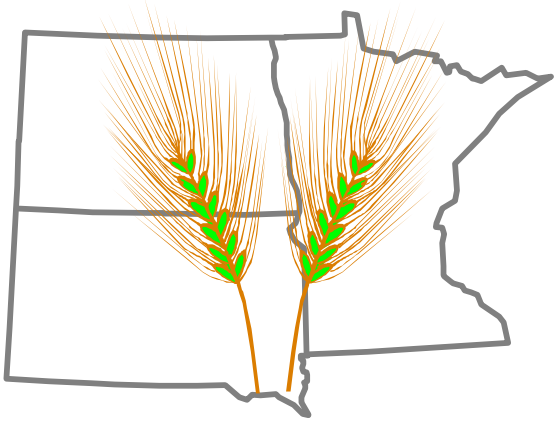
**Agricultural Economics Report No. 391** **April 1998**

# Economic Contribution of the Barley Industry



# in North Dakota, South Dakota, and Minnesota

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**ACKNOWLEDGMENTS**

Several people were helpful in providing data and information for in this study. Our appreciation and thanks are extended to

Demcey Johnson (Department of Agricultural Economics, NDSU)
Andy Swenson (Agricultural Economics, NDSU)
Paul Schwarz (Cereal Science, NDSU)
Mark Berwick (Upper Great Plains Transportation Institute, NDSU)
Doug Benson (Upper Great Plains Transportation Institute, NDSU)
Kim Vachal (Upper Great Plains Transportation Institute, NDSU)
Bridget Baldwin (Upper Great Plains Transportation Institute, NDSU)
Jim Jost (North Dakota Consolidated Farm Services)
Donna Wilkens (Minnesota Consolidated Farm Services)
Allen Barton (South Dakota Consolidated Farm Services)
John Mittleider (North Dakota Barley Council)
Bashir Qasmi (Economics Department, South Dakota State University)
Jerry Fruin (Department of Applied Economics, University of Minnesota)
Alan Pranke (Ladish Malting Company)
Ron Ackermann (Froedtert Malt Corporation)
Jon Alsip (Rahr Malting Company)
Robert Jensen (Minnesota Malting Company)
Bob Bollesen (Northland Community and Technical College)
Bruce Sebree (Archer Daniels Midland)
Steve Malin (Busch Agricultural Services)
Ray Juhl (Natural Ways Mill)
Dan Ward (Minnesota Grain Pearling)
Joel Dick (Roman Meal)
Wally Corum (NuWorld Nutrition)
Marjorie Volke (The Brewers Bulletin)
Richard Holcomb (International Grain Products Company)

Thanks are given to Norma Ackerson for document preparation, Shelly Swandal for the cover page graphics and to our colleagues for reviewing this manuscript.

Financial support was provided by the North Dakota Barley Council. We express our appreciation for their support.

The authors assume responsibility for any errors of omission, logic, or otherwise.

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## Abstract

Barley is an important crop in the upper Great Plains, yet its economic importance has not been quantified. Expenditures and returns from crop production, grain handling, transportation, and processing activities represented the direct economic impacts from the barley industry. Secondary economic impacts were estimated using an input-output model.

Barley production in the tri-state region averaged 3.3 million planted acres and 165 million bushels from 1994 through 1996. North Dakota had about 2.5 million acres. Barley production was estimated to generate $446 million in direct economic impacts. Total (direct and secondary) annual economic impacts from barley production were estimated at $1.2 billion.

Annual direct impacts from handling barley at country (local) elevators and terminal elevators in the region were estimated at $13 million. Total annual economic impacts from grain handling activities were estimated at $37 million. Annual regional expenditures and returns from transporting barley from country and terminal elevators to various market destinations were estimated at $47 million. Total annual economic impacts from barley transportation were estimated at $122 million. Impacts from barley processing were limited to regional malting of barley produced in the tri-state region. Annual direct impacts from barley processing were estimated at $58 million. Total annual economic impacts from barley processing were estimated at $180 million.

