

Economic Impact of Erath County's Dairy Industry

S. Hussain Ali Jafri

*Department of Accounting, Finance and Economics, Tarleton State University,
Stephenville, TX, 76402*

David Buland

NRCS, USDA, P.O. Box 6567, Fort Worth, TX 76115

ABSTRACT

Of the 264 counties in Texas, Erath County boasts the highest dairy production, accounting for 27% of the state's total milk production. This study estimates the economic impact of Erath County's dairy industry at both the county and state levels. Combining primary and secondary data and adjusting for leakages, an input-output model was constructed and the economic impacts assessed using IMPLAN. Results place the industry's impact in Erath County at \$543 Million, representing 36% of the county's economy, accounting for 5912 jobs or 31% of all employment in the county. At the state level, Erath County's dairy industry amounted to \$772 Million and 10,926 jobs. Much of the core economic impacts were attributed to the hay and pasture, wholesale trade, motor freight transportation, and warehouse sectors.

Key Words: Dairy Industry, IMPLAN, Repurchase coefficient, Economic Impact

INTRODUCTION

Erath County boasts the highest dairy production of any county in Texas, accounting for 27% of state's total milk production. In 2001, milk sales accounted for 79% of the county's total agricultural income. Overall, milk production in Texas peaked in 1994, while productions levels in Erath County rose continually and peaked in 2000 (Milk Marketing Administrator's Reports, 1994-2000). Dairy producers are leaving the county because of low and inconsistent prices, uncertainties surrounding environmental regulations, and the lure of more friendly business environments elsewhere (Stephenville Empire Tribune, March 12 and 18, 2001). Most producers who leave are believed to be moving to counties in west of Texas or to the state of New Mexico. New Mexico milk production exceeded that of Texas in 2000. In 1995, milk production in New Mexico accounted for only 25% of the state's total milk output (Milk Marketing Administrator's Reports,).

The number of dairy producers in Erath County has been declining steadily, from 202 dairies in 1994 to only 138 in 2001 (data released recently indicates that there

are only 106 dairies left in the county – Texas Dairy Review, July 2006). However, during this same period overall milk production increased—both from increased productivity as well as in the number of dairy cows in the county. This combination has led to larger dairies and to a more concentrated industrial structure. If this trend continues it may pose a major economic risk to the county’s well-being, as the economic impact of possible large producers leaving will be felt more acutely than if smaller producers exited.

OBJECTIVES: This study seeks to estimate the economic impact of Erath County’s dairy industry at the county and state level alike. The core output, employment and value-added effects will be identified first, a sensitivity analysis will follow which will investigate the various impacts associated with changes at the firm (1,000 cow operation), as well as with changes in the price of milk.

REVIEW OF LITERATURE

Using 1995 data from secondary sources, Nielsen et al. (1998) estimated the economic impact of Erath County’s dairy industry. This study made no adjustments for local purchases of inputs and relied primarily on the Impact Analysis for Planning (IMPLAN), data sets managed by the Minnesota Implan Group (MIG, Inc.) for the county’s dairy industry. The analysis was restricted to milk sales and made no attempt to account for additional income from the sales of calves, heifers, crops, government payments, or off-farm income. The study reported an output multiplier of 1.44 and an employment multiplier of 2.03. The county’s dairies sold \$185 Million (M) of milk in 1995, with an additional \$265 M in indirect and induced effects. The model concluded that the industry generated \$49 M in personal income and accounted for 3,157 additional jobs, representing 22% of total income and 25% of employment in the county.

At the regional level, in 1993 Jones et al. (1993) estimated the dairy industry’s economic impact in the Cross Timbers Region of Texas (which includes Erath and surrounding counties). The study applied the IMPLAN model to estimate the direct and secondary effects of the dairy industry. The output multiplier for milk sales was 1.52, and for employment was 2.22. The multipliers for livestock sales were higher, with 1.85 for sales and 3.8 for employment. The dairy industry accounted directly and indirectly for \$337 M or one-fifth of the region’s sales, representing \$136 M or 18% of personal income, and employing 5,150 or 16.5% of the region’s civilian labor force.

Mulkey and Clouser (1991) used sales of dairy products in Okeechobee County, Florida to calculate the direct, indirect, and induced economic effects. They used multipliers generated by the U.S. Department of Commerce’s Regional Input-Output Modeling Systems (RIMS). The output multiplier for the dairy sector was 1.58, and each million-dollar sale generated an additional 15 full-time equivalent jobs in the county. The earnings multiplier was 1.29, suggesting that every dollar of milk sales created an additional \$0.29 of earnings for the other sectors in the Okeechobee County. The report also included the impact on the county in terms of lost output and jobs from the loss of a hypothetical dairy farm with 1,000 cows.

