economic impact of a 174 million pound decline in milk production

Industry	Total Output	Employment	Value Added
Dairy Farm Products	(22,636,354)	(57.8)	(7,147,861)
Feed Grains	(1,008,967)	(6.7)	(373,467)
Hay & Pasture	(1,034,515)	(18.6)	(476,317)
Transportation (AGG)	(1,180,586)	(10.6)	(567,148)
Wholesale Trade	(1,681,448)	(18.6)	(1,150,921)
Other Trade (AGG)	(1,032,850)	(33.6)	(773,341)
Other Professional Services (AGG)	(1,890,690)	(42.3)	(1,160,914)
All other	(4,072,146)	(40.4)	(2,379,269)
Total	(34,537,556)	(228.6)	(14,029,238)

The direct, indirect, and induced impacts from increased dairy production via the 150 head and 1000 head dairy models are shown in Tables 4.7 and 4.8. Overall total output is greater for the 1000 head model due to increased spill over into the feed grains and hay/pasture sectors, which has been shown throughout the chapter. The wholesale trade sector differs greatly due to heifer purchases by the 1000 head dairy model, which is captured in this sector. The 150 head model is assumed to raise heifers on site.

As expected, employment numbers in the feed grains, hay/pasture, trade, and services sectors are greater in the 1000 head model since those dairies utilize more outside services and purchase all feed inputs. Employment numbers within the dairy production sector; however, can be misleading. Note that a 150 head dairy producing 19000 lbs/cow as specified by the budgets in Chapter 3 will produce 2.85 million pounds of milk per year. Approximately, 104 dairies operating under the preceding assumptions would be required to produce the additional 297 million pounds of milk projected. The additional hired labor specified in the 150 head dairy model is accounted for in the employment impacts; however, the additional number of owner operators along with family labor is not. The 1000 head model producing 22000 lbs of milk per cow as specified in the Chapter 3 budgets will produce 22 million pounds of milk per year. Approximately, 13.5 dairies would be needed to produce the additional 297 million pounds of milk projected per year under the 1000 head dairy model. Value added for the dairy products sector under the 150 head model is $18.7 million compared to $10.2 million in the 1000 head model. Family supplied labor and management together with

Table 4.7 State level economic impact of a 297 million pound increase in milk production--150 head model

Industry	Total Output	Employment	Value Added
Dairy Farm Products	38,610,036	104	18,712,816
Feed Grains	73,109	0.5	27,061
Hay & Pasture	74,960	1.3	34,513
Transportation (AGG)	717,709	7.5	322,085
Utilities	1,123,006	4.1	856,104
Wholesale Trade	2,762,310	30.6	1,890,753
Other Trade (AGG)	1,491,366	48.5	1,117,630
Banking & Financial Services	1,536,136	15.0	1,165,684
Other Professional Services (AGG)	2,644,469	59.6	1,620,897
All other	6,321,374	71.4	2,950,142
Total	55,354,475	342.5	28,697,685

Table 4.8 State level economic impact of a 297 million pound increase in milk production--1000 head model

Industry	Total Output	Employment	Value Added
Dairy Farm Products	38,610,768	189.0	10,170,574
Feed Grains	3,677,182	24.4	1,361,101
Hay & Pasture	3,770,291	67.8	1,735,935
Maintenance & Repair	1,044,094	18.9	604,003
Utilities	1,027,548	3.6	767,909
Transportation (AGG)	1,158,131	11.9	517,267
Wholesale Trade	6,320,443	69.9	4,326,232
Other Trade (AGG)	1,856,094	60.4	1,389,431
Banking & Financial Services	1,715,669	18.0	1,312,672
Real Estate	1,329,304	7.1	974,231
Other Professional Services (AGG)	3,434,717	77.7	2,105,573
All other	5,162,238	64.7	2,107,749
Total	69,106,479	613.4	27,372,677

Table 4.9 Net economic impacts resulting from the 150 head and 1000 head dairy model

	150 head	**1000 head**
Total Output	20,816,919	34,568,923
Employment	113.9	384.8
Total Value Added	14,668,447	13,343,439

self-raised feedstuffs explains much of the difference. Net results from the projected decline and the alternative dairy production increases are in Table 4.9

4.3 Forward Linkages

The backward linkages associated with dairy production have been the primary focus of this research; however, South Dakota's milk processing industry has an additional economic impact on the state. The economic impact on milk processing from the preceding dairy expansion scenario, where milk production increased by 123 million pounds, is considered in this section using 2002 IMPLAN data.

