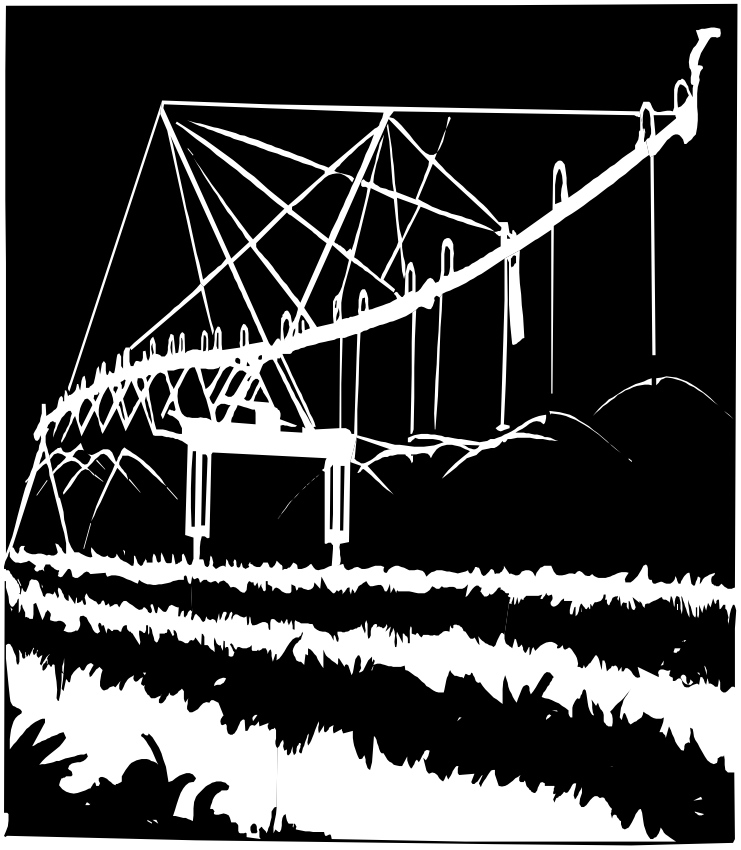
Agribusiness and Applied Economics Report No. 452 **February 2001**

Economic Impact of Production and Processing of Irrigated Potatoes in Central North Dakota



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ACKNOWLEDGMENTS

This study contributes to the alternative crops research program of the North Dakota Agricultural Experiment Station. The material is based upon work supported by the North Dakota Agricultural Experiment Station and the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, under agreement No. 97-34216-3995.

Sincere appreciation is extended to all the producers, businessmen, and company representatives who provided information. Without their input, this project would not have been possible.

Thanks are extended to Norma Ackerson for document preparation. Our gratitude is also extended to our colleagues for their helpful review of the manuscript.

The authors assume responsibility for any errors of omission, logic, or otherwise. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the U.S. Department of Agriculture.

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ABSTRACT

Agricultural areas can be significantly impacted by high-value crops. Irrigated potato production has significantly affected central North Dakota. Interested growers in the Jamestown area recognized the need and the potential for irrigated potato production and processing, and eventually convinced a private company to build a processing plant to make frozen potato products from their irrigated potatoes. Securing a private entity to process their product freed up capital for irrigation development and other potato enterprise purchases. Economic impacts resulting from the addition of irrigated potatoes and associated processing were analyzed in this study. This analysis is divided into two parts, construction/start-up (one-time) and operational (on-going) impacts. Construction/start-up phase includes plant construction, purchases of irrigation equipment, farmer purchases of potato machinery, and grower spending for potato storage facilities. The operational-phase includes processing plant expenditures and grower production expenditures net of the most likely non-irrigated crop.

Direct expenditures for the construction/start-up phase were over $50 million for the 1995-96 period. This was comprised of $10.5 million for plant construction, $23.1 million for irrigation equipment, $3.4 million for potato grower machinery, and $13.0 million for grower potato storage facilities. Annual operational-phase direct expenditures were over $55 million, with the processing plant expenditures being $33.4 million and grower production outlays at $22.0 million. These direct expenditures were applied to the North Dakota Input-Output model to determine the economic impact of this project.

Construction/start-up phase economic impact was estimated to be nearly $28 million in added personal income, over $44 million in new retail sales, and a total gross business volume of $115 million. Annual impacts from the operational phase included a personal income increase of nearly $48 million, increased retail sales of almost $48 million, and total business activity of $148 million. Increased tax collections to the state were estimated to total $2.7 million during the construction/start-up phase and $3.1 million annually during the operational phase. This economic development activity resulted in a peak of 260 plant construction jobs and a permanent plant work force of 250 full-time equivalents. In addition, operational-phase secondary employment was estimated to be 1,569 full-time equivalent workers.