Hemmer and Buland (1998) examined the local economic impact of changes in the environmental conditions due to the presence of dairies in Maricopa County, Arizona. They analyzed the loss resulting from the loss of a 1,000 cow dairy operation looking at costs and benefits to Maricopa County. The study numbers were applicable to a per-farm

basis. This study attempted to model the local dairy industry by using farm enterprise budgets and estimates of variable and fixed costs of a dairy operation. Unlike previous studies, they also attempted to estimate both the short and long-term impacts of a dairy operation within a defined region. Using selected discount rates, the study projected the costs to a community resulting from the loss of a typical large 1,000 dairy-head operation.

From this brief review of literature, we note that impact studies are becoming more common. Typically, the economic impact is higher when the impact region is larger and more inputs are bought locally (greater backward linkages involved in input-output relationships).

MATERIALS AND METHODS

This study's basic framework is built around a conceptual model that separates the dairy industry and the local economy into two separate entities (Figure 1). The dairy industry includes total annual revenues from milk sales and the corresponding expenses for producing milk, along with revenues from the sale of calves, bulls, and heifers, average capital expenditures, and other farm income such as custom-work, government payments, etc. The "local" economy is defined as the economic structure of Erath County at the regional level and the state of Texas at the state level. The dairy industry's interactions and backward linkages will be identified to estimate the output and employment that can be associated with the dairy industry present.

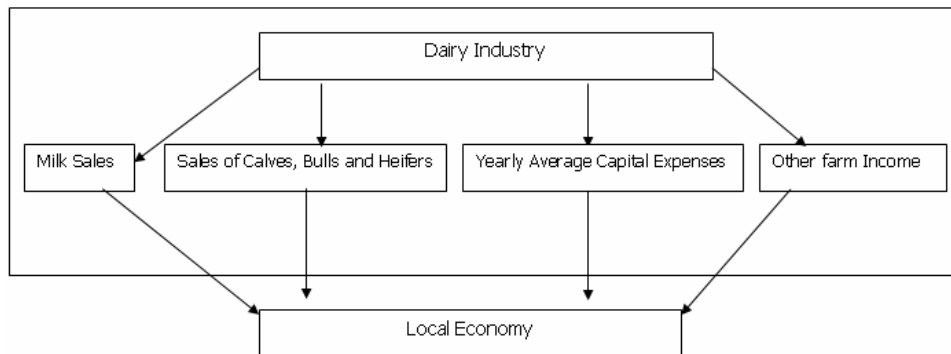


Figure 1: Conceptual Model.

Estimating the economic impact of an industry requires data on income, expenses, sources of inputs purchased, capital improvements, and taxes paid. Unlike the previous Nielsen et al. (1998) study, this research utilizes primary data acquired through a survey instrument in an attempt to improve and calibrate IMPLAN's production functions so they might better conform to local conditions. For example, the survey included questions on revenues received by producers for commodities other than milk, such as the sales of heifers and cattle, and government payments received. The expense categories included questions on the actual expenses incurred (operating and capital) and on the percentage purchased locally (within Erath County) and outside the area. For

capital expenses, producers were asked to provide these data for the last five years. An annual average of these expenses was computed from the data provided.

Surveys were sent to all 140 dairy producers identified in the county within the first six months of the study. Forty usable surveys were returned. These forty producers were responsible for 47% of all milk produced in 2000 and owned 33% of all cows in the county in 2000. Two local accounting firms also provided reports summarizing information about their dairy clients that included estimated enterprise budgets for each client. The IMPLAN datasets included economic data from the U.S. Bureau of Economic Analysis, Agricultural Census, and other economic data that approximated production functions at the county level. At the time the study was initiated, the county's 1998 IMPLAN dataset was the most current available. This dataset was used for the dairy industry, and adjusted to 2000 figures from the survey data. For the state, the 1997 Texas IMPLAN model was used and later updated to the 1999 Texas model when the more recent version was available.

The National Agricultural Statistical Service (NASS) publishes state-level average monthly and annual estimates of milk prices paid to producers (NASS, 2000). Erath County's prices are close to the state average because the county is centrally located and is the state's largest producer. This study uses the NASS average annual prices for the state of Texas, the Federal Milk Marketing Administrator numbers for county-level production are more extensive than those in the NASS survey. Combining the Milk Marketing Administrator's production estimate of 1,502,226,552 lbs. multiplied by the NASS Texas average price of \$13.30/cwt. calculated out to \$199,796,131 for milk sales in the year 2000. The major portion of the economic impact analysis was performed using the IMPLAN input/output model.

IMPLAN and other input/output models estimate economic impacts of policies that occur through forward and backward linkages in the economy. Backward linkages include purchased inputs, supplies, and services. Forward linkages include further value-added economic activities, such as preparation and processing. By going beyond measuring direct impacts only, these models provide a more thorough representation of the economic effects of various policy options. Purchases and sales are adjusted for in/and out-of- region sources, and are then summed to estimate the economic impacts arising from an initial policy change. The IMPLAN model estimates impacts on total output (sales), personal income, value-added, taxes, and employment. The theoretical basis for the model comes from work by Wassily Leontief (Garbo, 2002).