The economic impact of the cheese manufacturing industry was analyzed under the following assumptions:

- The entire dairy expansion of 123 million pounds of milk is processed into cheddar cheese.
- Ten pounds of cheese can be obtained from 100 pounds of milk
- Cheddar cheese: $1.60/lb[1]

Approximately, 12,300,000 pounds of cheddar cheese can be produced from the 123 million pounds of milk yielding a cheese manufacturing expansion of $19,680,000 at the

[1] NASS survey cheese prices are based on a weekly survey of the price received by cheese plants for a 40 pound block of cheddar cheese. The highest price obtained in 2005 for Minnesota/Wisconsin (MN/WI) was $1.73,while the lowest price was $1.47 with a majority of the weekly prices falling into the $1.55 to $1.60 range. South Dakota is not surveyed independently for cheese prices.

assumed cheddar cheese price of $1.60. Sector 64 (Cheese manufacturing) was shocked at the state level in the IMPLAN model by $19,680,000. Total results are presented in Table 4.10 along with selected sectors that exhibited relatively large impacts.

The results presented in Table 4.10 are not entirely additive economic impacts in addition to the net impacts in Table 4.9 and must be viewed separately from the dairy industry impacts. Nevertheless, the multipliers for total output, employment, and value-added are all larger than the corresponding multipliers for both the 150 and 1000 head dairy farms, which suggests the importance of maintaining a level of dairy production within the state that will attract and maintain processing capacity in South Dakota.

Table 4.10 Economic impacts from expanding the cheese manufacturing industry--State Level (S. Dakota)

Sector	Description	Output	Employment	Value-Added
10	All other crop farming	2,004,634	9.4	1,066,564
11	Cattle ranching and farming[a]	10,499,120	71.7	934,242
64	Cheese manufacturing	23,152,950	41.2	2,282,783
65	Dry- condensed- and evaporated dairy products	713,606	1.5	215,371
390	Wholesale trade	2,299,768	22.1	1,665,023
394	Truck transportation	480,435	4.7	202,898
431	Real estate	1,011,676	6.3	713,800
437-490	Other Services (e.g food, health care etc.)	2,532,404	41.8	1,440,069
	All Other	5,457,901	52.1	2,970,267
	Total	48,152,494	250.8	11,491,017
	Multiplier	2.08	6.09	5.03

[a] Production dairy farms are included in this sector in the 2002 IMPLAN models for South Dakota.

Chapter 5

Discussion and Conclusions

The objective of this research was to compare and contrast the economic impacts between a 150 head dairy and a 1000 head dairy by tracing the backward linkages associated with each system's production. This research was motivated in response to the problem of declining milk production in South Dakota combined with societal concerns over large, confinement dairies locating in South Dakota, which have the potential to stem production losses in the state. The results of this research were to provide the dairy industry and policy makers within the state with information of the impacts of developing the South Dakota dairy industry.

Structural differences in dairy production costs and methods for alternative sized dairies were evident from a review of literature. A farm panel approach was used to establish the current production practices and other requirements for a typical dairy farm with a 150 head and a typical dairy farm with a 1000 head. The Minnesota Farm Business Management Database, FINBIN, was used to smooth data and fill gaps in data received from the farm panels.

Economic impacts were examined for a six county area made up of Brookings and those contiguous to Brookings County including: Deuel, Kingsbury, Hamlin, Lake, and Moody counties. The output multiplier impact within the region was the greatest (1.60) for the 1000 head system that purchased all inputs with 100 percent of feed grains and hay inputs being purchased from within the region. The 150 head system had a total output multiplier of 1.30 within the same region. Internalizing the production of feed, which represents the economic structure of the 150 head dairy results in lower output multipliers.

Employment impact was the highest for the 1000 head dairy system with a multiplier of 2.84. The higher impact of the 1000 head system is expected since this system makes more purchases from other sectors than the 150 head system, which leads to higher indirect and inducted impacts on the other sectors. The employment multiplier of 2.84 results from a change in the regional purchase coefficients for feed grains and hay/pasture from 0.165 to 1.00. The employment multiplier under the default regional purchase coefficients was 2.26 while the 150 head system had an employment impact of 2.70 (Tables 4.2 and 4.3). This shows that larger operations do not necessarily help an economy if jobs and value added leak out of the local economy to neighboring counties and states. The 1000 head system did not exhibit an advantage in employment impacts until feed needs were supplied exclusively from within the study region.

The total value added multiplier was highest for the 1000 head dairy (2.21), which had significant contributions to the feed, trade, and service sectors. The 150 head dairy where feedstuffs were raised had a total value added multiplier of 1.37. The production value of the raised crops stays on the farm thereby minimizing the value added effect on other sectors.

