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# **The Contribution and Impact of the Red River Valley Potato Industry on the Economies of North Dakota and Minnesota**

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## Preface

The work upon which this report is based was partially supported by funds from the Red River Valley Potato Growers Association. The purpose of this research was to estimate the economic contribution and impact of the potato industry on the economies of North Dakota and Minnesota. Outside of the small geographic area of the Red River Valley involved in the production and processing of potatoes, the economic importance of this industry may not be fully realized. Because of the capital intensive nature of the industry and the degree of integration, the industry contributes significantly to the economies of North Dakota and Minnesota. Input-output analysis was used to estimate the effects of this industry on key economic variables such as total business activity, personal income, retail sales, employment, and tax revenues.

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## Table of Contents

	<u>Page</u>
List of Tables .....	iii
List of Figures .....	iv
Highlights .....	v
Introduction .....	1
Purpose of the Study .....	2
Red River Valley Potato Industry .....	4
History of the Red River Valley Potato Industry .....	4
Producing Area .....	6
Processing Facilities .....	6
Methodology .....	9
Production Expenditures .....	9
Storage Expenditures .....	12
Processing Expenditures .....	15
Input-Output Model .....	16
Interdependence Coefficients .....	17
Productivity Ratios .....	18
Tax Revenue Estimation .....	18
Model Validation .....	19
Economic Contribution and Impact .....	20
Expenditures and Total Business Activity .....	21
Tax Collections .....	23
Employment .....	24
Conclusions .....	24
Appendix A .....	27
Appendix B .....	37
Appendix C .....	47
References .....	53

## List of Tables

<u>Number</u>		<u>Page</u>
1	ACRES PLANTED, YIELD PER ACRE PLANTED, AND PRODUCTION OF FALL POTATOES IN NORTH DAKOTA AND MINNESOTA, SELECTED YEARS 1965-1984 .....	1
2	ESTIMATED LOCAL PER ACRE EXPENDITURES FOR PRODUCTION OF POTATOES, WHEAT, AND AMOUNT POTATO EXPENDITURES EXCEED THOSE FOR WHEAT, RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985 .....	10
3	POTATO ACREAGE AND PRODUCTION FOR THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, BY COUNTY, 1984 .....	12
4	ESTIMATED POTATO PRODUCTION, STORAGE, AND TOTAL LOCAL CONTRIBUTION AND IMPACT EXPENDITURES BY ECONOMIC SECTOR, BY FARMERS IN THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985 .....	13
5	ESTIMATED LOCAL MONTHLY EXPENDITURES BY ECONOMIC SECTOR FOR STORAGE OF POTATOES, RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985 .....	14
6	PERCENTAGE AND AMOUNT OF POTATO SALES BY MONTH, RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1984 .....	15
7	ESTIMATED POTATO PROCESSING LOCAL EXPENDITURES BY ECONOMIC SECTOR IN THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985 .....	17
8	STATISTICAL TESTS FOR COMPARISON OF PERSONAL INCOME ESTIMATES FROM THE NORTH DAKOTA AND MINNESOTA INPUT-OUTPUT MODELS WITH DEPARTMENT OF COMMERCE ESTIMATES, RED RIVER VALLEY POTATO INDUSTRY REGIONS AND STATE .....	20
9	ESTIMATED POTATO INDUSTRY'S TOTAL LOCAL CONTRIBUTION AND IMPACT EXPENDITURES BY ECONOMIC SECTOR, FOR THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985 .....	21
10	ESTIMATED PERSONAL INCOME, RETAIL SALES, BUSINESS ACTIVITY OF ALL BUSINESS (NONAGRICULTURAL) SECTORS, AND TOTAL BUSINESS ACTIVITY FOR THE POTATO INDUSTRY OF THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985 .....	22
11	ESTIMATED TAX REVENUES ASSOCIATED WITH THE POTATO INDUSTRY OF THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985 .....	23
12	ESTIMATED PRODUCTION, PROCESSING, AND SECONDARY EMPLOYMENT ATTRIBUTABLE TO THE POTATO INDUSTRY OF THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985 .....	24

List of Figures

<u>Number</u>		<u>Page</u>
1	United States Per Capita Consumption of Potatoes on a Fresh Weight Equivalent Basis, 1965-1984 .....	3
2	Total and Red River Valley Planted Acres of Potatoes, North Dakota and Minnesota, 1975-1984 .....	5
3	Potato Producing Counties in the Red River Valley of North Dakota and Minnesota .....	7
4	Potato Processing Facilities in the Red River Valley of North Dakota and Minnesota .....	8

### Highlights

The potato industry of the Red River Valley is concentrated in a rather small area of North Dakota and Minnesota, and acres planted to potatoes constitute a small percentage when compared with major crop plantings in the respective states. As a result of this, the potato industry's contribution to the economies of North Dakota and Minnesota is often overlooked or underestimated. The potato industry is capital intensive and includes farm production and storage, wash plants, and processing factories.

Input-output models previously developed for North Dakota and Minnesota were used to analyze the economic contribution and impact of the potato industry in the Red River Valley. The contribution analysis was based on all local expenditures, whereas the impact assessment used local expenditures net of an alternative crop (wheat for this analysis). Budgets were used to estimate local expenditures by farmers for production and storage of potatoes. Local contribution expenditures by farmers totaled about \$49 million in North Dakota and almost \$20 million in Minnesota, while impact expenditures were over \$41 million and almost \$17 million in the respective states. In addition to the local expenditures by farmers, the operation of wash plants and processing factories resulted in significant outlays in the area. Estimates of these expenditures were obtained through a survey of facilities operating in the Red River Valley. Potato processing local expenditures amounted to almost \$8 million in North Dakota and over \$6 million in Minnesota.

Application of the local contribution and impact expenditures to the input-output coefficients provided measures of key economic variables. Historic relationships were used to estimate indirect and induced employment and tax revenues. Total contribution business activity generated by the potato industry was almost \$163 million in North Dakota and almost \$75 million in Minnesota in 1985. Economic impact business activity amounted to about \$143 million and around \$67 million in North Dakota and Minnesota, respectively, during 1985. Personal income and retail sales attributable to the Red River Valley potato industry were about \$49 million and \$23 million for North Dakota and Minnesota, respectively, for the contribution analysis, and over \$45 million and \$21 million, respectively, for the impact assessment. Potato industry contribution expenditures resulted in tax collections of almost \$4 million, while impact expenditures accounted for over \$3 million in tax revenues.

In addition to the workers directly involved in the production and processing of potatoes, another 3,541 indirect and induced jobs resulted from contribution expenditures; a somewhat smaller number (3,173) were attributed to the impact expenditures. Potato industry contribution expenditures generate another \$1.86 in business activity for each dollar spent, for a total of \$2.86; impact expenditures created another \$1.93 which gave a total of \$2.93. These key economic variables provide an indication of the economic importance of the potato industry to the economy of the Red River Valley.

THE CONTRIBUTION AND IMPACT OF THE  
RED RIVER VALLEY POTATO INDUSTRY ON THE ECONOMIES  
OF NORTH DAKOTA AND MINNESOTA

Randal C. Coon, F. Larry Leistritz, and Donald F. Scott\*

Introduction

The potato industry of the Red River Valley of North Dakota and Minnesota is an integrated industry including both production and processing. Potato plantings in 1984 were 136,000 and 77,100 acres for North Dakota and Minnesota, respectively, with the resulting production being 20.6 and 13.8 million cwt for these states (Table 1). Total acres of fall potatoes planted in North Dakota have increased from 112,000 to 136,000 acres during the 1965 to 1984 period; corresponding with the acreage increases during that period were higher levels of total potato production. Minnesota fall potato acreage declined from 103,000 to 77,100 acres from 1965 to 1984; however, total potato production increased slightly during the period. North Dakota potato acreage in 1984 (136,000) was small when compared to the almost 5.5 million acres of wheat planted and was concentrated in a relatively small area of the state (North Dakota Crop and Livestock Reporting Service 1985). A similar situation existed in Minnesota, where total 1984 potato plantings (83,300 acres) were rather insignificant when compared to the almost 7.3 million acres of corn and 5.3 million acres of soybeans grown in the state during the same year (Minnesota Agricultural Statistics Service 1985). Potato production in Minnesota is distributed throughout a wider area of the state than the Red River Valley, and a small amount of summer potatoes are harvested in addition to the fall potatoes.

TABLE 1. ACRES PLANTED, YIELD PER ACRE PLANTED, AND PRODUCTION OF FALL POTATOES IN NORTH DAKOTA AND MINNESOTA, SELECTED YEARS 1965-1984

Year	North Dakota			Minnesota		
	Acres Planted	Yield Per Acre Planted	Production	Acres Planted	Yield Per Acre Planted	Production
	-000 acres-	----cwt-----	--000 cwt-	-000 acres-	----cwt-----	--000 cwt-
1965	112.0	137.2	15,370	103.0	125.3	12,905
1970	121.0	145.0	17,550	95.0	120.4	11,440
1975	116.0	151.7	17,600	70.0	138.4	9,690
1980	114.0	137.5	15,680	65.0	152.6	9,920
1984	136.0	151.6	20,615	77.1	178.7	13,775

SOURCE: Statistical Reporting Service 1972-1985.

\*Coon is research specialist and Leistritz and Scott are professors, Department of Agricultural Economics, North Dakota State University, Fargo.

Production increases for potatoes have followed a national trend of increased per capita consumption of potatoes from the mid 1960s to 1984 (Figure 1). Annual per capita consumption of potatoes has increased from 106.7 to 119.9 pounds during the 20-year period. During this time, the increased consumption of frozen potatoes has been responsible for per capita potato consumption remaining at its current level, because the fresh consumption has declined from 67.9 to 51.8 pounds annually from 1965 to 1984. In essence, the potato has not lost its popularity with the consumer, although the types of potato products being demanded have changed. The consumer wants the convenience of processed potatoes (i.e., frozen and chips), and as a result fresh potato consumption has declined.

The potato industry of the Red River Valley has made significant additions to the economies of North Dakota and Minnesota despite the fact that its acreage is small compared to the major crops of the respective states. Because the Red River Valley potato industry tends to be concentrated in a small area when compared to the major crops of North Dakota and Minnesota, the industry's contribution to the economies of the respective states is often overlooked. However, the industry is capital intensive, includes farm production and storage, wash plants, and processing factories, and makes a substantial economic contribution to the Red River Valley area.

#### Purpose of the Study

The purpose of this study was to estimate the economic contribution and impact the Red River Valley potato industry made to North Dakota and Minnesota in 1985. Such a study involves measuring, in terms of economic variables, the effects that all expenditures made by the industry have had on the economic unit (in this case, the state). This analysis included expenditures by farmers for production and storage of potatoes, wash plant expenditures, and outlays by potato processing factories. Economic impact differs from economic contribution in that an impact analysis shows the effects of an industry as it currently exists relative to the industry's absence. In other words, the impact assessment of the potato industry would include the net amount of local expenditures over a situation in which the industry did not exist. The concepts of contribution and impact analyses will be discussed in greater detail in the methodology section. Because both of these analyses provide useful and interesting information, each will be presented in this report.

Input-output analysis was used to analyze the contribution and impacts of the potato industry for each state. The direct effects of the potato industry include additional employment and income for residents in the Red River Valley. Expenditures by the potato industry are recirculated within the local economy in the form of purchases of goods and services, tax revenues to the state government, and wages and salaries to households. These expenditures result in indirect and induced effects because of subsequent rounds of respending. Secondary impacts include increased employment and income.