IMPLAN's data sets are derived from sources that include national, state, and local data. Further details about data sources and methods can be found in the IMPLAN User's Guide. All of the impacts were calculated based upon the 1998 Erath County model constructed with all SAM sectors included, excluding federal defense spending (no apparent relationship was seen to exist between the dairy industry and the defense industry). This SAM model included all local industries and households as well as federal, state, and local government sectors except federal defense. Erath County is relatively small (population of 30,815) and contains only 128 of the 528 industrial sectors within the IMPLAN model. With so many sectors absent, economic multiplier effects are likely to be smaller in this case than in larger economic areas.

The Regional Purchase Coefficients (RPCs) are the percent of income and expenses purchased/spent by producers in Erath County and in Texas for the county and state models, respectively. This data was also collected from the survey respondents. Dairy farm expenditures and RPCs were calculated primarily from survey data with

adjustments from the original Erath County IMPLAN data. The owner's draw, taxes, health insurance, other benefits, and labor expenses were excluded from these operating expense calculations and were treated separately later. Several survey categories were combined to better match the IMPLAN sectors and to minimize errors, using a pivot table and guidance from the base IMPLAN dataset.

The combination of the \$210 M dairy sales sector, \$18 M ranch fed cattle sector, and \$12 M range fed cattle sector covers the output of these dairy farms in the 1998 IMPLAN model for Erath County's economy. The dairy sector includes milk sales only in the IMPLAN model, while the other 10% of sales (in particular dry cows and heifers) are in the ranch and range fed cattle sectors, two sectors that are interchangeable for Erath County where they have identical production functions and outputs within the IMPLAN dataset. Their separation in the IMPLAN model dates back to the 1980s, when the Forest Service attempted to separate cattle on federal land from cattle on private land. The remainder of the replacement heifers sector was imported using local wholesale and transportation margins modified from the other sectors. In this study the dairy industry includes all three sectors.

Erath County includes only 125 of the potential 512 IMPLAN industrial sectors. The dairy industry purchases products from 81 sectors. The smaller ranch and range fed cattle sectors combined purchase from 88 sectors. The IMPLAN dairy and cattle sectors combined purchase from 96 different industrial sectors within Erath County.

Each sector was examined individually to determine whether the IMPLAN RPC, the survey RPC, or the IMPLAN retail margin should be used. For example, if the product was not produced in the county, such as John Deere tractors, then the household purchase margin was used, if IMPLAN had one estimated available. If not available, the industrial or institutional margins were used. All RPCs were constrained by the amount produced in the county.

Wages

Wages and owner's draw were run as separate calculations.¹ Total wages were estimated at \$17.2 M and local labor at 100% based on the survey. Based on lower than average incomes, 10% of gross income was deducted to account for taxes and savings; thus \$15.5 M was the direct impact used. The household income figure used with the IMPLAN institution impact group was set at \$20K - \$30K for calculating the impacts. This income range was considered average, since most farm workers earnings fall in this range. As consumption patterns were not included in the survey, the IMPLAN household consumption expenditures were used for sector allocations with the corresponding IMPLAN Household RPCs.

Owner's Draw

Owners' draw represents the amount retained by the proprietor/owner for family expenses. The total owners' draw was placed at \$4.2 M based on the interview data from the survey's final section. Based on higher average incomes, 25% of gross income was

1. Wages and Owners' draw were estimated independently. The impact from these expenditures was linked with consumption patterns. All other operating expenses had production backward linkages.

deducted to account for taxes and savings to estimate actual consumption. As in the previous case, the survey did not research owners' consumption patterns. In the absence of these details, the IMPLAN Households \$60K - \$70K sector (and the corresponding RPCs) was adapted to estimate the expenditures.

Capital Expenses

Besides operating expenses, producers occasionally incur expenses for capital improvements, purchases and/or construction of new equipment and vehicle, farm structures, silos, lagoons, and retention ponds (for complying with environmental regulations), and so on. The survey asked producers to estimate these expenditures for the last five years. Taking yearly averages and extrapolating the figures from the sample to the county dairy population provided estimates of capital expenses.

Texas Model

The Texas model was constructed from the 1999 MIG Texas data set using all federal, state, and local sectors except federal defense. The Texas dataset includes 497 industrial sectors, far more than the 125 industrial sectors active in Erath County. In 1999, Erath County accounted for only 0.21% of the state's total output (sales), but boasted 25.0% of the state's total dairy production. The dairy impact vectors were imported from the Erath County model into the Texas model. Again, the multiplier effects can be expected to be higher for the entire state than for the smaller economic area included in Erath County.