Key words: economic impact, economic development, agricultural processing, high-value crop production

HIGHLIGHTS

The purpose of this study was to determine the economic impact of processing high-value agricultural crops. Producing high-value crops can help an ailing agricultural economy and also provides an economic stimulus to the surrounding area. Early in the 1990s, a group of producers in the Jamestown, North Dakota, area expressed interest in bringing a high-value crop into their area. This area had an excellent potential for growing irrigated potatoes because of soil types and aquifers.

A growing demand for frozen french fries and processors' desire to contract irrigated potato production offered a unique opportunity for central North Dakota farmers. Growers organized with the intent of forming a cooperative to process their irrigated potatoes. However, capital requirements to build a processing plant, install irrigation, and grow potatoes were beyond their capabilities. Eventually a private business became involved; plant construction began in 1995 and potato processing late in 1996. A total of 33 growers were awarded contracts for 15,000 acres of irrigated potatoes. This analysis divides the economic impacts into one-time construction/start-up and the annually recurring operational-phases.

Construction/start-up phase economic impacts include the in-state expenditures for plant construction, grower investment for irrigation equipment, growers' purchases of potato machinery, and grower outlays for potato storage facilities. Expenditures (to in-state entities) for the processing plant were $10.5 million, irrigation equipment amounted to $23.1 million, and growers' expenses were $3.4 million and $13.0 million, respectively, for machinery and potato storage facilities. These expenditures were distributed through the construction; retail trade; business and personal services; and household sectors of the economy.

Operational-phase direct expenditures were also determined. These impacts differ from those of construction/start-up in that they occur each year the plant is operating. In-state expenditures for payroll, benefits, utilities, repairs and maintenance, supplies, insurance, and transportation amount to $33.4 million annually. Potato producer operational expenses also are included in this phase. Growing irrigated potatoes involves a high level of input expenditures. Potatoes are usually grown in a three-year rotation, so a three-year irrigated crop budget was used to determine an annual average outlay. This three-year outlay was used to estimate expenditures net of the most likely non-irrigated crop (wheat for this analysis). Net expenditures were used to measure the economic impact of irrigated potato production. Potato production expenditures totaling $22.0 million were distributed to the transportation; communications and public utilities; retail trade; finance, insurance and real estate; business and personal services; and household sectors of the economy.

All construction-phase and operational-phase expenditures were summed by sector and applied to the North Dakota Input-Output model. The model uses multipliers to measure the total economic activity generated by each sector for an additional dollar of expenditures in a given sector. Economic impacts resulting from the two-year construction-phase included increased levels of personal income ($27.8 million), retail trade activity ($44.1 million), business activity of all business sectors ($80.8 million), and increased level of total economic activity ($115.5 million). The increased level of economic activity would result in an additional $2.7 million in state tax

collections. Peak employment during plant construction was 260 workers, with an additional 1,139 secondary (indirect and induced) full-time equivalent jobs created.

Annually recurring operational-phase economic impacts included $47.7 million in increased personal income, $47.7 million in additional retail sales, $89.5 million in added business activity for all business sectors, and an increase in total economic activity of $147.6 million. Increased revenues from three major state taxes associated with these levels of economic activity totaled $3.1 million annually, highlighted by $2.2 million in sales and use tax collections. Currently, 250 full-time equivalent workers are employed at the processing plant, with an additional 1,569 secondary jobs created.

Although only 33 growers produce irrigated potatoes for the central North Dakota plant, the economic impacts affect a large geographic area. Jobs, business receipts, and tax revenues have all increased as the result of production and processing of a high-value agricultural crop. Each dollar spent in the production and processing activities creates another $1.66 in other sectors of the state economy, for a total of $2.66. These measures clearly show that this economic development project has had a significant economic contribution in central North Dakota, particularly in the Jamestown area.

Economic Impact of Production and Processing of Irrigated Potatoes in Central North Dakota

Randal C. Coon and F. Larry Leistritz[1]

Agriculture has always been a major component of North Dakota's economic base, although its relative contribution has been declining in recent years (Coon and Leistritz 1998). In an attempt to improve the fortunes of agriculture, production and processing of high-value crops, like irrigated potatoes, have received increased emphasis. Potato production has had a long history in North Dakota. Until recently, most of the production and processing had been located in the northern Red River Valley. However, industry trends toward increased reliance on irrigated potatoes for processing have given rise to an opportunity for farmers in central North Dakota. Available water resources and the need for a high-value crop to make irrigation economically feasible provided the impetus for the expansion of the potato industry into central North Dakota.

Expansion of the potato industry into central North Dakota began in 1991, when a group met in Jamestown to discuss how to intensify agriculture in the area. Irrigated potatoes appeared to offer the best opportunity because (1) there is a growing demand for processed potato products like frozen french fries, (2) major processors desire to base their supply on irrigated acres, and (3) the area had an excellent potential for growing irrigated potatoes, based on its aquifers and soil types. The group organized themselves as the *High Value Irrigated Crops Task Force*, and farmers involved in the task force created a cooperative called Central Dakota Growers.