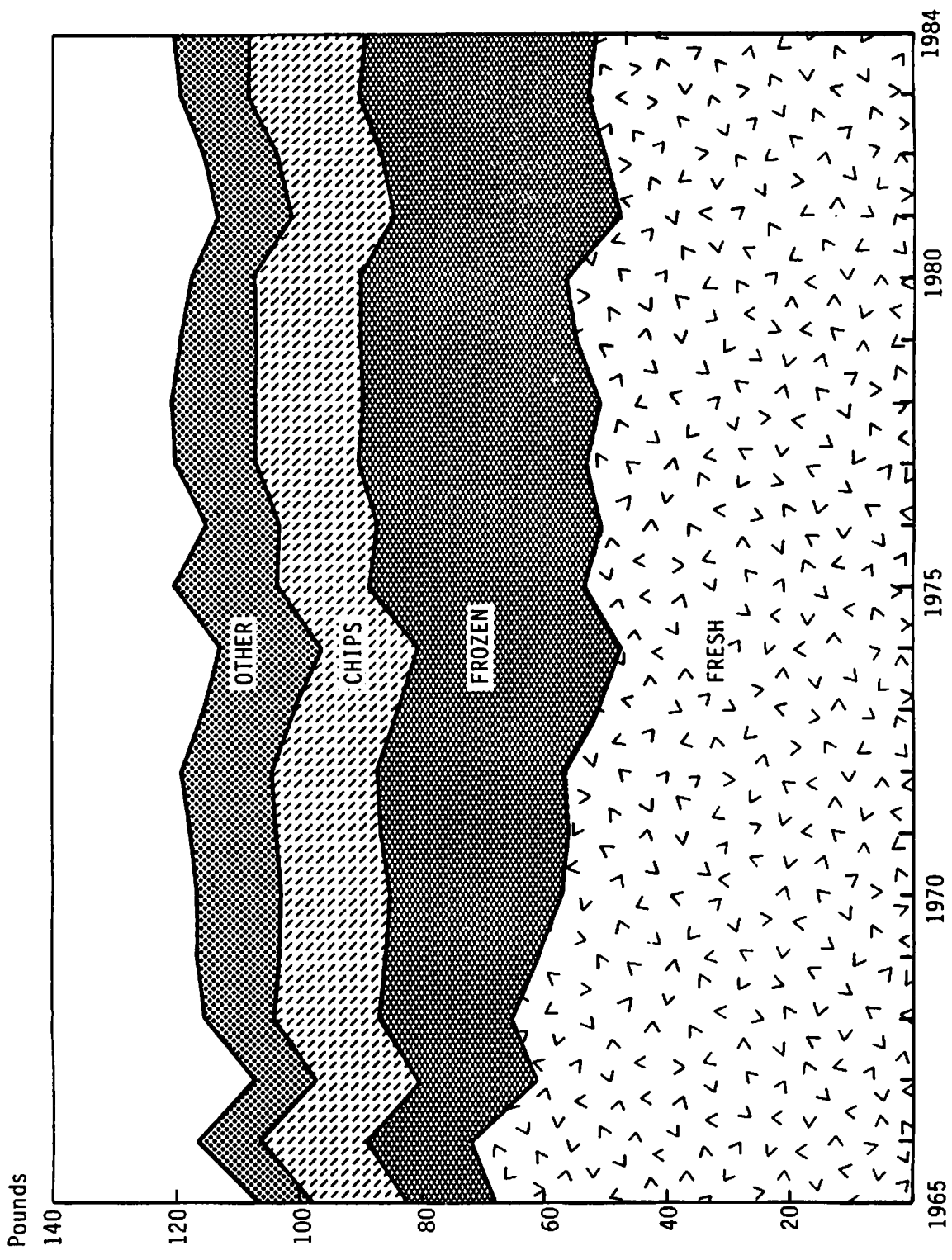


Figure 1. United States Per Capita Consumption of Potatoes on a Fresh Weight Equivalent Basis, 1965-1984

SOURCE: Economic Research Service 1985.

Determining the economic contribution and impact of a given industry provides detailed information regarding its importance to a local economy. In the case of the potato industry, this type of analysis is beneficial because the industry is concentrated in a small geographic area. The importance of this industry in terms of employment, personal income, and tax revenues should not be underestimated because it is not widely distributed throughout North Dakota and Minnesota. It should be mentioned that there are no federal government programs for potato production so all additions to the local economy are completely the result of private business expenditures. This report will provide a detailed economic analysis of the benefits accruing to the local economies in the Red River Valley as a result of the potato industry.

### Red River Valley Potato Industry

Potato production in the Red River Valley constitutes a large portion of the total for North Dakota and Minnesota. Figure 2 shows the total acreage planted to potatoes in North Dakota and Minnesota and the acres planted in the Red River Valley of those states. Since 1975, only a very small share of North Dakota potato plantings have occurred outside the Red River Valley. The amount of these plantings had declined to the 1,000-acre range by the early 1980s and has increased only slightly since that time. Since 1975, about two-thirds of the potato acres planted in Minnesota have been in the Red River Valley. This ratio has remained relatively stable over the last 10 years, and total acres planted in Minnesota have followed a pattern almost identical to that in North Dakota.

### History of the Red River Valley Potato Industry

Potatoes were first recorded as being planted in the Red River Valley in 1801. In the spring of that year, Alexander Henry planted potatoes on his farm near the present-day site of St. Vincent, Minnesota. The seed for this planting was apparently brought down the Red River from Canada. Potato production in the Red River Valley increased from about 2,000 acres to 25,000 acres from 1880 to 1890. By 1910, potato acreage had increased to 57,000 acres. Yields during this 30-year period ranged from 19 to 68 cwt per acre.

Mr. Nels Folson is considered one of the founders of the Red River Valley potato industry. In 1905, he started commercial plantings of potatoes near Hoople, North Dakota; 20 acres were planted that year. Folson expanded his potato plantings to 107 acres in 1906 and built a 9,000-bushel capacity potato storage house in 1907. He contracted with Duluth commission men to take his early crops and also was instrumental in establishing the northern Red River Valley in the seed trade. His contacts with southern growers ultimately led to the establishment of certified seed production and the demand for northern grown seed. Production of potatoes increased gradually with peak years during World War I and World War II. In recent years, potato acreage has been about 120,000 acres for North Dakota and near 80,000 acres in Minnesota. For a detailed discussion of the history of the Red River Valley potato industry, see Lana (1976).

Thousand Acres

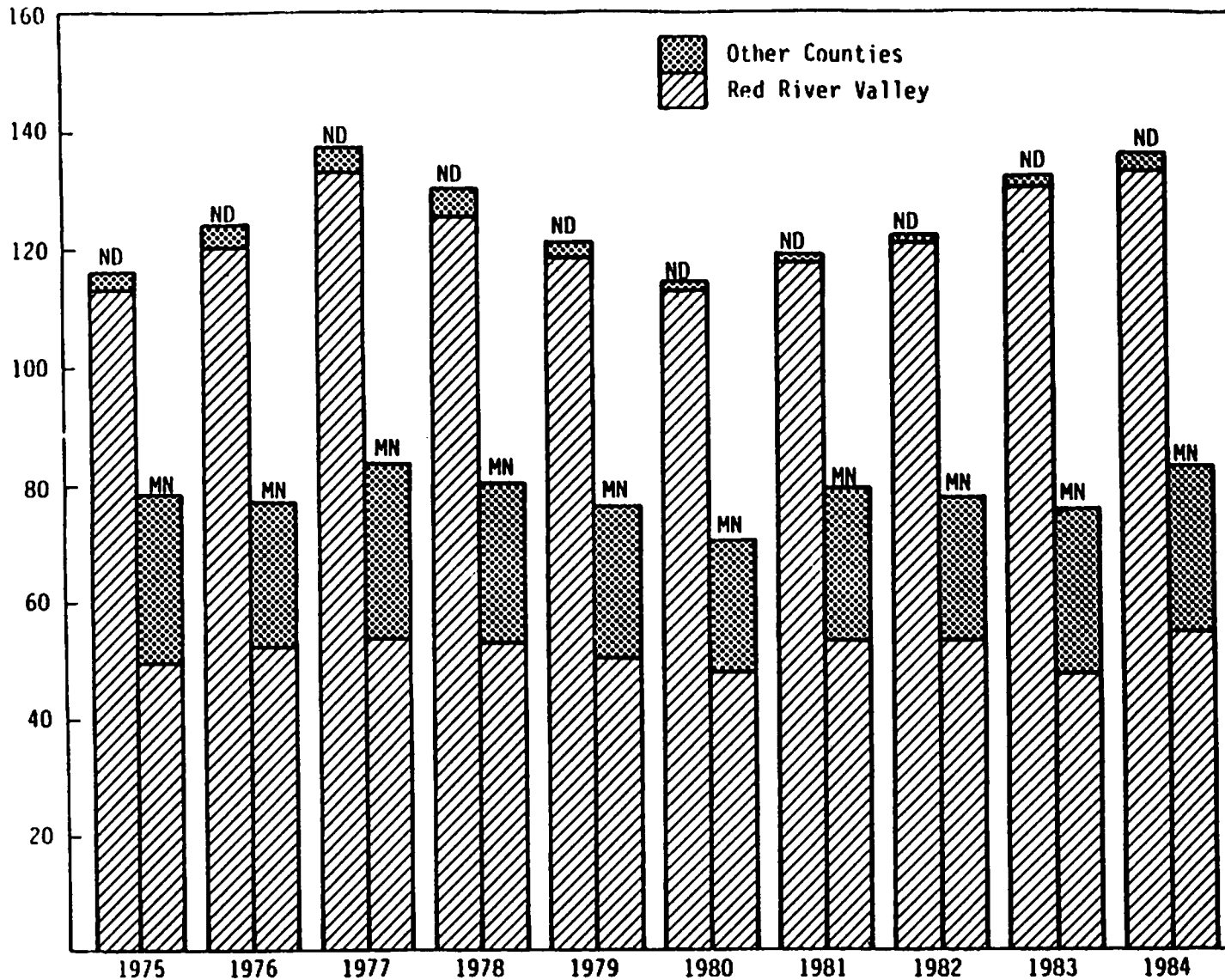


Figure 2. Total and Red River Valley Planted Acres of Potatoes, North Dakota and Minnesota, 1975-1984

SOURCE: North Dakota Crop and Livestock Reporting Service 1976-1985; Minnesota Agricultural Statistics Service 1976-1985.

## Producing Area

Red River Valley potato production includes five counties in North Dakota and five in Minnesota (Figure 3). Minnesota counties include Clay, Kittson, Marshall, Norman, and Polk. Grand Forks, Pembina, Towner, Traill, and Walsh Counties are the major potato producing areas of North Dakota.<sup>1</sup> Economic contribution and impact of the Red River Valley potato industry was defined as including local expenditures associated with production and storage of potatoes in this area. Previously developed budgets were used to estimate farmers' expenditures necessary to produce and store potatoes in the Red River Valley. These budgets will be discussed in detail in the methodology section of this report.

Because this was a study of the economic contribution and impact of the Red River Valley potato industry, only the area previously discussed was included in the analysis. It is acknowledged that there is significant potato acreage outside the Red River Valley, especially in Minnesota, but these areas were not incorporated into the analysis because of differences in their industry structure. Many of the potatoes grown in Minnesota and out of the Red River Valley are irrigated while others are summer-harvested potatoes. Also, some of the Minnesota potatoes are grown near the Minneapolis-St. Paul metropolitan area where the economic impacts would be extremely difficult to isolate.

## Processing Facilities

The potato industry of the Red River Valley consists of not only the farm production and storage but also the wash plants and processing factories located in that area. Figure 4 shows the location of potato wash plants and processing factories in the study area. Processing facilities are concentrated in the northern end of the Red River Valley; for example, wash plants are located in Walsh and Pembina counties and two processing factories are operating in Grand Forks, North Dakota. Processing facilities shown in the figure include only those located in the Red River Valley or directly associated with the potato industry in that area. Other processing facilities are located elsewhere in the two-state area; these facilities were excluded from this analysis because, as previously mentioned, the study included only the Red River Valley potato industry.

Local expenditures by the wash plants and processing factories were obtained through a survey of plant operators. These local expenditures were added to the estimated farmer outlays for production and storage of potatoes to obtain the total local expenditures. This total was then used to estimate the economic contribution of the industry in the Red River Valley. Expenditures were aggregated for each state so the contribution

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<sup>1</sup>Although Towner County is not located in the Red River Valley, it was considered to be part of that area's potato industry because of its proximity and the large amount of seed produced in that county for planting in the Red River Valley.

