Economic Impacts of Alternative Sized Dairy Farms in South Dakota[1]

By

Dr. Larry Janssen, Dr. Gary Taylor, Mr. Erik Gerlach, and Dr. Alvaro Garcia[2]

South Dakota State University[3]

Brookings, South Dakota

[1] Selected Paper submission to Western Agricultural Economics Association Meetings, Anchorage, Alaska, June 28 – 30, 2006

[2] Dr. Janssen is Professor of Economics, Dr. Taylor is Assoc. Professor of Economics, and Mr. Gerlach is former graduate research assistant in Economics. Dr. Garcia is Extension Dairy Specialist, SDSU

[3] Funding for this research was provided by the South Dakota Agricultural Experiment Station

Economic Impacts of Alternative Sized Dairies in South Dakota

by Dr. Larry Janssen, Dr. Gary Taylor, Mr. Erik Gerlach, and Dr. Alvaro Garcia
South Dakota State University

Abstract

South Dakota dairy industry has shifted toward large operations to offset declining numbers of dairy cows and milk production stemming from rapid exodus of smaller (<100-cow) dairy farms. This study examines the regional and state level economic impacts of expansion by large and medium size modern dairies. Whole-farm budgets were constructed from producer panel and secondary data. Based on IMPLAN results, the 1000-head dairy generally had higher output, employment and value added multipliers resulting from increased feed and wholesale purchases. The 150-head dairy, which raised its own feed and replacement heifers, had higher amounts of value added.

Introduction

South Dakota dairy production is declining in terms of number of dairy farms, and until recently, declining in number of dairy cows, and volume of milk production. Dairy farms with less than 100 cows are rapidly declining while the number of larger dairy farms is increasing. State policy makers and business interests have worked to encourage dairy development, especially new large dairies of 600 to 2500 cows in eastern South Dakota's Interstate 29 (I-29) corridor. This trend to large dairy units is leading to struggles between producers, local policy makers, and residents regarding environmental, social, and economic impacts of large dairy operations in eastern South Dakota.

The objective of this research is to compare and contrast the economic impacts of alternative size dairies with potential to expand in the state. This study provides an assessment of the regional and state level impacts of two alternative sized dairies (150-cow and 1000-cow) that

represent potential expansion of modern medium size and larger dairy units in South Dakota. The study is organized into the following segments: (1) past and prospective trends in the South Dakota dairy production industry, (2) determination of production functions for a medium (150-cow) and large (1000-cow) dairy in eastern South Dakota, (3) determination of the economic impacts of alternative dairy farm expansion scenarios on the regional and state economy, and (4) conclusions and implications.

Past and Prospective Trends

South Dakota's dairy industry has followed national (U.S.) trends to 2004 in terms of declining number of dairy cows, declining number of dairy farms, increased herd size, and increased milk production per cow. For example, from 1978 to 2004, the number of dairy cows in South Dakota declined 51 percent from 162,000 to 80,000 cows, while the number of dairy operations declined 86 percent from 7400 farms to 1000 farms in the same period. Average herd size in South Dakota in 2004 was nearly 80 dairy cows per farm compared to only 22 cows per farm in 1978. In 2004, dairies of 100 head of more were 21 percent of dairy farms in South Dakota and accounted for 70 percent of annual production. Milk production per cow in South Dakota increased 77 percent from 9,500 lbs. per cow in 1978 to 16,840 lbs. per cow in 2004 (NASS).

Despite declines in U.S. dairy cow numbers (18 percent) during the same time period, U.S. milk production steadily increased as the amount of milk production per cow increased. Total U.S. milk production increased 45 percent from 115.4 billion pounds in 1975 to 167.7 billion pounds in 2000 (Blayney). However, total milk production in South Dakota declined despite comparable 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 (NASS), but up

4.4% from a low of 1.29 billion pounds in 2002. The general trend of declining milk production in South Dakota has raised major concerns for dairy processors located in the state.

Examination of recent trends, 1998 – 2004, in South Dakota milk production by herd size (less than 50 head, 50 – 99 head, and 100 head or more) confirmed the rapid changes and consolidation of dairy production units. Total milk production of small (less than 100 head) dairies declined from 693 million pounds in 1998 to 404 million pounds in 2004, despite substantial increases in milk production per cow. Total milk production of larger dairies (100 cows or more) increased 250 million pounds from 693 million pounds in 1998 to 943 million pounds in 2004. Most of this increase came from new investment in larger dairies and from some expansion of existing dairies.