Central Dakota Growers originally planned to build and operate the plant as a closed cooperative. However, capital requirements to build a plant, install irrigation, and grow potatoes were beyond their capabilities. Efforts to secure a private industry potato processor ultimately led to discussions with Aviko, a company based in the Netherlands. Aviko decided to get involved in the project, and plant construction began in September, 1995. Potato processing operations began in late fall of 1996. Currently, the plant has 33 contract growers supplying irrigated potatoes from 15,000 acres, with most of the acreage located in Stutsman and Kidder Counties.

Development of irrigated potato production and processing industries has had a significant economic impact because of the capital intensive nature of these industries. Building the processing plant and start-up costs for irrigation and potato equipment had a one-time economic impact, whereas processing plant and production expenditures have annually recurring impacts. The purpose of this study is to estimate the one-time economic impact of construction/start-up costs and the annual impacts of production and processing. These economic impacts will measure, in terms of economic variables, the effects that industry expenditures have had on the Jamestown area economy.

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PROCEDURES

It was necessary to determine the new or additional expenditures resulting from the industry within North Dakota. Although the plant was constructed in the Jamestown area and potato production is located primarily in Stutsman and Kidder Counties (Figure 1), the economic impacts will reach a much broader area in North Dakota. Only expenditures within North Dakota were used to estimate the impacts of the construction/start-up phase. The increase in potato production expenditures over the next best alternative crop (wheat) were used together with plant operations expenditures made within the state to measure the contribution of this industry to the North Dakota economy. Economic impacts are divided into one-time construction/start-up (including plant construction, irrigation equipment and start-up, farmer expenditures for potato machinery and potato storage facilities) and annual operation (processing plant expenditures and grower production expenditures net of dryland wheat).

Processing Plant Construction

The potato processing plant was built in 1995-1996 at a total cost of $70 million. Because of the competitive nature of the potato processing industry and the fact that the Aviko plant is a private business venture, detailed estimates of plant construction expenditures were difficult to obtain. Several company officials provided estimates of construction expenditures in North Dakota and a breakdown of the sectors receiving the payments. (These company officials wished not to be named as references and so will be referred to collectively as Aviko.) Of the total construction cost, $10.5 million was estimated to be made to North Dakota entities (Aviko 2000). In-state expenditures were primarily for earthwork, concrete and concrete labor, land, pipe material, and electrical equipment and installation. The building, potato storage facilities, and potato processing equipment were all purchased out-of-state. In addition, the construction contract was awarded to an out-of-state firm which used its own workforce. Construction worker expenditures for things like food, housing, etc., in North Dakota would also be part of the economic impact. However, data were not available to estimate these outlays. Peak work force reached 260 workers in 1996. In-state processing plant construction expenditures were allocated to the construction, retail trade, and household sectors of the economy (Table 1). These expenditures represent the direct economic impacts for the processing plant construction phase.

Potato Growers Start-up Expenditures

Potato grower start-up costs are considered one-time expenditures similar to plant construction. These costs included: (1) irrigation equipment, (2) additional machinery necessary for potato production, and (3) potato storage facilities. These three categories represent one-time expenditures, replacement of machinery will be handled through operating budgets which will be presented later.

Grower Investment for Irrigation Equipment

Irrigation equipment investment is substantial, and the addition of a high-value crop like potatoes was a key factor in expanding irrigated acres in central North Dakota. Cost of a center-pivot irrigation unit is $74,000 (Aakre and Swenson 1998), and budgets indicate that expansion of irrigated acres would not be economically feasible without a high-value crop like potatoes.