RESULTS AND DISCUSSION

Economic Impact at the County Level

It was estimated that the dairy industry's operating expenses for 2000 equaled (after adjusting for local RPCs) \$200.9 M, spread over 97 of the 128 sectors within Erath County's economy. When these expenditures were imported into IMPLAN, the model calculated local purchases at \$190.9 M after adjusting for the RPCs. These represent the direct economic effects of the operating expenses associated with the county's dairy industry. These expenditures by individual sectors were then processed by IMPLAN, and after several iterations, the model computed the indirect effects at \$31.2M. Subsequently, the model estimated the induced effects of an additional \$27.4 M. Thus, the total effect from the partial operating expenses in the aggregate equals \$249.54 M in output (sales).

Wages were treated separately. As reported earlier, after adjusting for taxes and savings, \$15.5 M was the direct impact figure used. The total effects inclusive of direct, indirect and induced effects equaled \$18.84 M.

Owners' draw was also calculated separately. Owners' draw was placed at \$4.2 M and an adjustment of 25% (\$1 M) was deducted to reflect taxes and savings. The total effects—including direct, indirect, and induced effects equaled \$3.81 M.

Adding together the effects associated with operating expenses, wages, and owners' draw gave a total impact of \$272.2 M in output or sales (Table 1). To this last figure, the \$17.2 M in wages paid and \$4.2 M in owner's draw are added together to obtain a total economic impact from operating expenses of \$294.2 M.

To non-labor expenses, wages, and owners' draw, we also added the actual taxes (\$915,622) paid by dairy farmers in the county for the year 2000. This number was derived by obtaining information on the value of properties listed as dairies as obtained from the Erath County Appraisal District. As stated earlier, total direct expenses amounted to \$223.2 M. Dividing the total impact of \$294.2 M by \$223.2 M provides an output multiplier of **1.32** (Table 5). This is a relatively conservative and smaller multiplier as compared with those previously obtained by researchers: (a) 1.44 obtained in the 1995 Nielsen's study (Nielsen, et al., 1998) of Erath County's dairy industry, (b) 1.5 reported in the Jones (1993) study of the dairy industry in the Cross-Timbers region (Jones, et al. 1993), and (c) 1.58 obtained in the study of the dairy industry in Okeechobee County, Florida (Mulkey & Clouser, 1991). On reflection, our results appear to be reasonable and as expected, since Erath County represents only one county within the Cross-Timbers Region. It is also smaller in size and population than Okeechobee County, Florida. This study differs from the Nielsen study in the data collection methods; the Nielsen's study relied on the national IMPLAN baseline data whereas this study uses local survey data.

As mentioned earlier, the dairy producers' 2000 gross income from the sale of milk was estimated at \$199.8 M. This amount represented about 90% of the dairy industry's total income. The remaining 10% was derived from the sale of cows and heifers, government payments, and off-farm income. The combined income for Erath County's dairy industry equaled \$222.4 M. Adding this last figure to the economic impact of \$294.2 M obtained by applying the multiplier effects provided \$516.6 M for the total economic impact of the dairy industry from operating expenses alone and dairy industry sales (Table 5).

Average annual capital expenditures were estimated (direct impact) at \$19.1 M. Using IMPLAN, the estimated indirect and induced impact flowing from these direct expenditures added another \$7.5 M to give a total impact of \$26.6 M from capital expenditures. Adding capital expenditures to the previous figure of \$516.6 M (from operating expenses) provides a grand total of **\$543.2 M** for the dairy industry's economic impact in Erath County (Table 5). This amount represented **36%** of the county's total output in 2000.

Employment Impact

The IMPLAN data estimated 1,386 workers in the county's dairy industry sector and another 325 workers in the range and ranch fed cattle. The economic structure created by the IMPLAN input-output model estimated that in 1998 there were 1,386 workers in the county's dairy industry sector and an additional 325 in the range and ranch fed cattle sectors, for a total of 1,711 workers in the combined Erath County dairy sector in 1998. USDA's National Agricultural Statistical Service (NASS) estimated that there were 79,000 milking cows in the county in 1998. This translated into roughly 2.16 jobs per 100 cows. According to NASS, the number of milking cows in 2000 was estimated to have grown to 91,400. Using the ratio of 2.16 jobs per 100 cows (for a total of 91,400 cows) yields approximately 1,980 jobs located on the county's dairy farms in 2000.

The direct impact on employment from the operating expenses of almost \$200M provided 2,465 jobs; the indirect and induced economic impact created an additional 11,550 jobs, and the induced impact resulted in 600 more jobs created. By adding these three figures it becomes clear that for a total of 3,615 jobs are linked to operating expenses from the dairy industry in Erath County. Another 317 jobs are created from the capital expenses sector, for a total of 3,932 jobs (Table 1).