Using annual trend data from 1998 – 2004, Gerlach used OLS regression models to estimated annual growth rates in cow numbers and milk production to 2010. The estimated annual midpoint growth rates for cow numbers in smaller sized South Dakota dairies were -14.46 percent for herd sizes under 50 cows and -10.43 percent for herds of 50 – 99 cows, while a positive annual growth rate of 3.17 percent is estimated for larger (100-head plus) dairies. The share of milk produced from these larger dairies increased from 50% in 1998 to 70% in 2004 and is forecast at 84% in 2010. Statewide, milk production is projected to increase by 123 million pounds or 9.1% from 2004 to 2010. However, the confidence interval on milk production estimates for large dairies for 2010 is fairly large, primarily due to variation in production per cow estimates (Gerlach, 2005).

The trend analysis clearly indicates the declining contribution of small and moderate size dairies of less than 100 milk cows and the rationale for dairy business development emphasizing establishment of large dairies and expansion of existing dairies to more than 100 cows.

Economic costs, profitability considerations, availability of financing, environmental regulations, and local resident (social) acceptance will govern the actual magnitude of expansion and whether expansion will occur primarily with medium size (100 – 250 cow dairies) or much larger (600 – 2500 cow) dairy operations.

Table 1 South Dakota Dairy Industry Production Trends (1998-2004) and Forecast for 2010

	1998	2000	2002	2004	Midpoint Forecast 2010a
Herds of less than 50 cows					
Number of Cows	22770	16625	12900	8800	3450
Total Milk Production (Million lbs)	263	210	160	135	66
Milk per cow (lbs)	11565	12413	12490	15341	19057
Herds of 50-99 cows					
Number of Cows	32175	28975	21930	17600	9090
Total milk Production (Million lbs)	430	398	296	269	157
Milk per cow (lbs)	13354	13735	13519	15284	17300
Herds of 100 cows or more					
Number of Cows	44055	49400	51170	53600	64640
Total Milk Production (Million lbs)	693	874	831	943	1237
Milk per cow (lbs)	15730	17604	16248	17591	19155
All Herds					
Number of Cows	99000	95000	86000	80000	77180
Total Milk Production (Billion lbs)	1.386	1.474	1.289	1.347	1.470
Milk per cow (lbs)	14000	15516	14988	16838	18932

a: Forecast source: Gerlach (2005). 1998 -2004 data from NASS, 2005.

Production Function Characteristics of Alternative Size Modern Dairies

Separate production functions were developed for representative 1000 head and 150 head dairy farms from data provided by local dairy farmer/panelists and from FINBIN (Minnesota Farm Business Management) dairy farm data. Farmer panelists were used to help establish current production and marketing practices and many other requirements for a representative dairy farm. Two separate panels were conducted with one panel consisting of producers operating at or near the 1000 head level and another panel of producers operating near the 150 head level. Panel participants provided information on herd dynamics and feed demands for both dairy sizes and insight into the cost structure of both dairy farm sizes. However, panel sizes were not sufficiently large or prepared to produce reliable expenditure estimates for representative dairies in their size group. Thus, expenditure data was supplemented from the FINBIN database for medium-size (100 – 199 cow) and large dairies located in western and central Minnesota. The similarity in climate and production methods between western and central Minnesota and eastern South Dakota permits valid comparison and analysis.

The study region includes six counties in eastern South Dakota: Brookings, Deuel, Hamlin, Lake, Moody, and Kingsbury counties. The larger dairy is a commercial dairy operation which purchases almost all inputs, including feed, and employs mostly hired labor, while the medium size dairy would grow most of its own feed and employ both family and hired labor. Both dairies are assumed to be confinement-style operations. The milk price used in the analysis is $13.00 per cwt, which is lower than the 2005 FAPRI Agricultural Outlook forecast price for all milk in South Dakota from 2005 – 2014.