The economic impact of the dairy industry can vary with changes to the economic structure of the IMPLAN model. As stated earlier, the regional purchase coefficients for feed grains and hay/pasture were set to 1.00 from .165 for the 1000 head unit. The feed grains and hay/pasture sectors are not applicable to the 150 head dairy, which grows its own feed supply. Adjustments in these two sectors for the 1000 head dairy led to increases in output, employment, and value added impacts within the region.

The comparison of the six county study region multipliers against the national level multipliers for both systems illustrates a potential range in multipliers by changing the regional purchase coefficients.[1] The total output multipliers ranged from 1.60 to 3.2 for the 1000 head unit compared to a range of 1.30 to 2.68 for the 150 head unit. The employment multiplier for the 150 head unit was highest (8.63) at the national level compared to the 1000 head unit at 7.37. While the impact on other sectors is greater for the 1000 head dairy, the proportional increase is slightly less under the dairy structures designed for this research. Family labor, including an owner operator, which is not paid but has an owner's draw is assumed in the 150 head dairy model, therefore only one additional "employee" is assumed to be on the farm. The implied total employment impacts are divided by one for the 150 head unit to obtain an employment multiplier while the total employment impacts of the 1000 head dairy are divided by 14 to obtain an employment multiplier. Total value added ranged from 2.21 at the regional level to 5.41 nationally for the 1000 head dairy compared to multipliers of 1.37 to 2.83 for the 150 head dairy. Again, the 150 head dairy, where the feed is grown on the farm has a lower total output than the 1000 head dairy as most of the value of production remains on the farm.

What economic benefits would South Dakota be foregoing if the dairy industry cannot expand? In the analysis of the scenario where the dairy industry expands as

[1] Regional Purchase Coefficients are nearly one for all sectors at the national level.

forecasted by recent trends (See Chapter 1) substantial benefits in output, employment, and value added was observed. The comparison was done based on the production increase of 123 million pounds of milk achieved solely by the 150 head dairy structure versus the same gain achieved by the 1000 head dairy structure.

The expansion alone accounted for over $20 million in net total output, over $14 million in valued added, and an additional 114 jobs for the state when achieved via the 150 head dairy model. The 114 additional jobs do not include the additional proprietors needed for each dairy, which is estimated at 104. Under the 1000 head model, the expansion produced over $34 million in total output, over $13 million in value added, and an additional 385 jobs. Proprietary additions in this case would be 13-14. If the entire expansion was processed in South Dakota as additional cheese production the projected growth in milk production would provide an additional $48.2 million in total output, 251 additional jobs, and over $11 million in value added impacts for the state.

These results suggest that there are significant economic advantages to expanding the dairy industry. If the dairy industry cannot expand in the dairies sized at 100 cows or more, the trends suggest that not only will there be no additional gains in South Dakota dairy production, there will be continued decline. One can assume the results presented above as foregone costs in addition to economic losses of dairies sized below 100 head if expansion was impeded. Additionally, processing capacity is dependent on a certain level of local production. The cheese manufacturing multipliers suggest economic losses larger than that of dairy production if local production declines to a level that processors choose to exit the region.

These results show that existing dairy farms which can be profitably expanded together with new style large dairies can provide a boost to the dairy industry and generate new economic opportunities within the state.

5.1 Suggested Topics for Further Research

The number of new producers entering the dairy industry is lower than the number exiting; therefore new entrants must produce on a larger scale than their predecessors. This research considered primarily the economic impacts associated with larger sized future dairy production within South Dakota. Further research is needed to accomplish the difficult task of valuing the environmental impacts of dairy production at various sizes. The degree to which permitting becomes a significant barrier to larger operations will likely determine the course of dairy production within South Dakota. Environmental benefit and cost information together with economic impact information will provide policy makers with a sound basis regarding new dairy constructions and expansions.

Further research may need to be devoted to the occurrence of substitute economic activity over the long run. The substitute effect of dairies increasing their herd size and new dairies entering the industry to offset losses in dairies with less than 99 cows was examined briefly in this research over the short run. In the short run, the economy is basically inflexible; therefore when a dairy goes out of business the backward linked industries are negatively affected. Over the long run the economy is much more flexible. If decision makers in South Dakota opt to not pursue larger dairies to offset declines in smaller dairies, it will be important to understand how the economy will make adjustments like converting dairy hay acres to other crops or housing, finding new employment for hired labor, and establishing new businesses to replace dairy related industries.