Combining the 3,932 jobs from the direct, indirect, and induced effects with the estimated 1,980 jobs on the dairy farms provides an estimated **5,912** jobs that can be attributed to the presence of the dairy industry in the county. The county's total employment equaled 19,354 in 2000. Thus, the dairy industry accounted for **31%** of Erath County's total employment that year.

Table 1: Output and Job-Creation in Erath County

Impact	Event	Direct	Indirect	Induced	Total
Output	Operating Expenses	\$209.5 M	\$32.8 M	\$272.8 M	\$272.8 M
	Capital Expenses	\$19 M	\$3.5 M	\$4 M	\$26.6 M
	Total	\$228.5 M	\$36.3 M	\$276.8 M	\$299.4 M
Employment	Operating Expenses	2465	550	600	3615
	Capital Expenses	190	48.3	78.6	317
	Total	2655	598.3	678.6	3932

Value-Added

The IMPLAN model also estimated the total value added profits, rent, wages and local taxes. This 'value added' provides a measure of net economic income for Erath County, together amounting to \$123.1 M in 2000. This amount represented 18% of the \$706.6 M in 2000 personal income for Erath County. The impact on wages for the county (direct and indirect wages) paid by the dairy industry amounted to \$60 M also, which represented 18% of all the wages paid (total employee compensation in the county equaled \$338 M according to IMPLAN). The direct taxes (property and school) paid by the county's dairy producers were estimated at \$915,622 representing 4% of all property taxes collected by the county.

In addition to direct taxes, the model estimated that the county garnered \$9,443,409 in indirect business taxes (mainly sales taxes) on expenditures incurred by the dairy industry. Adding the direct taxes to indirect taxes yields a total of \$10.4 M that can be attributed to the dairy industry. Besides, the 1998 IMPLAN model is built on a national scale to model all 3,028 US counties simultaneously. IMPLAN estimates marginal taxes at the national, state, and county levels, and then makes adjustments—first so all the counties add up to the national estimate, and next so that all counties total the state estimate. As such, these tax estimates may not exactly reflect the current Erath County tax codes.

From the model results, we also extracted information on output and employment for the county's industries that were impacted the most by the presence of

the dairy industry. These industries will top the list of those that either benefit or lose by the expansion or contraction of the dairy industry in the county. It is important to note that the dairy farm sector includes the dairy farm products as well as the ranch and range-fed cattle.

Significant output (sales) impacts occurred in numerous sectors, including wholesale trade, motor freight, transportation and warehouse, hay and pasture, real estate, and banking/credit agencies (Table 2). In terms of employment, those industries impacted most by the dairy industry included the hay and pasture industry, which tops the list for numbers of jobs linked to the dairy industry. Other industries of significance were wholesale trade, motor freight transportation and warehouse, banking & credit agencies, agricultural services, and medical and health services (Table 3).

Table 2: Core Industries in Erath County Impacted by the Dairy Industry (\$ Millions)

Sector	Industry	Direct	Indirect/Induced	Total
447	Wholesale Trade	24.7	3.0	27.7
435	Motor Freight Transport & Warehouse	16.5	4.3	20.7
13	Hay & Pasture	15.0	1.6	16.6
462	Real Estate	6.8	8.0	14.8
456	Banking & Credit Agencies	9.3	3.7	13.0
493	Medical & Health Services	4.3	3.1	7.5
443	Electric Services	3.9	2.2	6.1
56	Maintenance & Repair Other Facilities	4.1	1.7	5.8
441	Communications	1.9	2.2	4.1
451	Automotive – Dealers, Repairs, & Services	0.6	2.05	3.1
454	Eating & Drinking	0.6	1.7	2.3
195	Drugs	1.2	0.9	2.1
459	Insurance Carriers	1.2	0.3	1.5

Table 3: Core Employment Impacts of the Dairy Industry on Erath County

IMPLAN Sector	Industry	Direct	Indirect+ Induced	Total
13	Hay and Pasture	746	79	825
447	Wholesale Trade	391	48	439
435	Motor Freight Transport and Warehouse	182	47	229
456	Banking and Credit Agencies	138	53	191
26	Agricultural- Forestry- Fishery Services	127	44	171
493	Medical and Health Services	89	50	138
454	Eating & Drinking	21	56	77
462	Real Estate	38	27	64
451/479	Automobile – Dealers, Repair Services	11	37	48
455	Miscellaneous Retail	14	30	44
450	Food Stores	11	22	33
449	General Merchandise Stores	10	22	32

Economic Impact at the State level

The state economic impact was also calculated with four types of expenses: operating, wages, owners' draw, and capital. Direct operating expenses were adjusted for the actual amount spent within the state— (the Regional Purchasing Coefficients or RPCs) by either adjusting the total by the percentage of respondents indicated, or by using IMPLAN RPCs. As expected, the RPCs at the state level were higher and the amounts of imports were lower than at the county level.