Based on key information provided by dairy farmer panel members the following assumptions were used to construct the production function and cost estimates:

- Dairy cows are milked for 305 days and dry for 60 days 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. Therefore, 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.
- Annual production levels of 22,000 lbs/cow are assumed for the 1000-cow dairy and 19,000 lbs/cow are assumed for the 150-cow dairy. The large dairy farm uses BST and milks three times per day while the medium size dairy farm does not use BST and milks twice per day.
- Specific feedstuffs used in a typical Total Mixed Ration (TMR) will vary based on many factors including changing costs and weather conditions. However, TMRs for both dairy operations are based on corn silage, alfalfa haylage, and alfalfa hay supplemented with energy, protein, and mineral components to complete the ration. The final feed rations used in the study were developed from producer panel information and from consultation with Dr. Alvaro Garcia, SDSU Dairy Production Specialist. The final ration assumed lactating cows consumed 51 pounds of dry matter per day, while dry cows consumed 24 pounds of dry matter per day.
- Large dairy farm panel members indicated that almost all feed (silage, haylage, hay, soybean meal, DDGs, etc) is purchased within the study region or the state from contracts with local farmers and from local soybean meal plants or ethanol plants. The medium size dairy raises most of its feed from an estimated 320 acres of cropland.
- The large and small dairies 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 medium size dairy operation raises its own heifer replacements. 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 dairy operation incurs a death loss of 5%, while 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 members recommended approximately 14 full time hired laborers 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.

Receipt and Cost Structure of Alternative Sized Dairy Farms

The receipt and costs structure for each representative dairy farm were based on the production practices above and related information supplied by dairy panelists and from dairy farm averages in FINBIN. A condensed whole-farm budget summary for the large and medium size dairy farms is shown in table 2 and is based on detailed budgets available in Gerlach.

Total receipts per cow for the 1000 head dairy was $3114 compared to $2882 per cow for the 150-cow dairy. Milk receipts were 91.8% of total receipts for the larger dairy compared to 85.7% of total receipts for the 150-cow dairy (table 2). The medium size operation kept all dairy heifer calves and sold those not needed for replacements, while the larger dairy farm outsourced raising replacement heifers to neighboring farmers. Most of the remaining differences in receipts per cow were due to differences in milk production levels.

Feed costs (market price) were slightly higher, $1106 vs. $1021 per cow, for the 150-cow dairy due to the added costs of feeding replacement heifers. In addition, the costs per cwt. of milk production were considerably higher for the smaller operation, $5.82 per cwt of milk sold, compared to the 1000-cow operation with feed costs of $4.64 / cwt. of milk sold. Feed costs are generally lower in South Dakota and western Minnesota than are often found in studies for other regions or for the nation. Since all feed requirements were purchased by the large dairy, the condensed budget in table 2 shows feed costs of $1021 per cow. However, the budget for the 150-cow dairy allocates feed costs into feed purchases, variable and fixed expenses of raised feed and forages, and other items.

Variable expenses, other than feed purchases and costs of heifer replacements, for the 1000-head dairy were $734 per cow or $3.34 per cwt. of milk sold. The 150-head representative dairy had variable expenses, other than purchased feed, of $843 per cow or $4.44 per cwt of milk sold. Nationally, dairies of 500 head of more had variable costs, other than purchased feed, of $3.86 per cwt of milk sold compared to dairies of 50 – 199 head with variable costs, other than purchased feed, of $4.22 per cwt of milk sold (Short).

The types of variable expenses differ between the alternative sized dairies. The large (1000-head) dairy incurs additional non-feed variable expenses related to BST use and purchasing (instead of growing) replacement heifers. The 150-head dairy farm incurs variable production expenses related to raising corn and forages for feed.

The fixed expense section of the budget consists of hired labor charges and overhead / ownership expenses. Based on discussion with panel farm members, the large dairy employs 14 full-time workers at an average rate of $10.23 per hour for a 55-hour week or $29,250 annually. The medium-size dairy employs one-full time worker at $30,000 per year and also uses

considerable family labor. Hired labor costs per cwt. of milk sold are $1.86 for the 1000-head unit and $1.05 per cwt. for the 150-head unit. Nationally, labor costs (in 2000) for dairy farms of 500 head or more were $1.41 per cwt. of milk sold compared to $1.01 per cwt. for dairies of 50 – 199 head (Short).