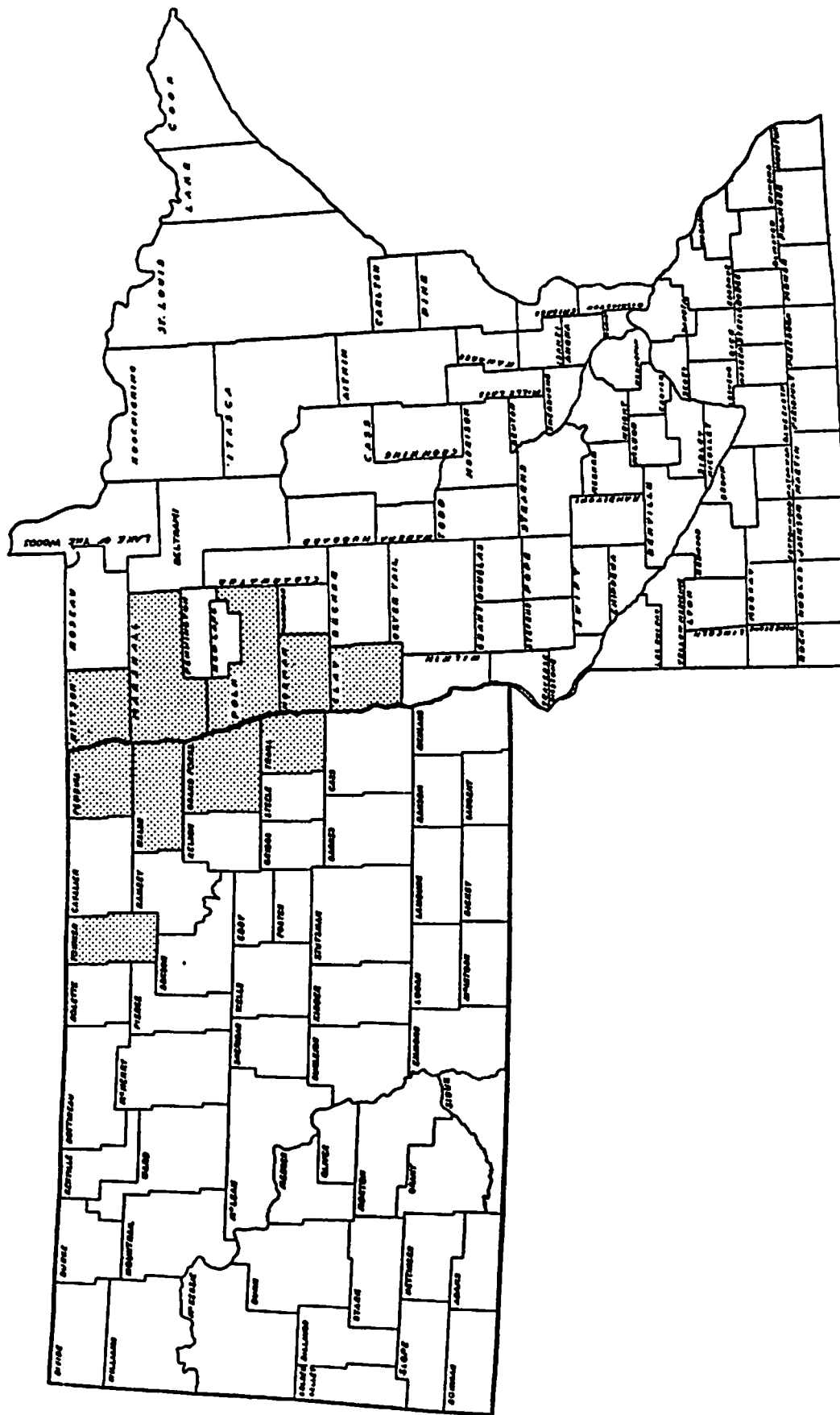
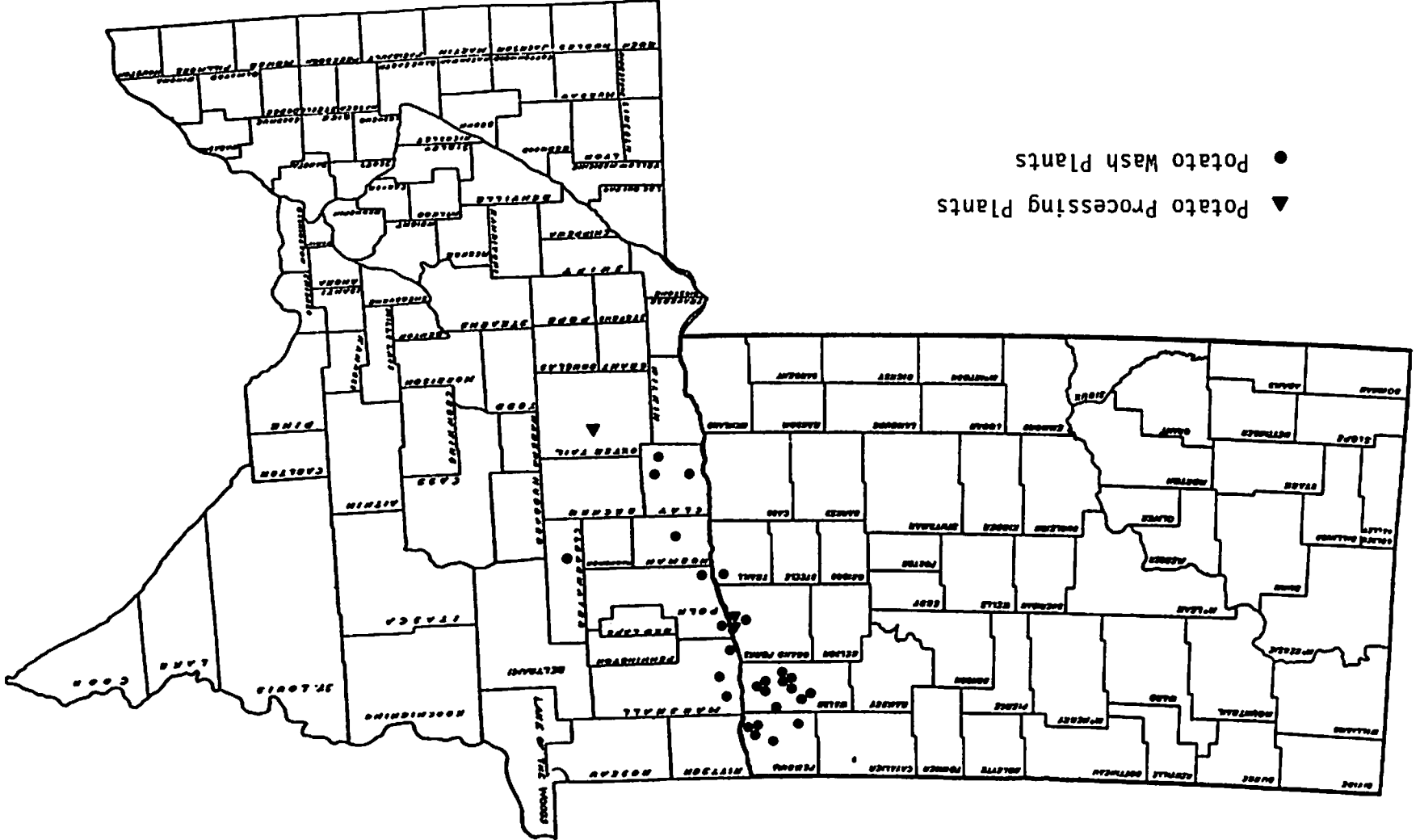


Figure 3. Potato Producing Counties in the Red River Valley of North Dakota and Minnesota

Figure 4. Potato Processing Facilities in the Red River Valley of North Dakota and Minnesota



and impact analyses could be conducted for North Dakota and Minnesota and then for the Red River Valley. The methodology employed to perform this analysis will be discussed in detail in the section that follows.

### Methodology

The methodology for this study will be described in detail because it was not feasible to obtain all local expenditures for the industry through survey techniques. As a result, a combination of primary data collection and secondary sources was used to estimate local expenditures from the potato industry. Also, because not all processing facilities responded to the expenditures questionnaire, estimation techniques were used so as not to understate the contribution and impacts of the industry. The assumptions made in order to complete the analysis will be discussed in this section.

As previously mentioned, both the economic contribution and impact of the potato industry of the Red River Valley will be estimated in this analysis. The contribution portion of the study consisted of estimating all local expenditures associated with the industry (i.e., farmer expenditures for potato production and storage, wash plant expenditures, and processing factory expenditures). Expenditures for the impact analysis were basically the same, except farmer expenditures for production and storage were calculated as net of the most popular alternative crop (wheat for this analysis). Impact expenditures included all additional money that would come into the local economy as a result of the industry existing there (i.e., if the industry were not located in the area the land would still be farmed but most likely planted into wheat). Local expenditures to produce wheat were subtracted from those to produce and store potatoes with the result added to wash plant and processing factory expenditures to obtain total local economic impact expenditures. Wheat storage variable costs are negligible and, therefore, were assumed to be zero for this analysis. Estimated local contribution and impact expenditures were applied to the North Dakota and Minnesota input-output models to determine their effects on the economy of each state and were then totaled to determine the effects for the Red River Valley. Throughout this report, analyses will be discussed and results will be presented for the economic contribution and impact of the industry, so it is important to distinguish between the two and remember the definitional differences when reading the results section.

### Production Expenditures

Local production expenditures were based on 1985 budgets for potatoes (Reff 1985) and wheat (Johnson et al. 1986). Detailed crop production budgets are presented in Appendix A, Table 1 for potatoes and Table 2 for wheat. These budgets were used to estimate per-acre local expenditures for production of potatoes and wheat. Potato production expenses were used for the contribution analysis and potato expenses less wheat expenses were used to determine the economic impact of the potato industry.

Local expenditures associated with the production of potatoes in the Red River Valley are summarized in Table 2. Local potato production

TABLE 2. ESTIMATED LOCAL PER-ACRE EXPENDITURES FOR PRODUCTION OF POTATOES, WHEAT, AND AMOUNT POTATO EXPENDITURES EXCEED THOSE FOR WHEAT, RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985

Item	Local Expenditures Per Acre		
	Potatoes	Wheat	Potatoes Net of Wheat
	-----dollars-----		
Seed <sup>1</sup>	99.00	6.84	92.16
Fertilizer <sup>2</sup>	29.70	17.96	11.74
Chemicals <sup>3</sup>	69.92	13.60	56.32
Fuel and lubrication	31.32	8.30	23.02
Repairs	28.75	8.00	20.75
Crop insurance <sup>4</sup>	14.44	1.69	12.75
Miscellaneous	16.44	0.35	16.09
Interest on operating capital	26.03	1.97	24.06
Labor <sup>5</sup>	<u>6.52</u>	<u>1.08</u>	<u>5.44</u>
Total	322.12	59.79	262.33

<sup>1</sup>Seed expenditure for potatoes includes seed cutting costs.

<sup>2</sup>Fertilizer includes nitrogen, phosphate, and potash.

<sup>3</sup>Chemicals include herbicides, fungicides, seed treatment, and sprout inhibitor.

<sup>4</sup>Crop insurance was not included in the complete wheat budget but was added to maintain consistency between the potato and wheat budget costs.

<sup>5</sup>Labor category includes only the local expenditures for hired help. Data were not available from crop budgets to estimate hired labor; therefore, a 16 percent ratio of hired farm labor to total (Tsigas 1981) was applied to the crop budget labor costs to obtain the estimate.

expenditures were estimated at \$322.12 per acre for 1985. These expenditures were less than the total cost of production for potatoes as presented in the crop budget, but it should be pointed out that many of those costs (i.e., land charge, opportunity costs for the operator's labor and management, and overhead) are not normally cash expenditures in the local economy. Local expenditures for the land charge were virtually impossible to estimate because the land could alternatively be (1) owned by the farmer-operator, (2) rented from local landlords, (3) rented from absentee landowners, (4) financed by farmer-purchaser through local institutions, and (5) farmer purchases financed by nonlocal institutions. The possibility exists that a rather small portion of the land potatoes are raised on is actually in the process of being purchased (i.e., it is likely that only a small percentage of total acres planted in potatoes is being

purchased and financed locally). For these reasons, including a land charge in the local expenditures would invariably overstate the economic contribution in this analysis.

Another budget cost that was excluded from the local expenditures was the machinery ownership cost. This cost, in essence, was the charge for machinery necessary to farm the land. Local expenditures by farmers for machinery were not included in this analysis because data were not available to accurately estimate these purchases in 1985, a time characterized by declining capital purchases (Coon, Ali, and Johnson 1986).<sup>2</sup> Thus, the results of this analysis may be conservative or may slightly understate the contribution and impact of the industry. This situation is more acceptable than the overstatement of the effects of the industry that would result if land and machinery charges that did not exist were included as local expenditures in the analysis. Essentially, the estimated local expenditures consisted of the production costs or variable costs associated with raising potatoes.

Wheat costs were used in this analysis to determine the potato expenditures net of an alternative crop. Table 2 presents estimated local expenditures for wheat production and potato expenditures net of those for wheat. Local expenditures to produce wheat were estimated to be \$59.79 per acre for 1985; thus, net local potato production expenditures amounted to \$262.33 per acre for the impact assessment. Assumptions used to determine local wheat expenditures were the same as those used for potatoes; this resulted in local expenditures for wheat including basically variable costs, corresponding with those for potatoes.

Estimated local expenditures for potato production were determined by applying per-acre expenditures to the total acres planted to potatoes. Acres of potatoes were kept separate for North Dakota and Minnesota to facilitate a more detailed analysis. Potato acreage by county was not available for 1985, so 1984 data were used. Table 3 presents Red River Valley potato acres planted. Potato acres planted in 1984 were compared with the previous four years and with the 1980-1984 average for Red River Valley counties and for the state to determine if 1984 acreages were appropriate for this analysis (Appendix A, Tables 3 and 4). Potato acres planted in 1984 were above the five-year average, consistent with preliminary state-level estimates for 1985 (Economic Research Service 1986); thus, 1984 acreages were used for this analysis. Red River Valley potato plantings were 133,400 acres for North Dakota and 54,300 acres for Minnesota.