As expected, the multiplier effects were indeed higher at the state level than at the county level. At the state level, the direct effects for operating expenses equaled \$204.4 M, as compared to \$190.9 M at the county level, reflecting the higher RPCs at the state level. The indirect and induced effects are also correspondingly higher, amounting to \$68.9 M and \$178.2 M, respectively. The total effects from the operating expenses alone are \$451.5 M. Wages and owners' draw were separately calculated following the approach used in the county calculations, with adjustments made as discussed in the previous section.

The state's total impact from wages (\$21.8 M) and from owners' draw (\$5.8 M) amounted to \$27.6 M. At the state level the total effect from operating expenses equaled \$479.1 M. We repeated the procedure by aggregating the operating expenses, wages, and owners' draw, and then processed the data into IMPLAN. The total effect was slightly higher—\$485.9 M. The marginal difference of 1.4% reflected the rounding calculations within the model. To this last figure we added the direct impact of wages of (\$17.2 M) and owner's draw (\$4.2 M) to obtain a total economic impact from operating expenses at \$507.3 M. Dividing this impact by total expenses (\$223.2 M) yielded a multiplier of 2.28. As expected, this multiplier is higher than its counterpart at the county level (1.32). It is higher than that for the state's wine industry (1.92) (Michaud, et al., 1998) and the state's poultry industry (1.35) (Carey, et al., 1998). However, it is almost identical to that of the California's dairy industry (2.27) (Dryer, 2005).

As indicated in the previous section, the combined total income of the dairy industry in Erath County equaled \$222.4 M. When this number is added to the total impact of \$507.3 M from operating expenses it results in an impact of \$729.8 M at the state level. (Table 4)

The direct impact of capital expenses was \$19.1 M. When these were processed in the state's IMPLAN model, the indirect/induced impacts generated an additional \$22.9 M to provide a total impact of \$42.0 M for capital expenses at the state level. When we add \$729.8 M impact from operating expenses to the \$42 M associated with capital expenses, the total impact of Erath County's dairy industry on the state of Texas was **\$771.8 M**. Please recall that the total impact at the county level was \$543.3 M. Subtracting this figure from the state's total impact calculates to a difference of \$228.5 M. This implies that Texas counties, other than Erath are directly or indirectly affected by the dairy industry by \$228.5 M. With 254 counties and 0.21% of the state's total output coming from Erath County, there is little backward impact into Erath County from other Texas counties.

Employment Impact at the State Level

The model also estimated the number of state jobs created due to Erath County’s dairy industry. As stated earlier, the RPCs at the state level were higher than at the county level. These added purchases translated into \$228 M in additional output at the state level. Thus, we should expect higher job-creation at the state level.

The \$200 M in operating expenses provides 5,211 jobs directly in the dairies. Once the indirect and induced effects were included, the total jobs figure increased to 8,170. As before, wages and owners’ draw were analyzed separately, and once the direct, indirect, and induced effects were considered, these expenditures accounted for 195 and 55 jobs, respectively. Thus, operating expenses accounted for 8,420 jobs. We repeated the procedure by aggregating the operating expenses, wages, and owners’ draw and then processed the data using IMPLAN. The total effect was slightly higher, at, 8,501 jobs. The difference reflects to rounding calculations within the model.

The indirect and induced jobs calculated with the state model added 255 jobs for a total of 445 jobs attributed to capital expenditures. Adding these 445 jobs to the 8,501 from operating expenses provided approximately 8,946 jobs (Table 4). To this last figure we added the dairy industry’s direct jobs , estimated at 1,980, for a grand total of **10,926** jobs in the state that are associated with the presence of the dairy industry in Erath County. Table 5 summarizes all the results of this study at the county and state levels.

Table 4: Output and Job Creation in the State of Texas

Impact	Event	Direct	Indirect	Induced	Total
Output	Operating Expenses	\$223 M	\$72.7 M	\$190.1 M	\$485.9 M
	Capital Expenses	\$19.1 M	\$8 M	\$14.9 M	\$42 M
	Total	\$242.1 M	\$80.7 M	\$205 M	\$527.9 M
Employment	Operating Expenses	5361	866	2274	8501
	Capital Expenses	190	77.2	178	445
	Total	5551	943.2	2452	8946

Sensitivity Analysis Modeling

Besides estimating total impact, we also conducted a series of tests to determine the marginal impact of changes in production and in prices for the dairy industry, along with the consequent impacts these changes will have on output and employment in the county. These questions were posed:

(1) What will be the impact on the county in terms of output and employment when a large dairy (1,000 cows) decides to locate or to exit the county? This question was taking on increasing importance as local newspaper reports were covering the exits

of larger dairies from the county, as they were being denied permit renewals to operate by the Texas Commission on Environmental Quality (TCEQ).