Overhead expenses, other than labor, for the 1000-head dairy were $281 per cow or $1.28 per cwt. of milk sold. The 150-head dairy had overhead expenses, other than labor, of $520 per cow or $2.74 per cwt. of milk sold. The higher overhead expenses were related to higher land ownership charges, insurance, and machinery/building deprecation associated with the dairy operation and raised feed for the dairy herd. Nationally, non-labor overhead expenses are also considerably higher for midsize dairy units compared to larger dairy operations.

The detailed whole-farm budgets developed by Gerlach, and summarized in table 2, were also used to develop the whole farm IMPLAN budgets shown in table 3. The budgets for both dairy farms in table 3 allocate whole farm expenditures to specific purchasing sectors or to "value added" sectors of hired labor, land charges, taxed, management, capital recovery, and returns above costs. The sum of expenditures and "value added" activities must equal total receipts.

All variable costs and selected fixed costs, such as interest and farm insurance expenses, shown in table 2 are allocated to specific IMPLAN purchasing sectors in table 3. All other fixed costs in table 2 such as hired labor, land charges, taxes, and building/machinery depreciation (capital recovery) are listed as "value added" activities in table 3. The remaining value added activities of management and return above costs are not included in the second table. The value added activities are reconstructed for IMPLAN modeling purposes into four sectors: proprietary income, labor, taxes, and other property income.

Table 2 Whole farm budget for large and medium size dairy operations

Item	Large (1000-cow) Dairy			Medium (150-cow) Dairy		
	Value per cow	Value for 1000 cows	Proportion of receipts	Value per cow	Value for 1000 cows	Proportion of receipts
Receipts:	$	$		$	$	
Milk	2,860	2,860,000	0.918	2,470	370,500	0.857
Other[a]	254	254,350	0.082	412	61,814	0.143
Total Receipts	**3,114**	**3,114,350**	**1.000**	**2,882**	**432,314**	**1.000**
Variable Expenses						
Feed purchase	1,021	1,020,800	0.328	469	70,363	0.163
Raised feed[b]	--	--	--	245	36,791	0.085
Replacement heifers[c]	396	396,000	0.127	--	--	--
Other variable expense[d]	734	733,870	0.236	618	92,706	0.214
Subtotal: Variable Expense	**2,151**	**2,150,670**	**0.691**	**1,332**	**199,860**	**0.462**
Fixed Expenses						
Hired labor	410	409,500	0.132	200	30,000	0.069
Raised feed	--	--	--	225	33,786	0.078
Other dairy expense	281	280,960	0.090	295	44,200	0.103
Subtotal: Fixed Expenses	**690**	**690,460**	**0.222**	**720**	**107,986**	**0.250**
All Costs (except mgt.)	**2,841**	**2,841,130**	**0.912**	**2,052**	**307,846**	**0.712**

[a]Other receipts include sale of cull cows, bull calves, and heifers.

[b]Variable expenses for raised feed and forage for the 150-cow dairy include crop related expenses for fuel and oil, equipment repairs, seed, fertilizer, herbicide and crop insurance.

[c]Replacement heifers are purchased by the large dairy and raised by the medium size dairy.

[d]Other variable expenses includes expenses related to marketing, hauling, bedding, vet and medicines, BST (large dairy only), fuel, building/equipment repair, breeding, utilities, livestock supplies, and water.

[e]Fixed expense for raised feed and forage for the 150-cow dairy include crop-related interest expense, machinery and building repair, farm insurance, and cropland rental charge.