Processing activities employed 431 full-time jobs, while overall economic activity from the industry supported 18,450 secondary full-time equivalent jobs. The barley industry was responsible for generating $32 million annually in sales and use, corporate income, and personal income taxes.

Annual economic impacts from all barley activities were estimated at $1.5 billion in the tri-state region. Total economic impacts in North Dakota, South Dakota, and Minnesota were estimated at $1.1 billion, $70 million, and $371 million, respectively.



Key Words: barley, upper Great Plains, economic impact





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## *Highlights*

The upper Great Plains region is a major producer of barley in the United States. Historically, North Dakota has been the nation's number one producer of barley. Production from North Dakota, South Dakota, and Minnesota accounted for nearly 44 percent of all barley produced in the U.S. from 1994 through 1996. During that period, barley production in the tri-state region averaged about 3.3 million planted acres and 165 million bushels annually.

Barley is produced in all areas of North Dakota, in the northwest region of Minnesota, and in the northern third of South Dakota. Barley produced in South Dakota and in the western half of North Dakota is used primarily as livestock feed, whereas, barley in the eastern regions of North Dakota and the northwest region of Minnesota is raised mostly to make malt.

Direct economic impacts from the barley industry were estimated for crop production, grain handling, transportation, and processing activities. Farmers and producers generate direct impacts to the state's economy through (1) expenditures for production inputs and (2) returns to unpaid labor, management, and equity. Grain handling, transportation, and processing activities similarly effect the economy through (1) expenditures for operating inputs and (2) net returns from operations.

Crop production budgets were used with estimates of barley acreage and yields to determine the economic impacts from barley production in the tri-state region. Barley production in the region averaged 3.3 million planted acres and 165 million bushels from 1994 through 1996. Average barley acreage during the period in North Dakota, South Dakota, and Minnesota was estimated at 2.5 million, 227,000, and 603,000 planted acres, repectively. Annual direct economic impacts from barley production were estimated at $446 million or about $135 per planted acre.

Grain handling impacts were estimated for country and terminal elevators using grain handling budgets, typical handling margins, and estimates of the amount of barley handled. Annual direct economic impacts from grain handling were estimated at $13 million.

The amount of grain shipped to various market destinations by mode of transport was used in conjunction with truck and rail budgets to estimate the direct economic impacts from barley shipments. Annual direct economic impacts were $24 million and $23 million for truck and rail transportation, respectively. Collectively, of the $96 million spent annually on barley transportation, about $47 million was retained within the regional economy.

Economic impacts from barley processing were limited to malting activities. Total direct economic impacts from processing barley (i.e., impacts limited to barley produced in the region) were $58 million annually.

Total annual direct economic impacts from all barley activities in the tri-state region were estimated at $564 million. An input-output model was used to estimate the secondary economic impacts. The $564 million in direct economic impacts generated another $952 million in secondary economic impacts. Annual economic activity (direct and secondary) was estimated at

about $1.5 billion. Each acre of barley planted was estimated to generate about $458 annually in regional business activity.

Annual tax collections from the barley industry were about $32 million, which included $20.7 million in sales and use, $8.7 million in personal income, and $2.5 million in corporate income taxes. Approximately 22,480 farms in 1992 raised barley in tri-state region. Barley processing activities in the region were directly responsible for about 431 full-time jobs. Secondary employment supported by barley production, grain handling, transportation, and processing activities was estimated at 18,450 jobs annually.

Annual direct impacts in North Dakota, South Dakota, and Minnesota from all barley industry activities were $401 million, $27 million, and $136 million, respectively. Total annual (direct and secondary) impacts in North Dakota, South Dakota, and Minnesota from all barley industry activities were $1.1 billion, $70 million, and $371 million, respectively.

Changes in crop production are likely to have the greatest effect on the economies of barley-producing states. Barley is an important regional crop in Minnesota and an important statewide crop in North Dakota; however, due to limited acreage, barley is of less economic importance in South Dakota. Whether measured by acreage, bushels, gross business volume, tax revenue, or employment, the barley industry is a substantial component of the regional economy.