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APPENDIX

Table 1

Livestock Enterprise Analysis, 2004
Minnesota Statewide Farm Business Mgmt. Data Base
Dairy -- Average Cow

Number of farms	10	Coefficients
Milk sold	3,655.26	.92558
Dairy Calves sold	50.32	.01274
Transferred out	83.72	.02119
Cull sales	159.87	.04048
Total production	3,949.17	1.00000
Direct Expenses		
Corn	139.79	.03539
Corn Silage	152.43	.03859
Hay, Alfalfa	98.26	.02488
Haylage, Alfalfa	122.27	.03096
Complete Ration	114.78	.02906
Protein Vit Minerals	587.97	.14888
Other feed stuffs	49.02	.01241
Breeding fees	28.53	.00722
Veterinary	134.92	.03416
BST	51.24	.01297
Livestock supplies	129.69	.03284
Fuel & oil	41.48	.01050
Repairs	92.29	.02337
Custom hire	51.87	.01313
Hired labor	109.40	.02770
Marketing	84.07	.02129
Bedding	48.65	.01232
Purchased Replacements	680.49	.17231
Total direct expenses	2,717.16	.68803
Overhead Expenses		
Custom hire	27.87	.007057
Hired labor	348.79	.088320
Machinery & bldg leases	28.10	.007115
Farm insurance	20.93	.005299
Utilities	43.65	.011052
Interest	124.00	.031399
Mach & bldg depreciation	115.22	.029175
Miscellaneous	41.36	.010473
Total overhead expenses	749.92	.189893
Total dir & ovhd expenses	3,467.08	.877926

Other Information	
Average Number of Cows:	707
Milk per cow	22,023
Avg price per Cwt.	16.61

Table 2

Livestock Enterprise Analysis, 2004
Minnesota Statewide Farm Business Mgmt. Data Base
Dairy -- Average Cow

Number of farms	15	Coefficients
Milk sold	3,314.41	.9250
Dairy Calves sold	13.76	.0038
Transferred out	119.36	.0333
Cull sales	135.56	.0378
Total production	3,583.09	1.00
Direct Expenses		
Corn	196.89	.0549
Corn Silage	116.94	.0326
Hay, Alfalfa	178.34	.0497
Haylage, Alfalfa	84.09	.0235
Complete Ration	67.74	.0189
Protein Vit Minerals	455.10	.1270
Other feed stuffs	98.10	.0274
Breeding fees	36.18	.0101
Veterinary	105.24	.0294
BST	25.49	.0071
Livestock supplies	149.45	.0417
Fuel & oil	43.00	.0120
Repairs	91.28	.0255
Hauling and trucking	24.01	.0067
Marketing	26.89	.0075
Bedding	28.17	.0078
Total direct expenses	1,726.90	.4820
Overhead Expenses		
Hired labor	234.66	.0655
Machinery & bldg leases	29.98	.0084
Farm insurance	31.72	.0089
Utilities	58.74	.0164
Interest	94.51	.0264
Mach & bldg depreciation	158.43	.0442
Miscellaneous	54.77	.0153
Total overhead expenses	662.81	.1850
Total dir & ovhd expenses	2,389.71	.6670
Other Information		
Avg. number of Cows	137.8	137.8
Milk produced per Cow	20,571	20,571
Avg. milk price per cwt.	16.14	16.14

Table 3 Crop Enterprise Budgets

Minnesota State wide Farm Business Mgmt. Data Base--2004

	Corn for Grain	Corn for Silage	Alfalfa	Other Hay	Total Costs	IMPLAN
Required Acres	105	68	118	27		
Direct Expenses						
Seed	44.60	38.63			7,309.84	447
Fertilizer	49.58	47.57	31.23	5.26	12,267.82	202
Crop chemicals	26.53	23.84	4.11	2.17	4,950.34	204
Crop insurance	11.49	6.46	1.70		1,846.33	459
Fuel & Oil	11.46	10.45	13.49	8.20	3,727.12	210
Repairs	18.16	20.83	27.70	3.62	6,689.58	482
Land rent equivalent/1	89.10	89.10	57.60	57.60	23,766.30	va
Operating Interest	5.76	4.90	5.92		1,636.56	456
Total Direct Expenses	256.68	241.78	141.75	76.85	62,193.89	
Overhead Expenses						
Insurance	2.96	5.68	5.37	4.91	1,463.27	459
Interest	4.41	18.78	3.50	3.75	2,254.34	456
Mach & Bldg Depr	12.10	18.73	16.33	7.27	4,667.37	va
Total Direct & Overhead	276.15	284.97	166.95	92.78	8,384.98	

Middle 80% of Lincoln, Pipestone, and Rock Counties
1/2005 South Dakota Agricultural Land Market Trends Circular

Table 4: Acres required—150 head dairy

Item	Required Tons	Potential Yield[2]	Acres Required
Corn (Gr)	13638.57	129.8	105
Corn (Si)	1045.73	15.3	68
Alfalfa	196.21	3.2	61
Alfalfa (Si)	395.8	7	57
Grass Hay	53.29	1.95	27

[2] 5-year average for Brookings County, S.D. (NASS)