Source: Gerlach, 2005

Table 3. Whole Farm IMPLAN Budget – 1000-head Dairy and 150-head dairy

IMPLAN Sector	Description	1000-head Dairy Total $	1000-head Dairy Coefficient	150-head Dairy Total $	150-head Dairy Coefficient
12	Feed Grains	346,683	0.111	0	0.000
13	Hay & Pasture	230,589	0.074	0	0.000
21	Oil bearing crops	97,864	0.031	14,650	0.034
26	Ag Services	268,030	0.086	21,186	0.049
56	Building Repair	31,000	0.010	4,692	0.011
76	Wet corn milling	50,124	0.016	11,470	0.027
78	Prepared Feeds	295,541	0.095	44,243	0.102
202	Fertilizers	0	0.000	12,268	0.028
204	Ag Chemicals	0	0.000	4,950	0.011
210	Petroleum Refining	41,480	0.013	10,177	0.024
435	Motor Freight Transport	33,000	0.011	3,600	0.008
443	Utilities	43,650	0.014	8,850	0.020
445	Water Supply	41,360	0.013	8,250	0.019
447	Wholesale Trade	574,350	0.184	33,954	0.079
456	Banking	124,000	0.040	18,068	0.042
459	Insurance Carriers	20,930	0.007	8,067	0.019
482	Misc. Repair Shops	61,000	0.020	15,690	0.036
512	Marketing Promotion	36,000	0.012	4,034	0.009
	Sum of purchasing sectors:	2,295,601	0.737	224,149	0.518
va	Hired Labor	409,500	0.131	30,000	0.069
va	Land Rent Equivalent	18,810	0.003	23,766	0.055
va	Taxes	10,000	0.003	1,500	0.003
va	Management	155,717	0.050	40,000	0.093
va	Capital Recovery	115,220	0.037	28,431	0.066
va	Return above costs	117,502	0.038	84,468	0.195
	Sum of value added sectors:	826,749	0.262	208,165	0.482
For IMPLAN					
va	Proprietary income	281,747	0.090	73,812	0.171
va	Labor	409,500	0.131	30,000	0.069
va	Taxes	10,000	0.003	1,500	0.003
va	Other Property income	117,502	0.038	102,853	0.238
	Sum of value added sectors:	826,749	0.262	208,165	0.482

Coefficient equals proportion of gross revenue in each dairy farm budget.
va = valued added sector

Source: Gerlach, 2005

A summary of key differences in the budgets for the alternate size dairy farms is as follows:

Production Receipts: Receipts per cow differ between the systems by $232 per 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 equaled 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 much of its own feed and raising its own heifers.

Overhead Expenses: Overhead costs make up 25 percent (7 percent labor) of the 150 head dairy farm 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.

Proprietary Income and other property income is substantially higher as percent of receipts for the 150-head dairy farm. Some of the proprietary income is used to pay for family labor in the medium size dairy. However, the total dollar magnitude of these residual income flows is much greater in the 1000-cow dairy.

Value added activities are a lower proportion of total activities for the large dairy (26 percent) than the medium size dairy (48 percent) due to much greater reliance on purchased feed and purchased replacement heifers.

Input-Output Analysis and Methodology

Input-output analysis is discussed by Richardson in 1972. The economic relationships 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). These are the relationships described earlier in the dairy production function and cost relationships section. The analysis in this paper is performed using IMPLAN Pro software.

There have been a number of studies done in the agricultural sector using input-output analysis to examine the potential gains/losses from industry entrance, exit, or expansion in a defined region (Venhuizen and Lawrence and Otto are examples). There have also been a number of dairy specific studies performed (Jafri et al., Boggess et.al., Ruwali, and Taylor). This study will build on the concepts introduced in these earlier studies.

Input-Output analysis using the IMPLAN Pro modeling software was used to estimate the overall economic impacts of a 150-head and 1000-head dairy. The IMPLAN Pro model uses a set of purchase coefficients, which makes up the industry's production function, to describe the amounts of purchases a specific industry makes from other industries and uses regional purchase coefficients (RPCs) to measure the percentage of inputs purchased locally. The IMPLAN Pro input-output model is 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. The multipliers generated within the system describe this effect.

Estimation Process

Default production functions and RPCs are included in the IMPLAN Pro software. In this study, the default IMPLAN Pro dairy industry data was replaced with production functions and RPCs representative of the following specific operation sizes and types:

1. A 150-head dairy that raises its own grain and forages, raises its own replacement heifers, and has owner/operator and family supplied labor in addition to one full-time hired employee. The dairy produces 19,000 pounds of milk per cow per year.
2. A 1000-head dairy that purchases all inputs, contracts off-site growers to supply replacement heifers, and hires all labor. The dairy produces 22,000 pounds of milk per cow per year.

The economic impacts of the 150-head and 1000-head dairies were calculated using IMPLAN Pro software. Total output, employment, and value added impacts were compared at the regional and state levels. The output and value added impacts are reported in 2005 (nominal) dollars.