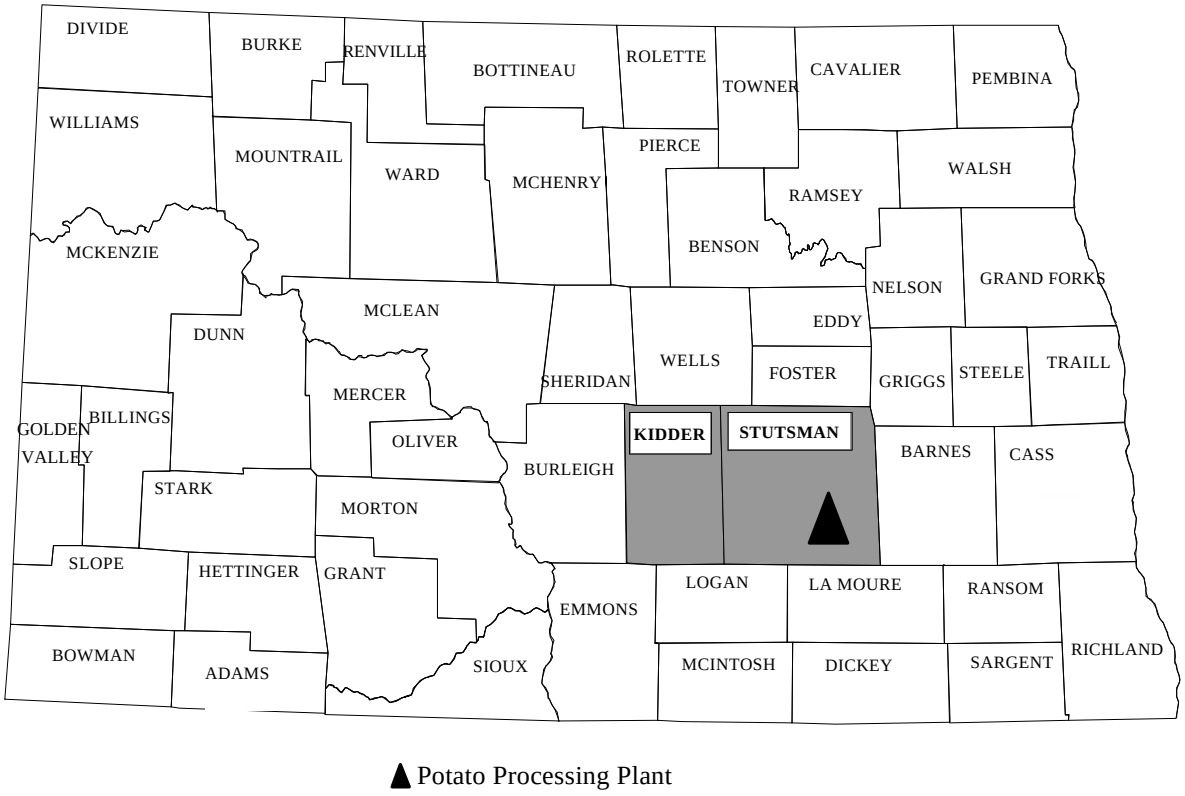

Figure 1. Location of Aviko Potato Processing Plant and Primary Area of Irrigated Potato Production

Table 1. Potato Processing Plant and Growers' In-State Expenditures for Project Construction and Start-up Phase, by Economic Sector, North Dakota, 1995-1996

Activity/Sector	Expenditure
	--- $000 ---
Processing Plant Construction:	
Construction	3,918
Retail trade	4,100
Households	2,492
Subtotal	10,510
Growers' Investment in Irrigation Equipment:	
Construction	1,249
Retail trade	18,592
Business & personal services	3,284
Subtotal	23,125
Growers' Investment in Potato Machinery:	
Retail trade	3,443
Growers' Investment in Potato Storage:	
Construction	12,994

To determine the total expenditures for irrigation equipment, several points need to be noted:

1. An average center-pivot irrigation unit covers 132 acres (Storm 2000).
2. Some center-pivot irrigation units existed before the Aviko processing plant was built.
3. Center-pivot units are not moved from one quarter to another, year to year.
4. Potatoes are typically grown on "new" potato ground in year 1, year 3, year 6, year 9, etc.(i.e., after the first two years, a three-year rotation is recommended).
5. A ratio of 2.75 center-pivot irrigation units is used for each quarter section of irrigated potatoes – this ratio reflects existing units and shortened crop rotations (Amundson 2000).
6. All center-pivot irrigation units will be attributed to potato start-up expenditures because without the high-value crop, irrigation development most likely would not have occurred.
7. 15,000 acres of irrigated potatoes are under contract.

Irrigation investment expenditures were calculated as follows:

Total irrigated acres = 15,000 acres of irrigated potatoes x 2.75 total acres per irrigated acres
Total irrigated acres = 41,250 acres

Irrigation investment per acre = $74,000 per irrigation unit/132 acres per unit
Irrigation investment per acre = $560.60

Total irrigation investment = 41,250 irrigated acres x $560.60 per acre
Total irrigation investment = $23,124,750

Total irrigation investment was allocated to sectors of the economy using budget data provided by Aakre and Swenson (1998). These expenditures were divided among the construction, retail trade, and business and personal services sectors. Table 1 shows the expenditures breakdown for the $23.1 million investment in irrigation units by potato growers.

Grower Investment in Potato Machinery

Producers adding a potato enterprise were required to purchase additional machinery including expensive equipment such as potato planters and harvesters. A machinery complement budget was available for a producer adding potatoes, assuming they had adequate machinery for the enterprise excluding dedicated potato equipment (Aakre and Swenson, 1998). This budget was compiled for an 800-acre irrigated potato enterprise; this machinery complement worked well for this analysis. A 400-acre potato enterprise was viewed as necessary to be viable, and the average irrigated potato grower with an Aviko contract grew 800 acres (Amundson, 2000). High costs associated with the purchase of irrigation and potato equipment resulted in many smaller acreage growers, although some larger enterprises were also involved.