# Economic Contribution of the Barley Industry in North Dakota, South Dakota, and Minnesota

Dean A. Bangsund and F. Larry Leistritz*

## INTRODUCTION

Agriculture remains a major industry in the upper Great Plains (Coon and Leistritz 1995; Beutler 1997; Senf et al. 1993), and most people familiar with the region realize the importance of agriculture to the area's economy. However, the economic significance of the various activities within the agriculture industry are less understood.

Throughout North Dakota, in northwestern Minnesota, and in the northern third of South Dakota, small grains (i.e., wheat, barley, oats) are important crops. They provide valuable feed for livestock in many regions of South Dakota and in the western regions of North Dakota. In addition to providing livestock feed in North Dakota, small grains account for the vast majority of crop sales in the state. In the Red River Valley of the North, small grains also provide a valuable agronomic component in the production rotation of high value row crops, such as potatoes and sugarbeets. The two prominent small grains in the tri-state region of North Dakota, South Dakota, and Minnesota are wheat and barley.

The economic importance of wheat in North Dakota and Minnesota has been documented (Bangsund et al. 1994; Bangsund and Leistritz 1995a). However, the economic importance of barley in the region has not been addressed. Barley is a rugged grain that grows well in cool, dry climates, making it well suited for the northern growing regions of the upper Great Plains.

Measured by acreage planted from 1994 through 1996, barley ranked sixth nationally among field crops (U.S. Department of Agriculture 1997). Regionally, barley ranked fourth among field crops in planted acreage and represented 8 percent of the acreage planted to the top four crops in the tri-state region. From 1994 through 1996, barley production in North Dakota, South Dakota, and Minnesota accounted for 44 percent of U.S. barley production (U.S. Department of Agriculture 1997).

Domestically, barley is primarily used as livestock feed or processed into malt for the beer industry. Small amounts (relative to other uses) of barley are processed into human food. The tri-state economy benefits by having both barley production and processing opportunities in the three states. Currently, malting capacity in Minnesota and North Dakota represents about 40 percent of U.S. malting capacity (Satyanarayana et al. 1996).

Information from an economic impact or contribution study can be valuable for industry, educational, and public relations efforts. Determining the economic contribution of a given industry provides information about its importance to local economies. Not only can the impacts on local economies be measured, but the impacts on specific economic sectors and industries also

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can be identified. Providing economic information on how an industry effects related industries can be valuable to policy makers and business leaders.

In the case of the barley industry in the tri-state region, an impact study is especially beneficial, not only for identifying specific economic impacts to various economic sectors and quantifying impacts to local economies, but also because it can draw attention to an important regional crop, demonstrate the economic importance of barley production to the various states' economies, and indicate the economic impacts that could result from potential changes in policies which affect the barley industry. Considering that a substantial part of U.S. barley production occurs in the region and a substantial portion of the industry's processing capacity is also located in the region, the industry can benefit in numerous ways from quantifying the economic impacts of the industry. Given recent problems associated with crop quality and trade issues, an economic study can highlight the importance of allocating resources to solve the agronomic problems of this regional crop and the consequences of various trade policies.

## OBJECTIVES

The purpose of this report is to estimate the economic contribution (direct and secondary effects) of the barley industry to the economies of North Dakota, South Dakota, and Minnesota. Specific objectives include:

1) estimate the direct and secondary impacts of barley production,

2) estimate the direct and secondary impacts of barley handling activities,

3) estimate the direct and secondary impacts of barley transportation, and

4) estimate the direct and secondary impacts of barley processing.

## PROCEDURES

An economic contribution analysis, as defined in this study, represents an estimate of all relevant expenditures and returns associated with an industry (i.e., economic activity from producing, handling, transporting, and processing barley within a geographic area). The economic contribution approach to estimating economic activity has been used for several similar studies (Bangsund and Leistritz 1995a, 1995b; Bangsund et al. 1994; Bangsund and Leistritz 1993).