The data files for the IMPLAN Pro model are updated annually and are usually available with approximately a three year time lag, i.e. the 2002 actual data is available in 2005. Due to some changes in the aggregation process in the 2002 data, dairy production was combined with all other cattle production, making analysis of individual cattle industries very difficult. The previous data set available at SDSU was the 1998 files. For this project 1998 data were used in the analysis since at that time dairy was listed as a separate industry in South Dakota.

The modifications to the default production functions and RPCs were derived from producer panels as described earlier this paper and as outlined in Lazarus. Average costs and returns for

similar dairy operations in the Minnesota Farm Business Management database, more commonly known as FINBIN. This data was also used to modify the RPCs.

The total output, employment, and value-added multipliers that would be generated by the 150 head operation are compared with that of a 1000-head operation at a regional (Brookings, Deuel, Hamlin Kingsbury, Lake, and Moody counties) and state level (tables 4, 5, and 6). Multipliers describe 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 of revenue generated in the dairy industry, $.72 of indirect and induced effects occur in related industries.

Results

Tables 4 and 5 show results of the estimated economic impacts of each dairy farm in South Dakota based on the IMPLAN Pro model. The specific industries that are subject to the largest impacts are listed separately. Table 4 shows the region level impacts of a modern 150-head dairy system. Results from table 5 represents the situation where the production function for the 1000 head facility purchases all of its feed grain and forage from local sources, allowing for a more accurate comparison between the impacts of the 150-head and 1000-head facilities.

If the feed, grain, and forage needs for the 1000-head operation are met locally, the RPCs for these items are reset to 100% and the multipliers increase to 1.60 for output, 2.84 for employment, and 2.21 for value added at the regional level (table 5).

Table 4 Regional level impacts of a 150 head dairy system

IMPLAN	Sector Description	Output (Receipts)	Employment	Total Value Added
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

Source: Gerlach, 2005.

Table 5. Impacts of a 1000 head dairy with feed needs met locally.

IMPLAN	Sector Description	Output	Employment	Total Value Added
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 Apparel, 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

Source: Gerlach, 2005

Table 6. Dairy Farm Multipliers at the Regional and State Levels

	150 cow Region	1000 cow Region (base)	**1000 cow Region***	150 cow State	1000 cow State*
Output	**1.30**	1.40	**1.60**	1.43	1.79
Employment	**2.70**	2.26	**2.84**	3.70	3.44
Value Added	**1.37**	1.88	**2.21**	1.53	2.69

In the base 1000 cow system the feed purchase RPCs are 16.5%

* The RPCs for the feed grain and forage purchases for the 1000 cow facility were reset to 100% to match the 150 cow system and to be consistent with farmer panel member recommendations

Source: Gerlach, 2005.

The total output impact of the 1000-head dairy was over 14 percent higher when feed needs were met locally. Meeting local 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 most its own feed and forage, spillover effects into the feed grain 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 differences between the regional and state level multipliers emphasize the effect of "leakage" in the system. As more goods and services are provided locally the economic impact of the industry on the area increases.

The 1000 head dairy system total output and total value added multipliers are higher relative to the 150 head dairy system when compared at the regional and state levels. The 150-head dairy has lower output multipliers because its economic structure is based on raising its own replacement heifers and growing most of its own feed.

Assuming the milk production levels stated previously at $13/cwt the 150-head dairy would generate $563,508 in total output, 2.7 jobs, and $286, 230 in value-added annually. The 1000-head dairy would generate $4,977, 184 in total output, 39.7 jobs, and $1,813,608 in total valued-added.

Economic Effects of Growth in the Dairy Industry

Total milk production in South Dakota for 2004 was 1.347 billion pounds and is forecast to be 1.47 billion pounds in 2010, a 123 million pound gain. The 2010 forecast is based on current trends in milk production per cow and number of dairy cows for the state. Dairy farms

with herds of 100 cows or more are forecast to increase total milk production by 297 million pounds from 2004 to 2010, while dairy farms with herds of less than 100 cows are forecast to decrease milk production by 174 million pounds (table 1). The gains projected for dairies of 100 cows or more occurs from increases in overall dairy cow numbers and increased milk production per cow. Decline in milk production for dairy herds of less than 100 cows is entirely from a forecast decline in cow numbers.