A potato machinery complement for an 800-acre enterprise was listed at $244,842 (Aakre and Swenson 1998). This equipment includes machinery used only for potato production, including such things as potato filler, row marker, planter, cultivator, windrower, harvestor, and high pressure sprayer. Tractors, tillage equipment, etc., were not included because they were

most likely already available as the result of existing farm enterprises. This machinery budget was based on list prices for new machinery. This value may overstate the actual expenditures by farmers, because the potato industry is not new to North Dakota and, in fact, the equipment retailers in northeast North Dakota had used equipment available to central North Dakota growers. Because potato farmers were able to purchase used machinery, the list price of the machinery complement was reduced by 25 percent to more accurately reflect actual cash expenditures (Amundson 2000). Machinery costs were calculated on a per acre basis because of the wide range of irrigated potato acreages Aviko growers contracted. Smaller growers may have a higher per acre machinery costs and larger producers a lower value. Costs for the 800-acre machinery complement reflect those for Aviko growers, where the average contract was about 800 acres.

Start-up potato machinery complement expenditures were calculated as follows:

Producer machinery cost = $244,842 list price x 0.75
Producer machinery cost = $183,631.50

Per acre machinery cost = $183,631.50 / 800 acres
Per acre machinery cost = $229.54 per acre

Total machinery expenditures = 15,000 acres x $229.54 per acre
Total machinery expenditures = $3,443,100

These machinery purchases were considered one-time expenditures necessary to add the potato enterprise, and replacement of the machinery was handled through annual operating budgets. Machinery purchases were made from the retail trade sector of the North Dakota economy (Table 1).

Grower Investment for Potato Storage

Potato growers with contracts at Aviko were required to provide some of the storage facilities for this production. Part of the cost of the processing plant construction was for potato storage, but Aviko required contract growers to provide storage for 45 percent of their production (Galbraith 2000). Storage requirements were determined using a 350 hundredweight per acre average production for the 15,000 acres contracted. Potato storage facility costs to producers in central North Dakota averaged $5.50 per hundredweight (Hatch 2000).

Calculation of potato grower storage facility investment was as follows:

Total potato production = 15,000 acres contracted x 350 cwt./acre
Total potato production = 5,250,000 cwt.

Grower storage requirement = 5,250,000 cwt. production x 45%
Grower storage requirement = 2.362,500 cwt.

Grower storage investment = 2,362,500 cwt. x $5.50 per cwt.
Grower storage investment = $12,993,750

Expenditures for potato storage facilities were for a complete building and, therefore, the breakdown of outlays by economic sector was not available. All of the $12,993,750 spent for potato storage was allocated to the construction sector (Table 1).

Processing Plant Operational Expenditures

Operational expenditures occur each year and result in an economic impact each year potatoes are processed. This differs from the construction/start-up impacts that occur "one-time," although they may occur over a multi-year period. Operational-phase impacts normally begin at the completion of construction, or as soon as processing begins.

Potato processing is a competitive business, and the only plant located in central North Dakota is a privately owned business. Aviko officials were reluctant to reveal detailed operating expenditures, but did provide annual operating expenditures to entities within North Dakota (Aviko 2000). To ensure confidentiality for Aviko's business practices, these expenditures will not be presented and discussed in detail, but rather as aggregated values corresponding to sectors of the economy. In-state expenditures included such items as payroll, benefits, utilities, repairs and maintenance, supplies, insurance, and transportation. Potato processing plant annual operating expenditures allocated to sectors of the economy are presented in Table 2. This single plant injects over $33 million into the state economy annually. Currently, Aviko employs 250 full-time equivalent workers as it operates 7 days a week and 24 hours per day.

Table 2. Potato Processing Plant Annual In-State Operating Expenditures, by Economic Sector, North Dakota, 2000

Sector	Expenditure
	$000
Construction	2,200
Transportation	5,000
Communications & public utilities	5,500
Retail trade	10,100
Finance, insurance & real estate	1,720
Business & personal services	1,000
Households	7,900
Total	33,420

Potato Producer Operational Expenses

Growing irrigated potatoes involves extensive management practices and a high level of input expenditures. Expenditures for irrigated potato inputs are much higher than those for other irrigation enterprises (Scherer et al. 1999). Irrigated potatoes are typically grown on "new" potato ground in year 1, year 3, and every third year after that. Essentially, potatoes are grown in a three-year rotation. For every quarter section of potatoes that are irrigated, there will be two additional quarters of other irrigated crops. As previously discussed, the grower start-up

investment included all three center-pivot irrigation units needed for one year's irrigated potatoes. The high-value potato crop carries the expenses for the other two less profitable rotational crops during the years when potatoes are not grown. Finding the two best rotational crops has been difficult, and the search is on-going (Radke 2000).

Expenditures for potato production were estimated net of an alternative non-irrigated crop to determine the economic impact of potato production. Because all the irrigation units were allocated to potato start-up costs, the expenditures for the three-year rotation of irrigated crops (potatoes, corn, and dry beans) were used in this study. The average of the three crop expenditures represent annual production outlays. This average is used to estimate annual expenditures net of the most likely non-irrigated crop (wheat). (Potato purchasing expenditures by the processing plant were not included in plant operating costs, to avoid double-counting.)