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<sup>2</sup>Capital purchases available in the crop budgets did not accurately represent the local expenditures by farmers, the value required for contribution and impact analysis. Budgeted machinery costs ignore trade-in values (i.e., local expenditures would be the cash difference between purchase price and trade-in). Also, estimating local machinery expenditures was extremely difficult during this period because of an abundance of lower priced used machinery due to farm financial problems, and purchase prices varied considerably as implement dealers engaged in aggressive price discounting (Coon and Mittleider 1985).

TABLE 3. POTATO ACREAGE AND PRODUCTION FOR THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, BY COUNTY, 1984

State	County	Acres	Production ---cwt---
North Dakota	Grand Forks	26,800	3,875,000
North Dakota	Pembina	36,400	5,989,500
North Dakota	Towner	2,400	300,000
North Dakota	Traill	5,000	630,000
North Dakota	Walsh	<u>62,800</u>	<u>9,345,500</u>
Total		133,400	20,140,000
Minnesota	Clay	8,600	1,120,000
Minnesota	Kittson	5,300	700,000
Minnesota	Marshall	11,300	1,512,000
Minnesota	Norman	1,500	162,500
Minnesota	Polk	<u>27,600</u>	<u>4,240,000</u>
Total		54,300	7,734,500

SOURCE: North Dakota Crop and Livestock Reporting Service 1985;  
Minnesota Agricultural Statistics Service 1985.

Estimated local potato production expenditures for North Dakota were almost \$43 million for the economic contribution and nearly \$35 million for the economic impact in 1985 (Table 4). Corresponding values for Minnesota were about \$17 million for the economic contribution and over \$14 million for the economic impact. These expenditures were distributed through six sectors of the local economies. The largest share of the local expenditures was to the retail trade sector for production inputs (i.e., chemicals, fertilizer, fuel, etc.) followed by seed purchases and financing and insurance expenditures.

#### Storage Expenditures

In addition to production costs, potato farmers also incur significant costs when storing potatoes. Budgets have been developed to estimate the costs for potato storage in the Red River Valley (Benson and Preston 1985). A detailed potato storage cost budget for 1985 is presented in Appendix A, Table 5. Storage expenses were calculated on a per-cwt basis from the budget estimates for a potato storage house with a 48,000 cwt storage capacity. Assumptions previously stated also applied to storage expenditures. Building costs were excluded because it was assumed very few or no storage buildings were constructed in 1985. Equipment and machinery expenses also were eliminated using the assumption that these purchases were at a minimum during 1985.

TABLE 4. ESTIMATED POTATO PRODUCTION, STORAGE, AND TOTAL LOCAL CONTRIBUTION AND IMPACT EXPENDITURES BY ECONOMIC SECTOR, BY FARMERS IN THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985

Sector	North Dakota Expenditures			Minnesota Expenditures		
	Production	Storage	Total	Production	Storage	Total
-----thousand dollars-----						
Economic contribution:						
Agriculture, crops	12,006	--	12,006	4,887	--	4,887
Communications and utilities	--	1,967	1,967	--	756	756
Retail trade	21,303	1,148	22,451	8,671	441	9,112
Finance, insurance, real estate	5,399	806	6,205	2,198	309	2,507
Business and personal service	2,193	--	2,193	893	--	893
Households	<u>2,070</u>	<u>2,188</u>	<u>4,258</u>	<u>843</u>	<u>840</u>	<u>1,683</u>
Total	42,971	6,109	49,080	17,492	2,346	19,838
Economic impact:						
Agriculture, crops	11,094	--	11,094	4,516	--	4,516
Communications and utilities	--	1,967	1,967	--	756	756
Retail trade	14,918	1,148	16,066	6,072	441	6,513
Finance, insurance, real estate	4,911	806	5,717	1,999	309	2,308
Business and personal service	2,146	--	2,146	874	--	874
Households	<u>1,926</u>	<u>2,188</u>	<u>4,114</u>	<u>784</u>	<u>840</u>	<u>1,624</u>
Total	34,995	6,109	41,104	14,245	2,346	16,591

Estimated local monthly expenditures for potato storage on a cwt basis are presented in Table 5. These local expenditures totaled 8.57

TABLE 5. ESTIMATED LOCAL MONTHLY EXPENDITURES BY ECONOMIC SECTOR FOR STORAGE OF POTATOES, RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985

Item	Local Expenditures Per Cwt <sup>1</sup>
	-----dollars-----
Electricity	.0193
Telephone	.0083
Insurance	.0113
Labor	.0307
Office supplies	.0035
Disinfectant	.0026
Sprout inhibitor	<u>.0100</u>
Total	<u>.0857</u>

<sup>1</sup>Monthly expenditures were based on a 48,000 cwt house storing potatoes for six months.

cents per cwt per month of storage. The methodology used to compute this cost was similar to that used for production costs except for one item--interest on potato inventory was not included whereas interest on operating capital for production expenses was. The reason for this difference was that the interest on the potato inventory was essentially an opportunity cost and not a cash outlay into the local community.

Data were not available on potato storage by month, but a methodology was derived to estimate the volume of potatoes in storage by month. Potato production data were available for the Red River Valley for 1984 (Table 3 and Appendix A, Tables 6 and 7). State-level production and disposition of potatoes were available for 1980 to 1984 (Statistical Reporting Service [1981-1985]), and the percent of production sold was determined for 1980 to 1984 (Appendix A, Table 8). The five-year average for North Dakota was used to estimate total Red River Valley potato production sold. The North Dakota five-year average, which was slightly lower than that for Minnesota, was used because it was assumed to more accurately reflect the Red River Valley potato sales situation. Monthly marketings of potatoes were available at the state level (Statistical Reporting Service 1981-1985), and five-year averages were calculated for

North Dakota and Minnesota (Appendix A, Table 9). Again, North Dakota averages were used because they were believed to more accurately reflect the Red River Valley potato marketings. Potato sales (i.e., production times percent sold) for each state were multiplied by monthly marketings to obtain potato sales on a monthly basis (Table 6). Application of the

TABLE 6. PERCENTAGE AND AMOUNT OF POTATO SALES BY MONTH, RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1984

Month	Monthly Marketings	Potato Sales	
		North Dakota	Minnesota
	--percent-	-----cwt-----	
September	8.2	1,423,576	546,705
October	9.0	1,562,461	600,042
November	11.2	1,944,396	746,720
December	11.2	1,944,396	746,720
January	13.6	2,361,052	906,731
February	12.6	2,187,446	840,060
March	16.0	2,777,709	1,066,742
April	13.4	2,326,331	893,397
May	4.8	833,313	320,022
Total	100.0	17,360,680	6,667,139

estimated local storage expenditures per cwt to the potatoes in storage on a monthly basis yields monthly storage expenditures (Appendix A, Table 10). Summation of the monthly storage costs yielded total estimated local potato storage expenditures for the Red River Valley (Table 4). Economic contribution and impact expenditures were identical for potato storage because all of the local expenditures were additions to the economy. In other words, all potato storage costs were net of those for the alternative crop (wheat) for purposes of this analysis.

Summation of potato production and storage expenditures gives total local expenditures as a result of potato farmer outlays in the Red River Valley. Estimated economic contribution expenditures totaled around \$49 million in North Dakota and almost \$20 million in Minnesota in 1985. North Dakota's estimated economic impact expenditures attributable to farmers totaled over \$41 million and Minnesota's corresponding value was over \$16 million for 1985. In addition to the farmer expenditures, significant local outlays were made by firms in the potato processing sector.

#### Processing Expenditures

Local expenditures also are made by potato wash plants and processing factories in the Red River Valley. Expenditures by these firms

were obtained through a survey of the plants in the Red River Valley. A sample survey instrument is presented in Appendix C. Essentially, the questionnaire asked for expenditures within North Dakota and Minnesota excluding potato purchasing costs. These costs were excluded to prevent double counting; processor potato costs were actually accounted for by farmer production expenditures. This logic is consistent with expenditure-side economic contribution and impact assessment theory.

A sample of wash plants was surveyed through a combination of personal interviews and telephone contact followed by a mail survey. Local expenditures from the surveys were aggregated and divided by the cwt of potatoes washed to give an average local expenditure per cwt. Estimates of cwt of potatoes washed for each facility were obtained through telephone interviews of selected knowledgeable industry personnel. Average expenditures were applied to the estimated cwt of potatoes washed for plants not surveyed or not responding to the survey, yielding nonrespondent local expenditures. These values were added to the actual survey responses to obtain estimated total local expenditures attributable to the potato wash plants. Potato wash plant expenditures for the economic contribution and impact were the same because they occur solely as a result of the industry. These expenditures have been added to those of the processing factories and are presented in that form to ensure complete confidentiality for all survey respondents.

Potato processing factories were surveyed (personal interview and telephone-mail contacts) to obtain their local expenditures. Two of the three factories responded to the survey; expenditures for the third were limited to an estimate of their payroll. The payroll amount was estimated by applying the average annual earnings per worker for the two respondents to the workforce at the nonresponding facility. Because payrolls constituted a large share of the responding processing factories' nonpotato expenditures, payrolls were estimated for the nonresponding factory. This estimation resulted in only a slight underestimation of the economic contribution and impact. It should be mentioned again that potato processing factory expenditures were combined with those for the wash plants to avoid disclosure of confidential data; separate totals were calculated for each state to facilitate a more detailed analysis. Estimated potato processing expenditures were almost \$8 million for North Dakota and over \$6 million for Minnesota in 1985 (Table 7). The largest share of these outlays was for payrolls, although the expenditures were distributed through nine sectors of the economy.

### Input-Output Model

Economic contribution and impact analyses require choosing a technique for estimating the indirect and induced effects of an industry or a new project on economic activity, employment, and income. The alternatives considered included 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 assessment framework for the Red River Valley potato industry. The primary

TABLE 7. ESTIMATED POTATO PROCESSING LOCAL EXPENDITURES BY ECONOMIC SECTOR IN THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985

Sector	North Dakota	Minnesota
	-----thousand dollars-----	
Construction	225	600
Transportation	423	996
Communications and utilities	163	688
Wholesale trade	--	4
Retail trade	74	19
Finance, insurance, real estate	101	44
Business and personal services	23	17
Professional and social services	32	12
Households	<u>6,918</u>	<u>3,906</u>
Total	7,959	6,286

reasons were that, compared to the economic base approach, I-O provides considerably more detailed assessment estimates (i.e., business volume 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 evaluating the impacts of various development proposals (Lewis 1968; Richardson 1972). Econometric techniques were thought to be inappropriate for this application because data were of insufficient detail for such analyses (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 for the state and substate areas of North Dakota (Leistritz et al. 1982) and Minnesota (Coon, Vocke, and Leistritz 1984a). The North Dakota model has been used extensively to estimate the economic contributions of a wide range of industrial sectors including, for example, the lignite industry (Coon, Mittleider, and Leistritz 1983), the recreation industry (Mittleider and Leitch 1984), and agriculture (Coon, Vocke, and Leistritz 1984b). 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).

#### Interdependence Coefficients

Input-output interdependence coefficients have previously been developed for North Dakota and Minnesota. These coefficients are commonly called multipliers because they measure the number of times a dollar of income "turns over" in the state. The multiplier effect results when each

producing sector buys some fraction of its inputs from other sectors of the state's economy and these sectors, in turn, use some fraction of that income to buy some of their inputs from still other sectors, and so on. The multiplier effect is due to the spending and respending within the state's economy of part of each dollar that enters the state.

The North Dakota input-output model groups the state's economy into 17 industrial classifications or sectors (Appendix B, Table 1) while the Minnesota model has 20 sectors (Appendix B, Table 2). Input-output interdependence coefficients for North Dakota are presented in Appendix B, Table 3, and those for Minnesota in Appendix B, Table 4. Application of the local expenditures to the respective multipliers will yield levels of business activity necessary to measure the economic contribution and impact of the potato industry. Because all local expenditures were in terms of 1985 current year prices, applying these values to the multipliers also yields economic assessments in similar terms.

### Productivity Ratios

The ratio of gross business volume to employment is called the productivity ratio. This ratio indicates the amount of business activity in a sector per worker in that sector. Productivity ratios are particularly useful when conducting economic impact or contribution studies. When in-state expenditures for a particular industry are applied to the multipliers, the resultant business activity can be divided by the productivity ratios to estimate secondary (or indirect and induced) employment. Secondary employment is that which will arise as a result of the expenditures from the industry as they are spent and respent throughout the economy by the multiplier process. This employment is in addition to the workers directly employed by the industry, and essentially comes into existence to serve and supply the industry.

Productivity ratios have been developed for North Dakota (Coon et al. 1985) and Minnesota (Coon, Vocke, and Leistritz 1984a). Data were not available to update the productivity ratios to 1985 for either state. However, North Dakota's ratios were available for 1984 and were believed to closely reflect the situation of the Red River Valley potato industry; these ratios were used to determine secondary employment in this analysis. Productivity ratios for 1984 were used rather than using a forecasting technique to estimate 1985 values because most techniques result in inconsistent estimates at the point of transition from historic to projected data. Productivity ratios used to estimate indirect and induced workers resulting from the potato industry expenditures in the Red River Valley are presented in Appendix B, Table 5.