What are the economic benefits South Dakota would be foregoing if the dairy industry does not expand in the herds of 100 cows or more to mitigate losses in the smaller herds?

The analysis was conducted from construction of three inter-related models: (1) state-level impact of decreased milk production of 174 million pounds using 1998 IMPLAN default production function and regional purchase coefficients, (2) state level impact of a 297 million increase in milk production using the 150-head dairy production function (table 4) and (3) state level impact of a 297 million pound increase in milk production using the 1000-head dairy production function, with RPC's for feed grain and forage purchases set to 1.0 (table 5). The first model examines the economic impact of continued decline in smaller dairies and no further investment in larger dairies. The second and third models examine the economic impact of trend-line increases in milk production from two alternative size modern units. The net economic impact is obtained from subtracting results of model 1 from either model 2 or 3.

Milk production continues to be valued at $13.00 per cwt. in all three models yielding a downward shock of $22.64 million in dairy production output in model 1 and an upward shock of $38.61 million in dairy production output in models 2 and 3. A summary of the combined direct, indirect, and induced impacts from decreased milk production in model 1, increased milk

production in models 2 and 3, and net increase of 123 million pounds of milk from medium vs. large dairies are shown in table 7.

The projected decline in milk production from smaller herds without offsetting gains from medium or large dairy herds (model 1) will cost South Dakota an estimated $35.5 million in total economic output, $14.0 million reduction in value added. Employment is reduced by an estimated 229 jobs, not including the number of owner-operators exiting the dairy industry.

Forecasted gross expansion by medium size dairies compared to large dairies results in lower increases in total output and employment, but slightly higher increases in value added. The employment gains are greater in the 1000-head dairy farm model since large dairies utilize more outside services and purchase all of their feed inputs. However, an estimated 104 medium size dairy farms are required to achieve the increase of 297 million pounds of milk production, compared to 13 or 14 additional large dairy farms. Thus expansion of medium size dairies (instead of large dairies) requires many more owner/proprietors and results in greater value added than expansion of large dairies. The $28.7 million value added in the 150-head model consists of $18.7 million value added in the dairy farm sector and $10.0 million in all other economic sectors. The $27.4 million value added in the 1000-head model consists of $10.2 million value added in the dairy farm sector and $17.2 million value added through linkages with all other economic sectors.

Table 7. State-level economic impact of alternative dairy production scenarios

	Scenario change from 2004 to 2010	Total output (thousand $)	Employment[a] (number)	Value Added (thousand $)
1	174 million lb. decline in milk production	($34,537)	(229)	($14,029)
2	297 million lb. increase in milk production from medium size dairies	$55,354	342	$28,697
3	297 million lb. increase in milk production from large dairies	$69,106	613	$27,373
	Net increase of 123 million lb:			
2-1	from medium size dairies	$20,817	113	$14,668
3-1	from large dairies	$34,569	385	$13,343

[a]Employment impacts exclude changes in the number of dairy farm proprietors.

Source: Gerlach, 2005

The expansion alone (123 million pounds of milk at $13/cwt) accounts for over $20 million in net total output, over $14 million in valued added, and an additional 113 jobs for the state when achieved via the 150 head dairy model. The 113 additional jobs do not include the additional proprietors needed for each dairy, which is estimated at 104. Under the 1000 head model, the expansion produces nearly $34.6 million in total output, over $13.3 million in value added, and an additional 385 jobs plus 13 or 14 additional dairy farm proprietors.

If the entire increase in production 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 (Gerlach).

These results suggest that there are significant economic advantages to expanding the dairy industry. If the industry cannot expand from dairies with 100 cows or more, the trend suggests 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.

Conclusions and Implications

These results show that existing dairy farms, which can be profitably expanded together with new style large dairies, can provide a boost to the South Dakota dairy industry and generate new economic opportunities within the state. We can also see that there can be significant economic impacts that are dependent upon the size of the facilities that are established. The multipliers for output are 1.30 for the 150-head facility and 1.60 for the large (1000-head) dairy farm. Employment multipliers are 2.70 for the 150-head dairy and 2.84 for the 1000-head facility. Total value added multipliers are 1.37 for the medium size dairy and 2.21 for the large dairy. These multipliers suggest that there is a preferred path or size for new facilities in South Dakota. Even though expansion with either size would have positive economic impacts on the state, the larger facilities would have more economic impact due to greater linkages with other sectors of the regional and state economy.