Detailed crop budgets were the source of producer expenditures for irrigated potatoes, corn, and dry beans (Table 3). The three crops were averaged to obtain the annual expenditures for irrigated crop production. Dryland wheat crop budget outlays (Swenson and Haugen 1999) were subtracted from the three-year irrigated crop expenditures to determine the net annual production expenses (Table 4). Additional expenditures as a result of irrigated potatoes were multiplied by the total irrigated acres to estimate additional expenditures (Table 5). Total irrigated acres were used to determine potato producer operational expenses because the potato enterprise required the additional center-pivot irrigation units. These units would not exist without high-value potatoes in the rotation. This is consistent with the reasoning for including all center-pivot irrigation units in the grower start-up investment costs, as previously discussed. These expenditures were allocated to various sectors of the North Dakota economy (Table 6).

Table 3. Crop Budgets for Three-Year Rotation of Irrigated Potatoes, Corn, and Dry Beans, South Central North Dakota, 2000

Item	Irrigated Potatoes	Irrigated Corn	Irrigated Dry Beans	Three-Crop Average
			$	
Seed	220.00	29.12	28.00	92.37
Chemicals	205.28	38.41	16.04	86.58
Fertilizer	38.14	33.38	15.08	28.87
Crop insurance	27.42	11.20	13.05	17.22
Fuel & lubrication	13.79	11.29	9.12	11.40
Repairs	34.43	13.70	12.74	20.29
Irrigation power	31.06	31.06	31.06	31.06
Irrigation repairs	9.97	9.97	9.97	9.97
Custom hauling	97.50	—	—	32.50
Drying	—	14.40	—	4.80
Labor	100.00	—	—	33.33
Miscellaneous	17.75	1.05	1.00	6.60
Operating interest	34.77	9.68	6.80	17.08
Overhead	13.98	9.11	7.47	10.19
Machinery cost	86.03	58.07	52.57	65.56
Return to management	363.86	—	36.58	133.48
Land cost	26.25	26.25	26.25	26.25
Total	1,320.23	296.69	265.73	627.55

Source: Aakre and Swenson (1998)

Table 4. Crop Budgets for Three Irrigated Crops, Dryland Wheat, and the Difference, South Central North Dakota, 2000

Item	Irrigated Crops	Dryland Wheat	Difference
	----------$----------		
Seed	92.37	7.50	84.87
Chemicals	86.58	11.44	75.14
Fertilizer	28.87	11.21	17.66
Crop insurance	17.22	3.00	14.22
Fuel & lubrication	11.40	6.08	5.32
Repairs	20.29	9.18	11.11
Irrigation power	31.06	—	31.06
Irrigation repairs	9.97	—	9.97
Custom hauling	32.50	—	32.50
Drying	4.80	—	4.80
Labor	33.33	—	33.33
Miscellaneous	6.60	1.00	5.60
Operating interest	17.08	2.41	14.67
Overhead	10.19	3.40	6.79
Machinery cost	65.56	12.16	53.40
Return to management	133.48	—	133.48
Land cost	26.25	25.74	0.51
Total	627.55	93.12	534.43

Source: Aakre and Swenson (1998); Swenson and Haugen (1999)

Table 5. Per acre and Total Additional Production Expenditures for Irrigated Crops Compared to Dryland Wheat, and Corresponding Input-Output Model Sectors, South Central North Dakota, 2000

Item	Additional Per Acre Irrigation Expenditures	Irrigated Acres	Additional Irrigation Expenditures	I-O Model Sector
	-- $ --	acres		-- $000--
Seed	84.87	41,250	3,502	Retail trade
Chemicals	75.14	41,250	3,100	Retail trade
Fertilizer	17.66	41,250	728	Retail trade
Crop insurance	14.22	41,250	587	FIRE
Fuel & lubrication	5.32	41,250	219	Retail trade
Repairs	11.11	41,250	458	Retail trade
Irrigation power	31.06	41,250	1,281	Comm. & Pub. Util.
Irrigation repairs	9.97	41,250	411	Retail trade
Custom hauling	32.50	41,250	1,341	Transportation
Drying	4.80	41,250	198	Bus. & Pers. Services
Labor	33.33	41,250	1,375	Households
Miscellaneous	5.60	41,250	231	Bus. & Pers. Services
Operating interest	14.67	41,250	605	FIRE
Overhead	6.79	41,250	280	Retail trade
Machinery cost	53.40	41,250	2,203	Retail trade
Return to management	133.48	41,250	5,506	Households
Land cost	0.51	41,250	21	Households
Total	534.43	41,250	22,040	

Table 6. Additional Annual Expenditures for Irrigated Potatoes Compared to Dryland Wheat, by Economic Sector, Central North Dakota, 2000

Sector	Expenditure
	-- $000 --
Transportation	1,341
Communications & Public Utilities	1,281
Retail trade	10,901
Finance, insurance & real estate	1,192
Business & personal services	429
Households	6,902
Total	22,046

Input-Output Analysis

Economic impact analysis requires choosing a technique for estimating the indirect and induced effects an industry's expenditures will have on economic activity, employment, and income. The alternatives considered typically include the economic base approach, econometric estimation based on time-series or cross-sectional data, and input-output analysis. Input-output (I-O) analysis was selected as the economic impact assessment method for this study. The primary reasons were that, compared to the economic base approach, I-O analysis provides considerably more detailed estimates (i.e., business volumes and employment by sector) and I-O allows the analyst to take explicit account of differences in wage rates and local input purchasing patterns in estimating the impacts of various development proposals (Lewis 1968, Richardson 1972). Econometric techniques were thought to be inappropriate for this application because data available for this nonmetropolitan area were of insufficient detail for such analysis (Glickman 1972).