### Tax Revenue Estimation

Several tax revenues can be estimated using the input-output model. These include state personal income tax, corporate income tax, and sales and use tax collections for each state. Tax revenue estimates are based on historic relationships between tax collections and input-output model

estimates of gross business volume for selected sectors. Tax rates calculated were based on rates in existence in 1983 for North Dakota (Coon et al. 1984) and 1982 for Minnesota (Coon, Vocke, and Leistriz 1984a). These estimates may be slightly out of date because rapidly shifting financial conditions in both states have caused numerous tax law changes since 1982. Data were not available at this time to update the tax estimating equations to reflect the 1985 tax structures.

Estimates of state personal income tax collections were based on the following relationships:

North Dakota personal income tax collections = 2.1 percent  
x personal income

Minnesota personal income tax collections = 3.43 percent  
x personal income

Personal income from the input-output models is the total business activity of the household sector. The equations to estimate state corporate income tax are as follows:

North Dakota corporate income tax collections = .31 percent  
x total business activity of all business sectors

Minnesota corporate income tax collections = .32 percent  
x total business activity of all business sectors

All business sectors consist of all sectors of the economy except for the agriculture, household, and government sectors. State sales and use tax collections were estimated based on the following formula:

North Dakota sales and use tax collections = 4.06 percent  
x retail trade activity

Minnesota sales and use tax collections = 2.44 percent  
x retail trade activity

Retail trade activity is the total business activity of the retail trade sector of the input-output model. Applying these tax estimating equations to the business activity generated from the local expenditures provides tax revenue estimates for the three major taxes for North Dakota and Minnesota.

### Model Validation

Input-output models for the respective states can be tested for how accurately they replicate the North Dakota and Minnesota economies. Comparing personal income for the household sector of the model with estimates of personal income published by the Bureau of Economic Analysis, U.S. Department of Commerce, provides a good indication of how the models perform. Potato production and processing occurs in two substate areas of North Dakota (State Planning Regions 4 and 5) and two substate areas of

Minnesota (Functional Economic Regions 1 and 4) as identified by the input-output model reports (Coon et al. 1984; Coon, Vocke, and Leistritz 1984a).

Table 8 presents a comparison of statistical tests for income estimation from the two sources. Personal income estimates from the I-0

TABLE 8. STATISTICAL TESTS FOR COMPARISON OF PERSONAL INCOME ESTIMATES FROM THE NORTH DAKOTA AND MINNESOTA INPUT-OUTPUT MODELS WITH DEPARTMENT OF COMMERCE ESTIMATES, RED RIVER VALLEY POTATO INDUSTRY REGIONS AND STATE

Statistical Test	North Dakota <sup>1</sup>			Minnesota <sup>2</sup>		
	Region 4	Region 5	State	Region 1	Region 4	State
Average absolute difference (percent)	9.77	18.64	5.47	12.11	5.57	2.71
Mean average difference (percent)	7.45	-18.28	-1.88	11.05	-0.12	1.04
Standard deviation	11.15	11.14	6.27	8.44	6.94	3.20
Theil coefficient	0.08	0.22	0.07	0.06	0.04	0.02

<sup>1</sup>Based on annual estimates for the 1958 to 1984 period.

<sup>2</sup>Based on annual estimates for the 1958 to 1982 period.

models were compared to Department of Commerce estimates to determine the models' accuracy (i.e., I-0 estimates were compared to Department of Commerce estimates to determine how much they deviated from the government estimates). (For a complete discussion of the four statistical tests used to validate the input-output models and interpretation of the results, see Coon et al. [1985].) State-level personal income estimates are relatively close for both North Dakota (absolute average difference of 5.47 percent) and Minnesota (absolute average difference of 2.71 percent). Estimates vary more at the regional level, but the Theil coefficient indicates this variability does not preclude the use of the models at this level. In fact, the closeness of the Theil coefficient values to 0.0 indicates that the model performs quite well and can be used with confidence.<sup>3</sup>

### Economic Contribution and Impact

The economic contribution and impact of the potato industry on the economies of North Dakota and Minnesota were analyzed. Estimates of the

<sup>3</sup>The Theil U<sub>1</sub> coefficient is a summary measure, whose value is bounded by 0 and 1. A value of 0 indicates perfect prediction, while a value of 1 corresponds to perfect inequality (i.e., between the actual and predicted values). (For further discussion of the Theil coefficient, see Leuthold [1975] and Pindyck and Rubinfeld [1981].)

industry's local expenditures provide the basis for estimates of business activity, personal income, retail sales, secondary employment, and selected tax revenue collections. Results will be reported separately for each analysis and also for each state. State summaries will then be summed to indicate the total effects of the industry on the Red River Valley.

### Expenditures and Total Business Activity

Total estimated economic contribution expenditures from the potato industry were over \$57 million in North Dakota and about \$26 million for Minnesota in 1985 (Table 9). The corresponding economic impact expenditures for the same time were almost \$49 million and \$23 million, respectively, for North Dakota and Minnesota. These expenditures were the

TABLE 9. ESTIMATED POTATO INDUSTRY'S TOTAL LOCAL CONTRIBUTION AND IMPACT EXPENDITURES BY ECONOMIC SECTOR, FOR THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985

Sector	North Dakota	Minnesota
	-----thousand dollars-----	
Economic contribution:		
Agriculture, crops	12,006	4,887
Construction	225	600
Transportation	423	996
Communications and utilities	2,130	1,444
Wholesale trade	--	4
Retail trade	22,525	9,131
Finance, insurance, real estate	6,306	2,551
Business and personal service	2,216	910
Professional and social service	32	12
Households	<u>11,176</u>	<u>5,589</u>
Total	57,039	26,124
Economic impact:		
Agriculture, crops	11,094	4,516
Construction	225	600
Transportation	423	996
Communications and utilities	2,130	1,444
Wholesale trade	--	4
Retail trade	16,140	6,532
Finance, insurance, real estate	5,818	2,352
Business and personal service	2,169	891
Professional and social service	32	12
Households	<u>11,032</u>	<u>5,530</u>
Total	49,063	22,877

total of outlays from farmers for production and storage, wash plants, and potato processing factories in the Red River Valley. These payments were to 10 sectors of the economies in the two states with the retail trade sector receiving the greatest amount.

Personal income, retail trade sales, total business activity for all business sectors, and total business activity attributable to potato industry expenditures were determined for 1985. The estimated economic contribution to the North Dakota economy included personal income of about \$49 million, retail sales totaling over \$53 million, and total level of business activity of almost \$163 million for 1985 (Table 10). Minnesota's

TABLE 10. ESTIMATED PERSONAL INCOME, RETAIL SALES, BUSINESS ACTIVITY OF ALL BUSINESS (NONAGRICULTURAL) SECTORS, AND TOTAL BUSINESS ACTIVITY FOR THE POTATO INDUSTRY OF THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985

Item	North Dakota	Minnesota	Total
	-----thousand dollars-----		
Economic contribution:			
Personal income	49,376	23,107	72,483
Retail sales	53,300	23,327	76,627
Business activity of all business sectors <sup>1</sup>	90,253	41,600	131,853
Total business activity	162,757	74,734	237,491
Economic impact:			
Personal income	45,076	21,356	66,432
Retail sales	43,969	19,529	63,498
Business activity of all business sectors <sup>1</sup>	77,812	36,532	114,344
Total business activity	143,704	66,975	210,679

<sup>1</sup>Includes all sectors except agriculture (livestock and crops), households, and government.

estimated potato industry economic contributions included personal income of about \$23 million, retail sales over \$23 million, and a total level of business activity of almost \$75 million for 1985. The total economic contribution of the potato industry was obtained by adding the North Dakota and Minnesota values. Thus, total personal income in the Red River Valley attributable to the potato industry was over \$72 million and retail sales were about \$77 million. The total economic activity in the Red River Valley of \$237,491,000 indicates that for every dollar spent by the potato industry, another \$1.86 is generated in the Red River Valley economy for a total of \$2.86.

Economic impacts for North Dakota and Minnesota also are presented in Table 10. Interpretation of these values is the same as for the contributions, although the amounts were somewhat less. Personal incomes were over \$45 million, \$21 million, and \$66 million, respectively, for North Dakota, Minnesota, and the Red River Valley. Retail sales were about \$44 million for North Dakota, \$19 million for Minnesota, and \$63 million for the Red River Valley. Total economic impact business activity for the area was \$210,679,000, indicating that each dollar spent in the local economy generated another \$1.93 for a total of \$2.93.

### Tax Collections

Data in Table 10 provided the necessary measures of business activity to estimate tax revenue generated by the potato industry. Categories of tax revenues consisted of sales and use, personal income, and corporate income. Estimated tax revenues associated with the economic contribution of the potato industry totaled \$3,843,000 with North Dakota receiving \$2,570,000 and Minnesota \$1,273,000 (Table 11). Economic impact tax revenues were estimated at \$2,321,000 for North Dakota and \$1,168,000 for Minnesota, for a total of \$3,489,000 for the Red River Valley. The greatest source of tax revenue in North Dakota was the sales and use tax collections, whereas state personal income tax was the largest category in Minnesota.

TABLE 11. ESTIMATED TAX REVENUES ASSOCIATED WITH THE POTATO INDUSTRY OF THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985

Area	Sales and Use Tax <sup>1</sup>	State Personal Income Tax	State Corporate Income Tax	Total
-----thousand dollars-----				
Economic contribution:				
North Dakota	1,253	1,037	280	2,570
Minnesota	<u>347</u>	<u>793</u>	<u>133</u>	<u>1,273</u>
Total	1,600	1,830	413	3,843
Economic impact:				
North Dakota	1,133	947	241	2,321
Minnesota	<u>318</u>	<u>733</u>	<u>117</u>	<u>1,168</u>
Total	1,451	1,680	358	3,489

<sup>1</sup>Most of the direct retail purchases made by farmers are for items exempt from sales tax (i.e., seed, fertilizer, chemicals, etc.) in both North Dakota and Minnesota. In order to not overestimate the sales and use tax collections, those purchases were deducted from the retail trade business activity before it was applied to the sales and use tax estimating equations for the respective states.

Employment

Direct employment in potato production totaled 850 workers for the Red River Valley. These workers were the total number of farmers involved in the growing of potatoes and should not be confused with full-time equivalents. Converting farmers who grew potatoes into full-time equivalent potato growers is virtually impossible and rather meaningless. Direct processing workers were estimated at 651 in North Dakota and 310 in Minnesota (Table 12). Direct employment (potato production and processing) was the same for the economic contribution and impact analyses.

TABLE 12. ESTIMATED PRODUCTION, PROCESSING, AND SECONDARY EMPLOYMENT ATTRIBUTABLE TO THE POTATO INDUSTRY OF THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985

Area	Employment		
	Production <sup>1</sup>	Processing	Secondary
Economic contribution:			
North Dakota	500	651	2,378
Minnesota	<u>350</u>	<u>310</u>	<u>1,163</u>
Total	850	961	3,541
Economic impact:			
North Dakota	500	651	2,117
Minnesota	<u>350</u>	<u>310</u>	<u>1,056</u>
Total	850	961	3,173

<sup>1</sup>Production employment includes all farmers involved in growing potatoes. These workers were not converted to full-time equivalents.

Potato industry expenditures also were responsible for creating secondary (indirect and induced) employment. Secondary employment for the economic contribution of the industry was 2,378 workers in North Dakota and 1,163 workers in Minnesota, for total secondary employment of 3,541 employees in the Red River Valley. Secondary workers associated with the economic impact of the potato industry totaled 3,173 workers, with 2,117 and 1,056 workers in North Dakota and Minnesota, respectively. This indirect and induced employment is the result of potato industry expenditures in the local economy.

Conclusions

The potato industry is concentrated in a rather small portion of the two-state area. Despite the relatively small geographic area in which its

production takes place, the industry is very capital intensive. A significant portion of the annual production is processed in the Red River Valley as is exemplified by the large number of wash plants and three processing factories. Injections into the local economy include production expenses, storage expenses, and outlays by the wash plants and processing factories. Because the production area is not widespread, the economic contribution and impact of the industry may be underestimated or even overlooked by many people.