The case for expansion by medium sized dairies is based on the greater number of dairy proprietors/owners willing to assume the financial and business risks of expansion and convincing lenders, and perhaps extended family members, to provide adequate credit.

Expansion by medium sized dairies is closer to the social and economic conditions that have occurred in the rural Upper Midwest during the past 60 years. However, the new generation of medium sized modern dairy farmers will need to have excellent production, marketing, finance, and human resource management skills to compete with the larger dairies. Results from financial simulation (CADSIM) conducted by Bailey, et al. for 150-, 300-, 500-, and 1000-cow dairy units suggests that only 500-cow and 1000-cow units are viable start-up operations in Missouri and other Midwestern states.

Producer panelists indicated that expansion of existing dairy operations to medium sized dairies was much more likely than developing new start-up 100 to 300 cow operations, while larger dairies were likely to be new start-up dairies of at least 600 cows and likely expanding from this point. Further economic and financial analyses would be needed to confirm or reject these propositions.

Changes in Previous Trends

In the NASS 2005 data there have been some changes in the trends cited in the introduction of this paper. The number of dairy cows in the state actually increased 1.3% to 81,000 and milk production increased to 1.437 billion pounds, up from 1.347 billion pounds in 2004. In addition, milk production per cow also increased in 2005 to 17,751 pounds per cow. These changes may indicate that increasing production from larger herds is indeed more than offsetting the losses from small farms and the industry is continuing to increase its efficiency.

References Cited

Bailey, K., D. Hardin, J. Spain, and J. Garrett. "An Economic Simulation Study of Large- Scale Dairy Units in the Midwest." J Dairy Sci 80 (1997): 205-214.

Blayney, Don. "The Changing Landscape of U.S. Milk Production." Electronic Report from the Economic Research Service June 2002. 10 Oct 2004 <www.ers.usda.gov>.

Boggess, William, Grace Johns, and Chris Meline. “Economic Impacts of Water Quality Programs in the Lake Okeechobee Watershed of Florida” J Dairy Science 80 (1997) 2682 – 2691.

FAPRI 2005: U.S. and World Agricultural Outlook. Food and Ag Policy Research Institute. Ames, IA. Jan. 2005.

Gerlach, Erik. Economic Impacts of Alternative Sized Dairies in South Dakota. Master’s Thesis, Dept. of Economics, South Dakota State University. Brookings, SD. Dec. 2005.

IMPLAN Professional, Version 2.0, Social accounting & Impact Analysis software, Second edition, June 2000.

Jafri, S. Hussain Ali, David Buland, and Stacie Randals. "Economic Impact of the Dairy Industry in Erath County." (2003) Paper presented at the annual meeting of the Southwestern Social sciences Association, San Antonio, Texas. April 2003

Lawrence, J. and Otto, D. “Economic Importance of the United States Cattle Industry.” Unpublished staff paper. Iowa State University, Ames, IA.

Lazarus, William F., Platas, Diego E., and Morse, George W., “IMPLAN’s Weakest Link: Production Function or RPC?” Jo of Reg Policy and Analy. 32:1-16.

National Agricultural Statistical Service (NASS) data at http://www.nass.usda.gov

Richardson, Harry W. Input-output and regional economics. London: Weidenfeld and Nicolson, 1972.

Ruwali, M. “Regional Economic Impacts of Alternative Dairy Production Systems.” Master’s Thesis, Department of Agribusiness Economics, Southern Illinois University, Carbondale, IL. August 2002.

Short, Sara D. “Characteristics and Production Costs of U.S. Dairy Operations.” Electronic Report from the Economic Research Service February 2004. 10 Nov 2004 <www.ers.usda.gov>.

Taylor, G. “Regional impact of adding additional diary cows and facilities to the I-29 corridor of South Dakota” SDSU Economics Department, Econ. Commentator 442. 2003.

Venhuizen, Laurel K. “Impacts of Post-CRP Policy Options and Land Use Decisions on Various South Dakota Economic Sectors.” Masters Thesis. South Dakota State University. 1996.