Analysis of the impacts associated with the barley industry[1] required several steps. Discussion of the procedures used in the study was divided into the following sections: (1) barley

[1]The barley industry, as described and analyzed in this report, is limited to activities associated with barley produced in North Dakota, South Dakota, and Minnesota.

production, (2) grain movement, (3) transportation, (4) processing, and (5) application of input-output analysis to estimate secondary impacts.

## Barley Production

Barley is grown in most regions of the U.S., but it is primarily raised in the northern states west of the Mississippi river. The top four barley producing states, North Dakota, Montana, Idaho, and Minnesota, accounted for over 70 percent of U.S. production from 1994 through 1996 (U.S. Department of Agriculture 1997). Other major barley producing states include Washington, Oregon, Utah, Wyoming, Colorado, California, and South Dakota. Barley output in North Dakota, South Dakota, and Minnesota from 1994 through 1996 accounted for 44 percent of U.S. production. Although South Dakota and Minnesota have historically been large barley producing states, their output has been overshadowed by barley production in North Dakota. North Dakota has historically been the most important barley producing state, leading the nation in production 47 of the last 50 years (North Dakota Agricultural Statistics Service *various issues*).

The importance of barley in each state's crop mix varies. Barley is the second most important crop in North Dakota, remaining a distant second to wheat (North Dakota Agricultural Statistics Service *various issues*). Barley is the fourth largest crop in Minnesota when measured by acreage planted from 1994 through 1996 (U.S. Department of Agriculture 1997). Measured in acreage planted, barley is surpassed in Minnesota only by corn, soybeans, and wheat. Over the same period, barley ranked seventh among field crops raised in South Dakota. Regionally, barley ranks fourth in annual acreage planted to major crops.

Barley is generally produced in most areas of the tri-state region; however, production is concentrated in north central North Dakota and in the Red River Valley of North Dakota and Minnesota (Figure 1). Barley is produced in every county in North Dakota. However, barley production diminishes in the southern portions of South Dakota and Minnesota. Barley production was averaged to eliminate fluctuations in yearly production levels, thus providing a better indication of typical impacts generated by the industry. A three-year average (1994-1996) was used throughout the study to estimate the economic impacts from production, handling, transportation, and processing activities.

Barley production in North Dakota averaged about 2.5 million planted acres and 125.4 million bushels per year from 1994 through 1996 (North Dakota Agricultural Statistics Service *various years*) (Appendix A). County barley yields in North Dakota during the period varied from 29 to 62 bushels per planted acre, with an overall state average of 52 bushels per acre. County yields in Minnesota over the same period ranged from 36 to 64 bushels per planted acre, with an overall state average of 54 bushels per planted acre. Minnesota averaged just over 600,000 planted acres and about 30.8 million bushels annually during the period (Minnesota Agricultural Statistics Service *various years*). South Dakota had county yields ranging from 22 to 60 bushels per planted acre from 1994 through 1996. The state average yield in South Dakota was 41 bushels per planted acre over the period. South Dakota averaged 227,000 planted acres and 8.5 million bushels annually during the period (South Dakota Agricultural Statistics Service *various years*).

Barley yields were generally highest in the Red River Valley, north central North Dakota, and in the southeastern corner of Minnesota (Figure 2). Barley production for the tri-state region averaged 3.3 million planted acres and 165 million bushels annually. The tri-state average county yield for the period was 51.6 bushels per acre.

Production budgets were developed for crop reporting regions in North Dakota, South Dakota, and Minnesota (Appendix B). Separate budgets for various regions in each state were developed because of differences in growing conditions and farming practices throughout the tri-state area. Expenditures were calculated from budgets obtained from the Farm Business Management Programs (Adult Vocational-Agriculture Programs) in each state. Expenditures were averaged from 1994 through 1996. Revenues were a combination of county yields, marketing-year statewide prices, and barley deficiency payments by county averaged from 1994 through 1996 (Appendix B).