The potato industry does contribute significantly to the Red River Valley economy. Estimated local contribution expenditures amounted to \$57,039,000 in North Dakota and \$26,124,000 in Minnesota during 1985. During the same time the estimated economic impact expenditures were \$49,063,000 and \$22,877,000 for the respective states. In the contribution analysis, these expenditures generated personal income of \$72,483,000, retail sales of \$76,627,000, and a total level of business activity amounting to \$237,491,000. Corresponding economic impacts were \$66,432,000, 63,498,000, and \$210,679,000, respectively. These economic contribution and impact analyses results present in absolute terms an indication of the importance of the potato industry to the economy of the Red River Valley. Relating these results to the economic base of a local economy would help put the industry's importance in perspective; however, data were not readily available for comparison of a substate level with the counties whose activities comprise the potato industry. (For a complete discussion of the economic base of North Dakota and its planning areas, see Coon et al. [1986].)

Estimated tax revenue collections totaled \$3,843,000 and \$3,489,000, in the economic contribution and impact analyses, respectively. In addition to those workers directly employed by the industry, secondary jobs were created for an estimated 3,541 workers and 3,173 workers based on economic contribution and impact expenditures, respectively.

Each dollar spent by the potato industry creates another \$1.86 in the local economy based on the contribution expenditures and an additional \$1.93 based on the impact expenditures. The potato industry is a very important factor in the Red River Valley economy. Its economic contribution and impact are sizeable when measured in such economic terms as personal income, retail sales, total business activity, tax revenue collections, and employment (direct and secondary). These key economic variables provide an indication of the importance of the potato industry to the Red River Valley.

**APPENDIX A**

APPENDIX TABLE A1. POTATO PRODUCTION COSTS FOR THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985

Item	Cost Per Acre	Cost Per Cwt
	-----dollars-----	
<b>Direct costs:</b>		
Seed	90.00	0.55
Phosphate	10.50	0.06
Potash	7.20	0.04
Anhydrous ammonia	12.00	0.07
Fertilizer application	2.44	0.02
Insecticide	34.87	0.21
Fungicide	14.80	0.09
Seed treatment	8.25	0.05
Seed cutting	9.00	0.06
Sprout inhibitor	12.00	0.07
Crop insurance	14.44	0.09
Advertising	7.42	0.05
Fuel and lubrication	31.32	0.19
Repairs	28.75	0.17
Custom hire	14.00	0.08
Interest on operating capital	<u>26.03</u>	<u>0.16</u>
<b>Total direct costs</b>	<b>323.02</b>	<b>1.94</b>
<b>Indirect costs:</b>		
Machinery ownership	87.17	0.53
Labor	40.72	0.24
Management	45.89	0.28
Overhead	<u>8.00</u>	<u>0.05</u>
<b>Total indirect costs, excluding land</b>	<b>181.78</b>	<b>1.10</b>
<b>Total costs, excluding land</b>	<b>504.80</b>	<b>3.06</b>
Land charge	75.00	0.45
<b>Total costs</b>	<b>579.80</b>	<b>3.51</b>
<b>(Expected yield per acre = 165 cwt)</b>		

SOURCE: Reff 1985.

APPENDIX TABLE A2. SPRING WHEAT PRODUCTION COSTS FOR THE RED RIVER VALLEY OF NORTH DAKOTA, 1985

Item	Cost Per Acre	Cost Per Bushel of Production
	-----dollars-----	
Variable costs:		
Seed	6.84	0.20
Nitrogen	12.60	0.37
Phosphate	4.86	0.14
Potash	0.50	0.01
Herbicide	13.00	0.38
Fungicide	0.60	0.02
Soil test	0.35	0.01
Repairs	8.00	0.23
Fuel-gasoline	2.17	0.06
Diesel	5.05	0.15
Lube (15% of fuel cost)	1.08	0.03
Labor	6.76	0.20
Interest on operating capital	1.97	0.06
Total variable costs <sup>1</sup>	<u>63.78</u>	<u>1.87</u>
Ownership costs:		
Capital replacement	20.48	0.60
Insurance	0.73	0.02
Interest	15.37	0.45
Total ownership costs <sup>1</sup>	<u>36.58</u>	<u>1.07</u>
Other costs:		
Land charge-cash rent	52.00	1.53
General farm overhead	8.55	0.25
Total other costs <sup>1</sup>	<u>60.55</u>	<u>1.78</u>
Total of above costs <sup>1</sup>	160.91	4.72
(Yield per planted acre <sup>2</sup> = 34.07 bushels)		

<sup>1</sup>Totals do not tally due to rounding error.

<sup>2</sup>Weighted average yield based on acres planted to hard red spring wheat and durum (1980-1984).

SOURCE: Johnson et al. 1986.

APPENDIX TABLE A3. NORTH DAKOTA RED RIVER VALLEY POTATO ACRES PLANTED AND FIVE-YEAR AVERAGE, BY COUNTY, 1980-1984

County	1980	1981	1982	1983	1984	5-Year Average
Grand Forks	25,500	26,500	27,500	30,500	26,800	27,360
Pembina	26,500	28,000	28,000	34,000	36,400	30,580
Towner	2,200	2,100	2,700	2,500	2,400	2,380
Traill	4,800	5,500	5,400	4,700	5,000	5,080
Walsh	54,000	55,500	57,000	58,500	62,800	57,560
Other counties	1,000	1,400	1,400	1,800	2,600	1,640
North Dakota	114,000	119,000	122,000	132,000	136,000	124,600

SOURCE: North Dakota Crop and Livestock Reporting Service 1985.

APPENDIX TABLE A4. MINNESOTA RED RIVER VALLEY POTATO ACRES PLANTED AND FIVE-YEAR AVERAGE, BY COUNTY, 1980-1984

County	1980	1981	1982	1983	1984	5-Year Average
Clay	8,800	9,100	8,500	7,600	8,600	8,520
Kittson	4,200	4,800	4,500	4,500	5,300	4,660
Marshall	10,800	11,300	11,300	8,300	11,300	10,600
Norman	1,600	2,000	2,200	1,400	1,500	1,740
Polk	22,200	25,800	26,100	25,000	27,600	25,340
Other counties	22,900	26,200	25,100	28,900	29,000	26,420
Minnesota	70,500	79,200	77,700	75,700	83,300	77,280

SOURCE: Minnesota Agriculture Statistics 1982-1985.

APPENDIX TABLE A5. POTATO STORAGE COSTS FOR THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, 1985

Item	Annual Cost <sup>1</sup>
	---dollars---
Overhead costs:	
Building	37,200
Refrigeration	1,550
Equipment	13,865
Railroad siding lease	<u>1,000</u>
Total annual overhead costs	53,615
Operating costs:	
Electricity	5,571
Telephone	2,400
Insurance	3,240
Labor	8,850
Office Supplies	1,000
Interest on Inventory	12,636
Disinfectant	750
Sprout inhibitor	<u>2,880</u>
Total operating costs	37,327
Total annual cost	90,942
Total cost per cwt stored	1.89
Total cost per cwt (marketed 10 percent shrink)	2.11

<sup>1</sup>Based on a 48,000 cwt house and storing potatoes for six months.

SOURCE: Benson and Preston 1985.

APPENDIX TABLE A6. NORTH DAKOTA RED RIVER VALLEY POTATO ACREAGE, YIELD PER ACRE PLANTED, AND PRODUCTION, BY COUNTY, 1984

County	Acres Planted	Yield Per Acre Planted	Production
Grand Forks	26,800	145	3,875,000
Pembina	36,400	165	5,989,500
Towner	2,400	125	300,000
Traill	5,000	125	630,000
Walsh	62,800	150	9,345,500
Other Counties	2,600	185	475,000
North Dakota	136,000	150	20,615,000

SOURCE: North Dakota Crop and Livestock Reporting Service 1985.

APPENDIX TABLE A7. MINNESOTA RED RIVER VALLEY POTATO ACREAGE, YIELD PER ACRE PLANTED, AND PRODUCTION, BY COUNTY, 1984

County	Acres Planted	Yield Per Acre Planted	Production
Clay	8,600	130	1,120,000
Kittson	5,300	132	700,000
Marshall	11,300	134	1,512,000
Norman	1,500	108	162,500
Polk	27,600	154	4,240,000
Other Counties	29,000	266	7,720,500
Minnesota	83,300	186	15,455,000

SOURCE: Minnesota Agriculture Statistics 1985.

APPENDIX TABLE A8. FALL POTATO PRODUCTION, FARM DISPOSITION, AND SALES AS A PERCENT OF PRODUCTION, NORTH DAKOTA AND MINNESOTA, 1980-1984

Year	Production	Used for Seed	Used on Farms	Sold	Production Sold
	-----cwt-----				--percent--
North Dakota					
1980	15,680	1,726	1,650	14,030	89.5
1981	20,125	1,784	3,015	17,110	85.0
1982	17,250	1,914	2,085	15,165	87.9
1983	20,480	1,972	2,358	18,122	88.5
1984	20,615	2,175	4,020	16,595	80.5
Average					86.2
Minnesota					
1980	9,920	1,108	1,042	8,878	89.5
1981	13,300	1,086	1,264	12,036	90.5
1982	11,520	1,149	1,270	10,250	89.0
1983	10,313	1,234	907	9,406	91.2
1984	13,775	1,256	1,405	12,370	89.8
Average					90.0

SOURCE: Statistical Reporting Service 1982-1985.

TABLE A9. FARM MARKETINGS OF FALL POTATOES, BY MONTHS, NORTH DAKOTA AND MINNESOTA, 1980-1984

Year	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
-----percent-----												
North Dakota												
1980	1	8	6	14	12	17	16	16	8	1	1	--
1981	--	5	10	14	13	13	11	16	14	3	1	--
1982	--	10	8	7	8	14	11	17	17	7	1	--
1983	1	8	10	10	12	12	13	15	16	3	--	--
1984	--	8	11	11	11	12	12	16	12	6	1	--
Average	--	8.2	9.0	11.2	11.2	13.6	12.6	16.0	13.4	4.8	--	--
Minnesota												
1980	--	7	8	10	13	14	12	17	15	4	--	--
1981	2	10	12	9	8	10	14	12	15	4	3	1
1982	--	16	11	19	5	4	8	15	12	5	4	1
1983	--	20	6	9	4	6	13	18	16	5	3	--
1984	--	18	8	7	7	10	8	15	20	7	--	--
Average	--	14.6	9.0	10.8	7.4	8.8	11.0	15.4	15.6	5.0	2.4	--

SOURCE: Statistical Reporting Service 1982-1985.

TABLE A10. ESTIMATED POTATOES IN STORAGE AND LOCAL STORAGE EXPENDITURES FOR THE RED RIVER VALLEY OF NORTH DAKOTA AND MINNESOTA, BY MONTH, 1985

Month	Potatoes in Storage	Local Expenditures			
		Comm & PU	Retail	FIRE	Households
	----cwt----	-----dollars-----			
North Dakota					
September	--	--	--	--	--
October	15,937,104	439,864	256,587	180,089	489,269
November	14,374,643	396,740	231,432	162,433	441,302
December	12,430,247	343,075	200,127	140,462	381,609
January	10,485,851	289,409	168,822	118,490	321,916
February	8,124,799	224,244	130,809	91,810	249,431
March	5,937,353	163,871	95,591	67,092	182,277
April	3,159,644	87,206	50,870	35,704	97,001
May	833,313	22,999	13,416	9,416	25,583
Total		1,967,408	1,147,654	805,496	2,188,388
Minnesota					
September	--	--	--	--	--
October	6,120,434	168,924	98,539	69,161	187,897
November	5,520,392	152,363	88,878	62,380	169,476
December	4,773,672	131,753	76,856	53,942	146,552
January	4,026,952	111,144	64,834	45,505	123,627
February	3,120,221	86,118	50,236	35,258	95,791
March	2,280,161	62,932	36,711	25,766	70,001
April	1,213,419	33,490	19,536	13,712	37,252
May	320,022	8,833	5,152	3,616	9,825
Total		755,557	440,742	309,340	840,421

**APPENDIX B**

APPENDIX TABLE B1. ECONOMIC SECTORS AND ASSOCIATED STANDARD INDUSTRIAL CLASSIFICATION CODES FOR THE NORTH DAKOTA INPUT-OUTPUT MODEL

Economic Sector	SIC Code
1. Agriculture, Livestock	Major Group 02 - Agricultural Production, Livestock
2. Agriculture, Crops	Major Group 01 - Agricultural Production, Crops
3. Nonmetallic Mining	Major Group 14 - Mining and Quarrying of Nonmetallic Minerals, Except Fuels
4. Contract Construction	Major Groups 15, 16, 17 - Contract Construction
5. Transportation	Major Groups 40, 41, 42, 43, 44, 45, 46, and 47 - Transportation
6. Communications and Utilities	Major Group 48 - Communication, and Major Group 49 - Electric, Gas, and Sanitary Services, Except Industry No. 4911
7. Agricultural Processing and Miscellaneous Manufacturing	Major Group 50 and 51 - Wholesale Trade, Major Group 20 - Food and Kindred Products Manufacturing
8. Retail Trade	Major Groups 52, 53, 54, 55, 56, 57, 58, and 59 - Retail Trade
9. Finance, Insurance, and Real Estate	Major Groups 60, 61, 62, 63, 64, 65, 66, and 67 - Finance, Insurance, and Real Estate
10. Business and Personal Services	Major Groups 70, 72, 73, 75, 76, 78, and 79 - Business and Personal Services
11. Professional and Social Services	Major Groups 80, 81, 82, 83, 84, 86, 88, and 89 - Professional and Social Services
12. Households	Not Applicable
13. Government	Major Groups 91, 92, 93, 94, 95, 96, and 97 - Government
14. Coal Mining	Major Group 12 - Bituminous Coal and Lignite Mining
15. Thermal-Electric Generation	Major Group 491 - Electric Companies and Systems
16. Petroleum and Natural Gas Exploration and Extraction	Major Group 13 - Crude Petroleum and Natural Gas
17. Petroleum Refining	Major Group 29 - Petroleum Refining and Related Industries

SOURCE: Office of Management and Budget 1972.