Since the IMPLAN model assumes fixed coefficients, we modeled the change by adjusting total production. In 2000, NASS estimated 91,400 dairy cows in Erath County. A change in 1,000 cows provides a net change of 1.094% in total dairy production. Using previous IMPLAN estimates of output and employment, a 1.094% change translates into a change of \$5.6 M in output, 61 jobs, and \$1.3 M in value added. The change in wages will be \$655,762.

(2) What will be the impact in terms of output, value-added and employment for the county if the price of milk changes by \$1/cwt? Since dairy producers are price-takers, their fortunes increase or decrease with changes in the price of milk. Meanwhile, the price of milk is a contested issue in national farm policy debates. We conducted an exercise to measure the impact on dairy producers of a \$1 increase or decrease in the price of milk and the consequent implications for output and employment for the rest of the county.

Since the IMPLAN model assumes fixed coefficients, we modeled this by assuming that all the impact would be entirely reflected in the owners' profits (owner's draw), and that no direct impacts on wages or other expenses would occur. Using the 2000 production figures for the county (1,502,226,552 lbs of milk), a \$1 change in the price of milk will translate into a change in \$15.0 M in the income received by dairy producers.

We assigned this change to owners' profits for a given year to directly affect the owners' income because all other expenses are either expended or committed. To estimate the impact of this change in owners' profits, we subtracted 25% of \$15.0 M to adjust for taxes and savings, leaving \$11.3 M as a direct loss in spending. Once the indirect and induced impacts are estimated using the IMPLAN model, the total output (sales) change equals \$13.6 M. Subtracting \$5.6 M in domestic and foreign trade leaves a final impact of \$8 M sales of goods and services produced in Erath County. The corresponding employment change was 128.7 jobs and the Value added change was \$4.9 M. The change in wages was \$2.2 M.

SUMMARY

In 2000, Erath County has the largest production of milk in Texas accounting for 27% of the state's milk production. Revenues from milk production represented 79% of the county's overall agricultural income in 2001. Milk sales for 2000 were estimated at about \$200 M, and total income from all sources was estimated at \$222 M for dairy producers. This study attempted to estimate the dairy industry's economic impact on the county and on the state, and used the IMPLAN input-output model.

A survey instrument was distributed to all producers in the county. After three mailings, 40 out of the 135 producers responded, representing almost 30% of the producers, accounting for 33% of all cows in the county, and producing 47% of the county's milk in the year 2000. This survey data produced income and expense estimates while, adjusting for leakages at the county and state levels. The adjusted direct expenditures were then processed through the input-output model (IMPLAN) to calculate the re-spending or multiplier effects.

Table 5: Summary of Impacts

	Erath County	Texas
NASS Milk Price	\$13.30	\$13.30
Milk Income	\$199,796,131	\$199,796,131
Dairy Producer's Gross Income	\$222,429,097	\$222,429,097
Expenses	\$200,897,100	\$200,897,100
Property+ School Taxes	\$915,622	\$915,622
Wages (Pre-Tax)	\$17,222,413	\$17,222,413
Owners Draw (Pre-Tax)	\$4,201,127	\$4,201,127
Total Expenses/Income	\$223,236,262	\$223,236,262
Erath Output Impacts	\$294,202,950	\$507,356,248
Output Multiplier	1.32	2.28
Total Impact from Operating Expenses	\$516,632,047	\$729,785,345
Total Impact including Capital Expenses	\$543,256,573	\$771,797,420
JOBS IMPACTS		
Dairy Industry Jobs	1,980	1,980
Additional Jobs Created from Operating Expenses	3,615	8,501
Total Jobs	5,595	10,481
Employment Multiplier	1.83	4.29
Total Jobs including Capital Expenses	5,912	10,926
Value Added (Profits, Rent, Wages, Local Taxes)		
Direct Value Added	\$29,004,256	\$29,004,256
Additional Value Added	\$94,109,426	\$271,577,667
Total Value Added	\$123,113,682	\$300,581,923
Wages		
Direct Wages Paid by Dairy	\$17,222,413	\$17,222,413
Indirect Wages	\$42,719,252	\$116,609,876
Total Wages Paid	\$59,941,665	\$133,832,289
Property Income		
Rent paid by Dairies	\$6,665,094	\$6,665,094
Indirect Property Income	\$28,506,353	\$72,059,819
Total Property Income	\$35,171,447	\$78,724,913
Profits		
Dairy Owners Draw (Pre-Tax)	\$4,201,127	\$4,201,127
Proprietors Income	\$13,440,443	\$56,662,106
Total Profits	\$17,641,570	\$60,863,233
Taxes		
Dairy Property+ School Taxes	\$915,622	\$915,622
Indirect Business Taxes	\$9,443,409	\$26,245,864
Total Local Taxes	\$10,359,031	\$27,161,486