Input-output analysis is a technique for tabulating and describing the linkages or interdependencies between various industrial groups within an economy. The economy considered may be the national economy or an economy as small as that of a multicounty area served by one of the state's major retail trade centers. Input-output models have previously been developed and updated for the state and substate areas of North Dakota (Leistritz et al. 1982; Coon and Leistritz 1987, 1997). A microcomputer version of the North Dakota Input-Output model has been developed and was used in this analysis (Coon et al. 1988).

The North Dakota Input-Output model has been used extensively to estimate the economic impacts of a wide range of industrial sectors, including the Red River Valley potato industry (Coon et al. 1986). For a complete discussion of input-output theory and methodology, as well as a review of the North Dakota Input-Output model, see Coon et al. (1985).

The North Dakota Input-Output model uses interdependence coefficients, or multipliers, to measure the total level of economic activity generated in each sector from an additional dollar of expenditures in a given sector. Expenditures from the central North Dakota potato industry were divided into two categories – the one-time construction/start-up expenditures and the annually recurring processing and production outlays. These categories will be analyzed separately to determine the economic impacts. Application of these respective expenditures to the input-output model's interdependence coefficients provides an estimate of the levels of economic activity associated with the industry. The economic impacts of the industry are measured by the changes in indicators such as personal income, retail trade volume, gross business volume (gross receipts) for all business sectors, and total gross business volume. These measures can also be used to estimate additional economic measures, such as indirect and induced employment and revenues from selected state taxes, based on historic relationships (Coon et al. 1985).

Economic Impacts

The economic impacts resulting from the development of the potato industry in central North Dakota include construction/start-up, production, and processing activities. These activities have been split into one-time expenditures (construction/start-up) and annually recurring effects (production and processing). In-state expenditures for these items comprise the direct

economic impact of the industry. Application of these expenditures to the North Dakota Input-Output model results in estimates of the direct plus secondary (indirect and induced) impact, or total economic impact. Construction/start-up activities are comprised of expenditures for plant construction, potato grower purchases of irrigation equipment and potato production machinery, and potato storage facilities for growers. These expenditures are summarized in Table 7. These were outlays to entities or individuals within North Dakota and occurred over a two-year period (1995-1996). The total expenditures during this period were over $50 million.

Operational-phase economic impacts are important because they occur annually, providing long-term increases in employment, retail trade, and personal income. Operational expenditures are made by the Aviko processing plant and by potato growers. A large percentage of the processing plant's annual expenditures are made within North Dakota. As previously noted, expenditures for potatoes were not included in the processing plant outlays, to avoid double counting as these costs are accounted for by the potato growers' expenditures and net returns. Table 8 presents the operational-phase expenditures for the processing plant and the potato growers. Annual operational-phase expenditures were $55.5 million.

Table 7. Total Construction/Start-up Phase Expenditures for Processing Plant and Grower Equipment and Facilities, by Economic Sector, Central North Dakota, 1995-1996

Sector	Processing Plant	Irrigation Equipment	Potato Grower Machinery	Potato Grower Storage	Total
			$000		
Construction	3,918	1,249	—	12,994	18,161
Retail trade	4,100	18,592	3,443	—	26,135
Business & personal Services	—	3,284	—	—	3,284
Households	2,492	—	—	—	2,492
Total	10,510	23,125	3,443	12,994	50,072

Table 8. Total Operational-Phase Expenditures for Processing Plant Operations and Additional Grower Expenditures for Growing Potatoes, by Economic Sector, Central North Dakota, 2000

Sector	Processing Plant	Potato Growers	Total
	---------- $000 ----------		
Construction	2,200	—	2,200
Transportation	5,000	1,341	6,341
Communications & public utilities	6,500	1,281	6,781
Retail trade	10,100	10,901	21,001
Finance, insurance & real estate	1,720	1,192	2,912
Business & personal services	1,000	429	1,429
Households	7,900	6,902	14,802
Total	33,420	22,046	55,466

RESULTS

Expenditures were summed for the construction/start-up and operational-phases for application to the North Dakota Input-Output model (Table 9). Rather than present the economic impacts for each component of each phase, the total impacts for the two phases are presented. Application of the in-state expenditures to the input-output model yields measures of economic impact. During the construction/start-up phase, the economic impact was estimated to be nearly $28 million in added personal income, slightly over $44 million in new retail sales, and total gross business volume of over $115 million (Table 10). These were one-time impacts that were essentially spread over a two-year period. Annually recurring impacts included a personal income increase of over nearly $48 million, increased retail sales of almost $48 million, and total gross business volume of $148 million.