APPENDIX TABLE B2. ECONOMIC SECTORS OF INPUT-OUTPUT MODEL AND ASSOCIATED STANDARD INDUSTRIAL CLASSIFICATION CODES FOR MINNESOTA EXTENSION OF NEODAM

Economic Sector	SIC Code
1. Agriculture, Livestock	Group 013 - Livestock
2. Agriculture, Crops	All of Major Group 01 - Agricultural Production, Except Group 013 - Livestock
3. Metal Mining	Major Group 10 - Metal Mining
4. Coal Mining	Major Group 12 - Bituminous Coal and Lignite Mining
5. Petroleum and Natural Gas Exploration and Extraction	Major Group 13 - Crude Petroleum and Natural Gas
6. Nonmetallic Mining	Major Group 14 - Mining and Quarrying of Nonmetallic Metal, Except Fuels
7. Contract Construction	Division C - Contract Construction (Major Groups 15, 16, and 17)
8. Lumber and Associated Products	Major Group 08 - Forestry, Major Group 24 - Lumber and Wood Products, Except Furniture, and Major Group 26 - Paper and Allied Products
9. Agricultural Processing and Miscellaneous Manufacturing	Major Group 50 - Wholesale Trade, Major Group 20 - Food and Kindred Products Manufacturing
10. Petroleum Refining	Major Group 29 - Petroleum Refining and Related Industries
11. Metal Processing	Major Group 33 - Primary Metal Manufacturing
12. Transportation	All of Division E - Transportation, Communications, Electric, Gas, and Sanitary Services, Except Major Groups 48 and 49
13. Communications and Utilities	Major Group 48 - Communication, and Major Group 49 - Electric, Gas, and Sanitary Services, Except Industry No. 4911
14. Thermal-Electric Power Generation	Industry Number 4911 - Electric Companies and Systems
15. Retail Trade	All of Division F - Wholesale and Retail Trade, Except Major Group 50 - Wholesale Trade
16. Finance, Insurance, and Real Estate	Division G - Finance, Insurance, and Real Estate
17. Business and Personal Services	All of Division H - Services, Except Major Groups 80, 81, 82, 86, and 89
18. Professional and Social Services	Major Group 80 - Medical and Other Health Services, Major Group 81 - Legal Services, Major Group 82 - Educational Services, Major Group 86 - Nonprofit Membership Organizations, and Major Group 89 - Miscellaneous Services
19. Government	Division I - Government
20. Households	Not Applicable

SOURCE: Office of Management and Budget 1972.

APPENDIX TABLE B3. INPUT-OUTPUT INTERDEPENDENCE COEFFICIENTS, BASED ON TECHNICAL COEFFICIENTS FOR 17-SECTOR MODEL, NORTH DAKOTA

Sector	(1) Ag, Lvstk	(2) Ag, Crops	(3) Nonmetallic Mining	(4) Const	(5) Trans	(6) Comm & Pub Util	(7) Ag Proc & Misc Mfg	(8) Retail Trade	(9) FIRE
( 1) Ag, Livestock	1.2072	0.0774	0.0445	0.0343	0.0455	0.0379	0.1911	0.0889	0.0617
( 2) Ag, Crops	0.3938	1.0921	0.0174	0.0134	0.0178	0.0151	0.6488	0.0317	0.0368
( 3) Nonmetallic Mining	0.0083	0.0068	1.0395	0.0302	0.0092	0.0043	0.0063	0.0024	0.0049
( 4) Construction	0.0722	0.0794	0.0521	1.0501	0.0496	0.0653	0.0618	0.0347	0.0740
( 5) Transportation	0.0151	0.0113	0.0284	0.0105	1.0079	0.0135	0.0128	0.0104	0.0120
( 6) Comm & Public Util	0.0921	0.0836	0.1556	0.0604	0.0839	1.1006	0.0766	0.0529	0.1321
( 7) Ag Proc & Misc Mfg	0.5730	0.1612	0.0272	0.0207	0.0277	0.0239	1.7401	0.0452	0.0704
( 8) Retail Trade	0.7071	0.8130	0.5232	0.4100	0.5475	0.4317	0.6113	1.2734	0.6764
( 9) Fin, Ins, Real Estate	0.1526	0.1677	0.1139	0.0837	0.1204	0.1128	0.1322	0.0577	1.1424
(10) Bus & Pers Services	0.0562	0.0684	0.0430	0.0287	0.0461	0.0374	0.0514	0.0194	0.0766
(11) Prof & Soc Services	0.0710	0.0643	0.0559	0.0402	0.0519	0.0526	0.0530	0.0276	0.0816
(12) Households	1.0458	0.9642	0.8424	0.6089	0.7876	0.7951	0.7859	0.4034	1.2018
(13) Government	0.0987	0.0957	0.0853	0.0519	0.2583	0.0999	0.0796	0.0394	0.1071
(14) Coal Mining	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(15) Thermal-Elec Generation	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(16) Pet Exp/Ext	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
(17) Pet Refining	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Gross Receipts Multiplier	4.4931	3.6851	3.0284	2.4430	3.0534	2.7901	4.4509	2.0871	3.6778

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APPENDIX TABLE B3. INPUT-OUTPUT INTERDEPENDENCE COEFFICIENTS, BASED ON TECHNICAL COEFFICIENTS FOR 17-SECTOR MODEL, NORTH DAKOTA (CONTINUED)

Sector	(10) Bus & Pers Service	(11) Prof & Soc Service	(12) Households	(13) Govt	(14) Coal Mining	(15) Thermal-Elec Generation	(16) Pet Exp/Ext	(17) Pet Refining
( 1) Ag, Livestock	0.0384	0.0571	0.0674	0.0000	0.0376	0.0251	0.0159	0.0145
( 2) Ag, Crops	0.0152	0.0229	0.0266	0.0000	0.0285	0.0321	0.0062	0.0057
( 3) Nonmetallic Mining	0.0043	0.0050	0.0057	0.0000	0.0032	0.0019	0.0045	0.0037
( 4) Construction	0.0546	0.0787	0.0902	0.0000	0.0526	0.0328	0.1148	0.0929
( 5) Transportation	0.0118	0.0100	0.0093	0.0000	0.0084	0.0048	0.0180	0.0172
( 6) Comm & Public Util	0.1104	0.1192	0.1055	0.0000	0.0712	0.0378	0.0510	0.0444
( 7) Ag Proc & Misc Mfg	0.0237	0.0362	0.0417	0.0000	0.0618	0.0782	0.0097	0.0089
( 8) Retail Trade	0.4525	0.6668	0.7447	0.0000	0.3995	0.2266	0.1838	0.1675
( 9) Fin, Ins, Real Estate	0.1084	0.1401	0.1681	0.0000	0.0771	0.0977	0.0388	0.0358
(10) Bus & Pers Services	1.0509	0.0455	0.0605	0.0000	0.0289	0.0201	0.0139	0.0127
(11) Prof & Soc Services	0.0497	1.1026	0.0982	0.0000	0.0493	0.0301	0.0210	0.0195
(12) Households	0.7160	1.0437	1.5524	0.0000	0.6666	0.3973	0.3205	0.2951
(13) Government	0.0774	0.0881	0.1080	1.0000	0.0511	0.0444	0.0280	0.0285
(14) Coal Mining	0.0000	0.0000	0.0000	0.0000	1.0000	0.1582	0.0003	0.0002
(15) Thermal-Elec Generation	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000
(16) Pet Exp/Ext	0.0000	0.0000	0.0000	0.0000	0.0138	0.0084	1.0981	0.8227
(17) Pet Refining	0.0000	0.0000	0.0000	0.0000	0.0168	0.0102	0.0000	1.0000
Gross Receipts Multiplier	2.7133	3.4159	3.0783	1.0000	2.5664	2.2057	1.9245	2.5693

SOURCE: Coon et al. 1984.

APPENDIX TABLE B4. INPUT-OUTPUT INTERDEPENDENCE COEFFICIENTS FOR 20-SECTOR MODEL, MINNESOTA ECONOMY

Sector	(1) Ag, Lvstk	(2) Ag, Crops	(3) Metal Mining	(4) Coal Mining	(5) Pet/NG Exp/Ext	(6) Nonmetallic Mining	(7) Constr	(8) Lumber	(9) Ag Proc & Misc Mfg	(10) Pet Refining
( 1) Ag, Livestock	1.2072	.0774	.0244	.0375	.0159	.0445	.0343	.0287	.1911	.0040
( 2) Ag, Crops	.3938	1.0922	.0112	.0285	.0063	.0176	.0134	.0162	.6488	.0016
( 3) Metal Mining	.0000	.0000	1.1333	.0000	.0000	.0000	.0000	.0000	.0000	.0000
( 4) Coal Mining	.0000	.0000	.0005	1.0000	.0003	.0000	.0000	.0000	.0000	.0000
( 5) Pet/NG Exp/Ext	.0000	.0000	.0000	.0016	1.0981	.0000	.0000	.0000	.0000	.0954
( 6) Nonmetallic Mining	.0084	.0069	.0039	.0031	.0045	1.0396	.0303	.0038	.0063	.0007
( 7) Construction	.0722	.0794	.0339	.0514	.1148	.0521	1.0501	.0807	.0619	.0168
( 8) Lumber & Assoc Prod	.0000	.0000	.0392	.0000	.0000	.0000	.0000	1.0117	.0000	.0000
( 9) Ag Proc & Misc Mfg	.5730	.1612	.0193	.0617	.0097	.0272	.0207	.0315	1.7402	.0025
(10) Pet Refining	.0000	.0000	.0000	.0168	.0000	.0000	.0000	.0000	.0000	1.0000
(11) Metal Processing	.0000	.0000	.0097	.0000	.0000	.0000	.0000	.0005	.0000	.0000
(12) Transportation	.0151	.0113	.0679	.0082	.0180	.0284	.0105	.0258	.0128	.0053
(13) Comm & Public Util	.0921	.0836	.0696	.0707	.0510	.1557	.0605	.0756	.0767	.0106
(14) Electric Generation	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
(15) Retail Trade	.7072	.8130	.2701	.3975	.1839	.5235	.4101	.3156	.6115	.0458
(16) Fin, Ins, Real Estate	.1526	.1677	.0753	.0767	.0388	.1140	.0837	.0903	.1322	.0101
(17) Bus & Pers Service	.0562	.0684	.0277	.0286	.0139	.0430	.0287	.1528	.0514	.0035
(18) Prof & Soc Service	.0711	.0644	.0384	.0491	.0210	.0560	.0402	.0714	.0531	.0055
(19) Government	.0987	.0957	.0626	.0508	.0280	.0853	.0519	.0545	.0796	.0094
(20) Households	1.0459	.9643	.5249	.6630	.3206	.8428	.6091	.5608	.7862	.0828
Gross Receipts Multiplier	4.4935	3.6855	2.4119	2.5453	1.9248	3.0297	2.4435	2.5199	4.4518	1.2940

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APPENDIX TABLE B4. INPUT-OUTPUT INTERDEPENDENCE COEFFICIENTS FOR 20-SECTOR MODEL, MINNESOTA ECONOMY (CONTINUED)