The overall multiplier for all expenditures was 1.32 in 2000, a smaller multiplier than that estimated by previous I-O studies of dairy production in this region. This is a conservative multiplier and is smaller than multipliers obtained in similar studies for this region as well as other parts of the country (Nielsen et al., Jones et al., Mulkey and Clouser). Applying this multiplier to a combined total income of \$222 M yields a total impact of \$294 M, and adding the last figure to the direct impact of \$222 M results in the total impact (from operating expenses alone) of \$516 M. Besides operating expenses, the study also estimated average annual capital expenditures incurred by dairy producers (averaged over five years). The direct capital expenditures were estimated at \$19 M and the indirect and induced effects added another \$8 M, for a total of \$27 M. Thus, the overall impact of the county's dairy industry amounts to \$543 M, or 36% of the county's total output. The dairy industry directly and indirectly created 5,912 jobs and was responsible for 31% of the county's employment. The total value-added (income) in the dairy industry equaled \$123 M, representing 18% of the county's agriculture/agribusiness sector's contribution to GDP. The dairy producers paid over \$900,000 in county taxes in 2001, 75% of which were school taxes. In addition to the direct taxes, the model also estimated that \$9 M in taxes was generated from all direct and induced effects connected with the dairy industry.

At the state level, the dairy industry contributed \$772 M in output and provided 10,926 jobs (directly/indirectly). Once we subtract the impacts in Erath County, note that the dairy industry contributes \$229 M in output to the rest of the state and creates 5,014 jobs.

Like most economic impact studies, this study does not attempt to estimate negative externalities and their associated costs to the county/region. The limited scope of this study cannot include these factors that instead are suggested for further research. A large dairy industry with Concentrated Animal Feed Operations (CAFOs) is expected to create negative externalities. These may include but not restricted to water and air pollution, stress on roads and bridges (with the continuous movement of inputs and milk), inflationary land/property values, tax burden, long-term economic/social instability, and so on. These negative externalities have received increased media and political attention of late. This study offers the community, public-policy officials, and the dairy industry an economic perspective of the county's dairy industry and its contributions to the overall economic well being there.

REFERENCES

Carey, John B., Sarah G. Birkhold, and Lynette L. Ryan. 1998 "Economic Impact of the Texas Poultry Industry." Texas Agricultural Extension Service, L-5214, July.

Dryer, Jerry. 2005. "California Dairy Business" Prepared for the California Milk Dairy Advisory Board. <http://www.californiadairyroom.com/pdfs/CompleteEconomic.pdf> p.4

Garbo, Lorenzo. 2002. "Wassily Leontief (1906-1999): The Founder of Input-Output Analysis and the Laureate of 1973" in *Frontiers of Economics*, Abu N.M. Wahid (Ed), Greenwood Publishing.

Hemmer, Ronald. and David Buland. 1998. "Some Aspects of Arizona Department of

Environmental Quality (ADEQ), Enforcement in the Dairy Industry in Maricopa County – Arizona.” United States Department of Agriculture (USDA), AAEA Session OS-7F, <http://waterhome.brc.tamus.edu/NRCSdata/implan/>

Jones, Lonnie L., Allen J. Wyse, Robert B. Schwart, Jr., Amy P. Pagano, and Ronald D. Lacewell. 1993. “Economic Analysis of the Dairy Industry in the Cross Timbers Region of Texas,” Texas Agricultural Station and the Department of Agricultural Economics.

Michaud, Marc, Eduardo Segarra, and Tim Dodd. 1998. “From Texas Vineyards to the Final Consumer: An Economic Impact Analysis,” Texas Journal of Agriculture and Natural Resources, Vol.11.

MIG, Inc. 2000 IMPLAN Pro, Version 2.0., User’s Guide, MIG Inc. Stillwater, MN.

Milk Market Administrator’s Reports. (January 1994 – January 2002). Southwest Marketing Area, Carrollton, TX, <http://www.dallasma.com/>

Mulkey, David and Rodney L. Clouser. 1991. “Economic Impact of the Dairy Industry in Okeechobee County, Florida.” University of Florida Gainesville, Staff Paper, SP #91-40,

National Agricultural Statistical Service (NASS). 2000 (January – December). http://www.nass.usda.gov/Statistics_by_State/Texas/Publications/Agricultural_Facts/

Nielsen, Tommie G, Keith O. Keplinger, and Robert H. Neal. 1998. “Economic Impacts of the Erath County Dairy Industry: An Input-Output Analysis.” Texas Institute Applied Environmental Research. <http://brahma.tarleton.edu/publications/pr9606.pdf>

Stephenville Empire Tribune. March 12, 2001, March 18, 2001.

Texas Dairy Review. 2006. 15 (9) July 2006