These enhanced levels of economic activity will generate additional tax revenues for the state. Construction-phase tax collections from three major state taxes amounted to $2.7 million, with sales and use tax collections the largest component at $2.0 million (Table 11). Operational-phase tax collections were estimated to be $3.1 million annually, and again the sales and use tax constituted the largest amount, $2.2 million (Table 11).

In addition to increased levels of economic activity and tax revenues, the most noticeable impact may be employment. During the construction-phase, 260 workers were employed at the peak of plant construction in 1996. Construction expenditures generated additional jobs necessary to serve and support the project (often termed secondary employment or indirect and induced employment). Secondary employment during the construction-phase was estimated to be 1,139 full-time equivalent workers (Table 12). Operational-phase employment for the potato processing plant is currently 250 workers. It is very difficult to estimate how many additional farm workers have been hired because of the production of potatoes, because labor is shared among several farm enterprises. The operational-phase direct employment presented in Table 12 reflects only those workers employed by the potato processing plant. This value understates the direct employment effects, but data were not available to account for the additional farm workers

hired. Full-time equivalent operational-phase secondary jobs were estimated to be 1,569 (Table 12).

Table 9. Construction-Phase and Operational-Phase Direct Expenditures Associated with Potato Production and Processing, by Economic Sector, Central North Dakota

Sector	Construction-Phase Expenditures	Operational-Phase Expenditures
	$000	
Construction	18,161	2,200
Transportation	—	6,341
Communications & public utilities	—	6,781
Retail trade	26,135	21,001
Finance, insurance & real estate	—	2,912
Business & personal services	3,284	1,929
Households	2,492	14,802
Total	50,072	55,466

Table 10. Estimated Direct plus Secondary Economic Impacts (Personal Income, Retail Sales, Gross Business Volume for all Business Sectors, and Total Gross Business Volume) from Potato Production and Processing, Construction and Operational Phases, Central North Dakota

Sector	Construction Phase	Operational Phase
	$000	
Personal income	27,821	47,699
Retail trade	44,068	47,683
Business activity of all business[1] sectors	80,750	89,491
Total business activity	115,495	147,621

[1] Includes all sectors except agriculture (livestock and crops), households, and government.

Table 11. Estimated State Tax Revenues Resulting from Potato Production and Processing, Construction and Operational Phases, Central North Dakota

Tax	Construction Phase	Operational Phase
	$000	
Sales and use	2,040	2,208
Personal income	362	620
Corporate income	250	277
Total	2,652	3,105

Table 12. Estimated Direct and Secondary Employment Resulting from Potato Production and Processing, Construction and Operational Phases, Central North Dakota

Employment	Construction Phase	Operational Phase
	---------- FTE workers----------	
Direct[1]	260	250
Secondary	1,139	1,569

[1] Direct employment for the construction-phase is peak plant construction workforce; operational phase direct employment is full-time equivalent processing plant workers.

CONCLUSIONS

Agriculture in North Dakota has been experiencing tough economic times. This has led producers to search for new crop enterprises to increase profitability. A group of people in the Jamestown area recognized the availability of natural resources (water and land) that could produce high-value crops. This group also recognized that production of a high-value crop would require an associated processing plant to make the enterprise feasible. The work of this group resulted in the construction of the Aviko potato processing plant, and 33 growers were awarded contracts to grow 15,000 acres of irrigated potatoes. Socio-economic impacts of this project for Jamestown and the surrounding area have been analyzed previously (Leistritz and Sell 2000); this study quantifies the economic impacts of the project.

The economic impact of the addition of the potato industry to central North Dakota has been analyzed in two phases: construction/start-up and operational. Construction/start-up phase direct expenditures of over $50 million have increased the total level of economic activity by over $115 million, highlighted by increased levels of personal income and retail sales. These increased levels of economic activity also resulted in increased collections of major state taxes. Although this phase lasted less than two years, it provided employment for 260 workers at the peak of plant construction, as well as for another 1,139 secondary workers. Operational-phase direct expenditures were nearly $56 million annually, which resulted in a $148 million increase in total economic activity. Personal income and retail sales were estimated to be almost $48 million, larger as a result of operation phase impacts. Increased state tax collections resulting from the operational-phase would be $3.1 million annually. The operational-phase also results in 250 full-time equivalent jobs at the plant, as well as 1,440 secondary jobs. An important aspect of the operation phase is that the impacts are “permanent” in that they occur each year the industry is operating.

Although only 33 growers have contracts to grow irrigated potatoes, the economic impacts reach far beyond the 15,000 irrigated potato acres. Jobs, business activity, and tax revenues have all increased as the result of production of a high-value specialty crop. Each dollar spent in the production and processing activities creates another $1.66 in the state economy, for a total of $2.66. This industry has become an important factor in the economy of central North Dakota, and the Jamestown area in particular.

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