Sector	(11) Metal Proc	(12) Trans	(13) Comm & Pub Util	(14) Electric Gen	(15) Retail	(16) FIRE	(17) Bus & Pers Service	(18) Prof & Soc Serv	(19) Govt	(20) House- holds
( 1) Ag, Livestock	.0171	.0455	.0379	.0250	.0889	.0617	.0384	.0571	.0000	.0674
( 2) Ag, Crops	.0128	.0179	.0152	.0321	.0318	.0368	.0152	.0230	.0000	.0267
( 3) Metal Mining	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
( 4) Coal Mining	.0001	.0000	.0000	.1582	.0000	.0000	.0000	.0000	.0000	.0000
( 5) Pet/NG Exp/Ext	.0000	.0000	.0000	.0010	.0000	.0000	.0000	.0000	.0000	.0000
( 6) Nonmetallic Mining	.0016	.0092	.0044	.0019	.0025	.0050	.0044	.0051	.0000	.0058
( 7) Construction	.0207	.0496	.0653	.0320	.0348	.0740	.0546	.0787	.0000	.0902
( 8) Lumber & Assoc Prod	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
( 9) Ag Proc & Misc Mfg	.0276	.0277	.0239	.0781	.0452	.0704	.0237	.0363	.0000	.0417
(10) Pet Refining	.0000	.0000	.0000	.0102	.0000	.0000	.0000	.0000	.0000	.0000
(11) Metal Processing	1.0132	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
(12) Transportation	.0280	1.0079	.0135	.0046	.0104	.0120	.0118	.0100	.0000	.0093
(13) Comm & Public Util	.0509	.0840	1.1006	.0375	.0529	.1322	.1104	.1192	.0000	.1056
(14) Electric Generation	.0000	.0000	.0000	1.0000	.0000	.0000	.0000	.0000	.0000	.0000
(15) Retail Trade	.1754	.5476	.4318	.2256	1.2735	.6765	.4526	.6669	.0000	.7449
(16) Fin, Ins, Real Estate	.0487	.1205	.1129	.0976	.0578	1.1424	.1085	.1401	.0000	.1681
(17) Bus & Pers Service	.0153	.0461	.0375	.0200	.0194	.0766	1.0509	.0455	.0000	.0605
(18) Prof & Soc Service	.0274	.0519	.0527	.0300	.0276	.0816	.0497	1.1026	.0000	.0982
(19) Government	.0495	.2583	.0999	.0443	.0395	.1071	.0774	.0881	1.0000	.1080
(20) Households	.3401	.7878	.7953	.3953	.4036	1.2019	.7161	1.0438	.0000	1.5526
Gross Receipts Multiplier	1.8284	3.0540	2.7909	2.1934	2.0879	3.6782	2.7137	3.4164	1.0000	3.0790

SOURCE: Coon, Vocke, and Leistritz 1984a.

APPENDIX TABLE 85. GROSS BUSINESS VOLUME TO EMPLOYMENT (PRODUCTIVITY) RATIOS, BY ECONOMIC SECTOR, NORTH DAKOTA, 1958-1984

Year	(1) & (2) Ag	(3) Nonmetallic Mining	(4) Const	(5) Trans	(6) Comm & Pub Util	(7) Ag Proc & Misc Mfg	(8) Retail Trade	(9) FIRE	(10) Bus & Pers Service	(11) Prof & Soc Service	(12) Households	(13) Govt	(14) Coal Mining	(15) Thermal-Elec Generation	(16) Pet Exp/Ext	(17) Pet Refining
1958	9,444	53,846	6,486	1,768	10,644	19,169	19,939	29,783	5,122	4,798	--	3,030	2,894	--	8,828	39,104
1959	9,290	54,330	6,259	1,687	10,035	17,659	18,451	26,617	4,597	4,304	--	2,787	2,610	--	12,611	39,692
1960	8,887	55,284	7,409	1,624	9,760	17,353	17,593	24,713	4,275	4,045	--	2,660	2,610	--	19,568	39,682
1961	9,414	52,307	7,188	1,779	10,824	18,846	18,451	25,166	4,288	4,159	--	2,729	3,403	--	23,296	41,311
1962	11,016	69,565	6,986	2,168	13,605	18,827	23,753	30,488	5,179	5,102	--	3,260	3,937	--	27,786	42,229
1963	12,872	77,981	7,999	2,344	14,551	19,251	24,422	31,894	5,361	5,161	--	3,238	3,561	--	29,850	43,706
1964	12,649	82,300	8,972	2,503	16,086	18,583	25,087	33,178	5,523	5,566	--	3,286	4,297	--	30,516	46,014
1965	15,406	71,111	9,135	2,656	16,060	19,562	25,420	32,893	5,807	5,437	--	3,169	5,190	--	27,822	50,375
1966	17,930	77,037	11,896	2,933	17,673	21,005	28,358	36,465	6,543	6,012	--	3,414	5,649	23,404	30,742	53,007
1967	18,988	78,906	12,355	2,853	16,765	21,745	27,589	33,397	6,189	5,451	--	3,086	9,855	43,298	31,613	55,263
1968	19,376	84,800	14,093	3,046	17,968	21,858	29,140	35,118	6,561	5,654	--	3,071	13,056	63,730	37,650	58,203
1969	22,584	88,235	16,356	3,428	20,153	27,370	32,433	39,220	7,325	6,322	--	3,376	13,230	59,693	29,449	61,133
1970	27,374	129,545	26,968	4,002	24,828	28,071	36,472	46,044	8,012	6,987	--	4,036	16,167	57,740	45,862	71,296
1971	28,922	106,060	16,353	3,992	24,964	29,513	36,402	45,721	7,842	6,739	--	4,096	17,647	70,281	50,458	77,777
1972	38,088	134,108	17,549	4,932	30,102	32,432	42,244	54,486	8,816	7,804	--	4,923	17,914	79,553	55,781	85,500
1973	61,728	190,625	23,762	7,042	41,942	42,699	59,244	77,240	11,984	10,545	--	7,071	18,750	68,683	64,096	92,822
1974	66,322	200,000	25,637	7,763	45,645	44,746	63,783	81,936	12,619	11,207	--	7,736	23,876	71,794	99,225	113,930
1975	59,977	171,333	21,977	7,356	44,515	36,673	56,823	72,700	11,346	10,288	--	6,932	24,413	61,676	83,949	125,870
1976	52,517	151,923	16,800	7,019	41,584	43,572	50,590	64,487	10,626	9,483	--	6,424	42,996	109,039	81,215	137,128
1977	46,259	146,583	16,377	6,615	39,361	40,263	49,143	58,964	10,220	9,038	--	6,207	42,737	129,329	66,699	147,058
1978	59,804	170,303	17,481	7,264	42,991	42,946	57,438	66,303	11,471	9,996	--	7,057	43,665	180,165	48,564	154,368
1979	70,488	192,012	20,660	7,904	45,971	48,201	62,930	72,542	12,019	11,058	--	8,013	57,794	248,913	60,578	233,696
1980	74,811	215,297	28,091	8,903	50,255	55,070	70,394	78,103	12,793	12,253	--	9,014	69,524	311,139	84,707	360,075
1981	85,034	243,533	36,367	10,977	58,170	57,768	83,851	89,267	14,125	13,439	--	10,594	67,983	282,730	134,764	618,212
1982	84,080	218,788	30,620	10,309	55,042	53,484	77,073	82,571	12,691	11,723	--	9,826	64,293	292,948	144,954	642,088
1983	93,635	240,042	31,356	11,662	64,527	58,772	87,188	92,571	14,018	12,973	--	11,007	77,439	327,880	195,633	586,323
1984	89,744	235,691	39,630	11,188	63,537	58,285	83,311	90,558	13,280	12,710	--	10,987	84,996	350,310	174,591	558,256

SOURCE: Coon et al. 1985.

**APPENDIX C**

## INSTRUCTIONS

This questionnaire is designed to help you provide us with information on your purchases. All information will be kept strictly confidential.

Please do not write the name of your firm on the questionnaire. Individual firm's characteristics will not be disclosed in the final published tables.

The following general instructions are suggested in completing the questionnaire.

1. Use your records from the most recently completed fiscal year.
2. Information should be recorded in dollar terms.
3. If your firm operates more than one establishment in North Dakota, it is preferred that you include only one establishment for each questionnaire. Common costs should be identified on at least one of the questionnaires.
4. If your firm is an affiliate of a national firm, then the data should be only for the North Dakota plant.
5. When exact information is not available, please estimate.
6. A definition of sectors with corresponding Standard Industrial Classification (SIC) code listing is included to help in determining which sector's expenditures should be allocated to.
7. If you have questions, please contact:

Randy Coon (701)-237-7451

or

Larry Leistritz (701)-237-7455

Department of Agricultural Economics  
North Dakota State University  
Fargo, ND 58105

POTATO WASH PLANT EXPENDITURES SURVEY

I. Expenditures ( \_\_\_\_\_ year)

Sector to Which Input Payments are Made	Estimated Annual Expenditure In	
	North Dakota	Minnesota
	----- dollars -----	
1. Agriculture: Livestock	_____	_____
2. Agriculture: Crops (excluding potatoes)	_____	_____
3. Nonmetallic Mining	_____	_____
4. Contract Construction	_____	_____
5. Transportation	_____	_____
6. Communications	_____	_____
7. Public Utilities	_____	_____
8. Agricultural Processing	_____	_____
9. Heavy Manufacturing	_____	_____
10. Miscellaneous Manufacturing	_____	_____
11. Wholesale Trade	_____	_____
12. Retail Trade	_____	_____
13. Finance, Insurance, and Real Estate	_____	_____
14. Business and Personal Services	_____	_____
15. Professional and Social Services	_____	_____
16. Coal Mining	_____	_____
17. Thermal-Electric Generation	_____	_____
18. Petroleum/Natural Gas Exploration/Extraction	_____	_____
19. Petroleum Refining	_____	_____
20. Households	_____	_____
21. Government	_____	_____

II. Total Annual Revenue \$ \_\_\_\_\_

III. Potatoes processed in \_\_\_\_\_ (year): \_\_\_\_\_ cwt.

IV. Number of employees in full-time equivalents: \_\_\_\_\_ workers

DEFINITIONS OF SECTORS  
(According to the Standard Industrial Classification Manual)

1. Agriculture: Livestock  
(Major Group 01)
2. Agriculture: Crops  
(Major Group 02)
3. Nonmetallic Mining  
Includes mining and quarrying of nonmetallic minerals, except fuels.  
(Major Group 14)
4. Construction  
Includes building construction--general contractors engaged in construction of residential, farm, industrial, public, and other buildings. (Major Groups 15, 16, and 17)
5. Transportation  
Includes railroad, motor freight, water transportation, air transportation, pipeline transportation of petroleum, and other transportation to include packing and crating services, and rental of transportation equipment.  
(Major Groups 40, 41, 42, 43, 44, 45, 46, and 47)
6. Communications  
Includes establishments engaged in telephone, telegraph, radio, television, and other communication services. (Major Group 48)
7. Public Utilities  
Includes natural gas companies engaged in the transmission, storage, or distribution of natural gas. Also, water supply and sanitary services are included. (Major Group 49 except Group 491)
8. Agricultural Processing  
Includes manufacturing or processing foods and beverages and related products for human consumption. Also, textile, apparel, lumber, and leather products are included.  
(Major Groups 20, 21, 22, 23, 24, 25, 26, 27, and 31)
9. Heavy Manufacturing  
Includes processing of primary metals, fabricated metal products, farm and industrial machinery and equipment, electrical equipment and supplies, and transportation equipment.  
(Major Groups 33, 34, 35, 36, and 37)
10. Miscellaneous Manufacturing  
Includes establishments engaged in manufacturing miscellaneous products not classified in another Major Group. (Major Groups 38 and 39)

11. Wholesale Trade  
Includes establishments primarily engaged in selling merchandise to retailers; to industrial, commercial, institutional, or professional users; or to other wholesalers, or acting as agents in buying merchandise for or selling merchandise to such persons or companies.  
(Major Groups 50 and 51)
12. Retail Trade  
Includes establishments engaged in selling merchandise for personal, household, or farm consumption, and rendering services incidental to the sale of the goods. (Major Groups 52, 53, 54, 55, 56, 57, 58, and 59)
13. Finance, Insurance, and Real Estate  
Includes institutions engaged in banking, or other financial institutions, insurance, and real estate.  
(Major Groups 60, 61, 62, 63, 64, 65, 66, and 67)
14. Business and Personal Services  
Includes firms operating lodging services, repair, laundry, entertainment, other personal services predominantly to private individuals, credit collection, janitorial, and stenographic services.  
(Major Groups 70, 72, 73, 75, 76, 78, and 79)
15. Professional and Social Services  
Includes establishments engaged in furnishing health, medical, legal, educational, research and development, and other professional services.  
(Major Groups 80, 81, 82, 83, 84, 86, 88, and 89)
16. Coal Mining  
Includes establishments engaged in producing bituminous coal or lignite.  
(Major Group 12)
17. Thermal-Electric Generation  
Includes establishments engaged in transmission and/or distribution of electric energy for sale. (Group No. 491)
18. Petroleum/Natural Gas Exploration/Extraction  
Includes establishments engaged in production of crude petroleum or natural gas. (Major Group 13)
19. Petroleum Refining  
Includes establishments engaged in petroleum refining. (Major Group 29)
20. Households  
Includes all payments to persons as rents, interest, wages and salaries, and profits (to self-employed and also dividends and royalties).
21. Government  
Includes payments of taxes, fees, and user charges for municipal services.

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