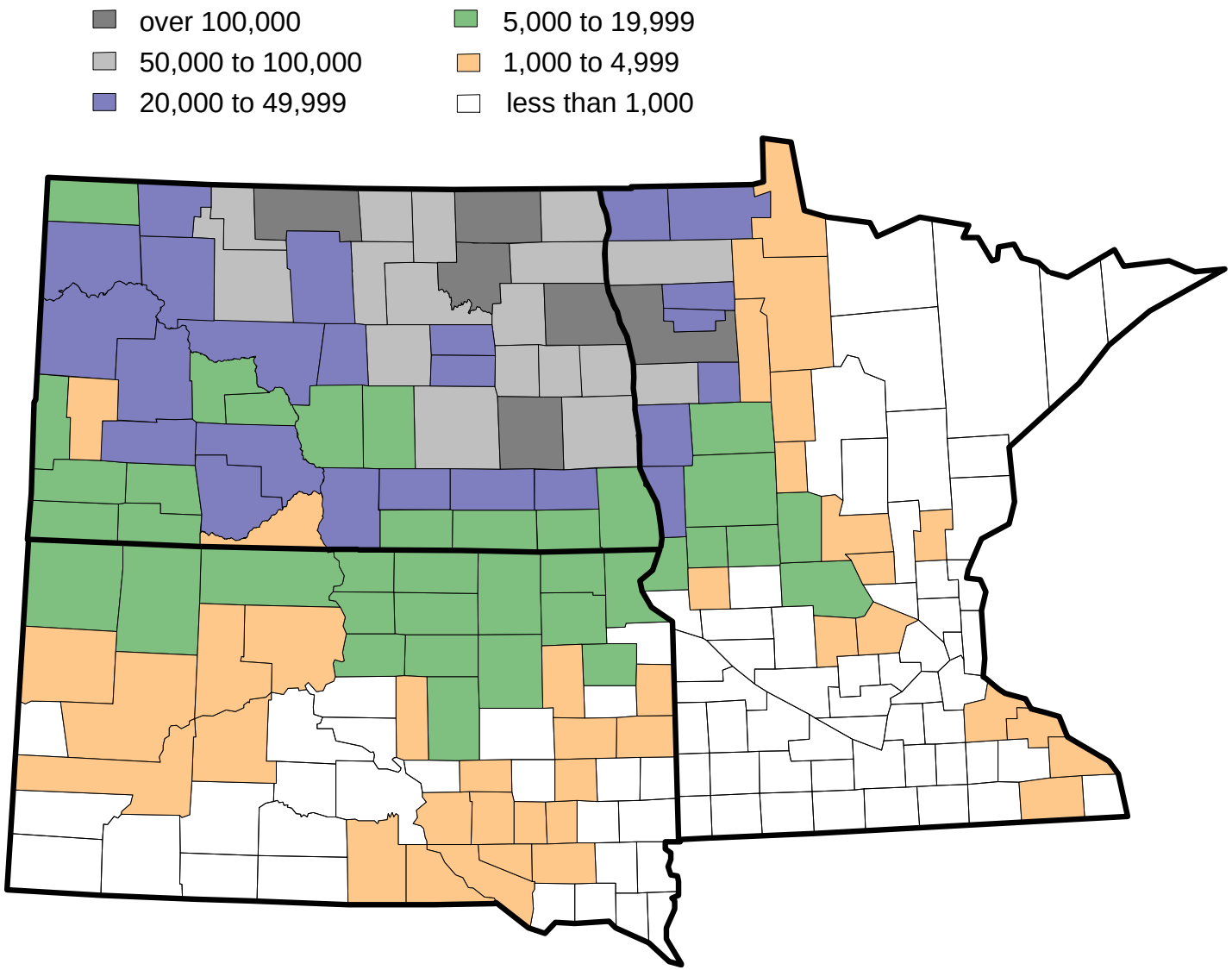


Figure 1.
Average Planted Acreage of Barley in North Dakota, South Dakota, and Minnesota, by County, 1994 to 1996

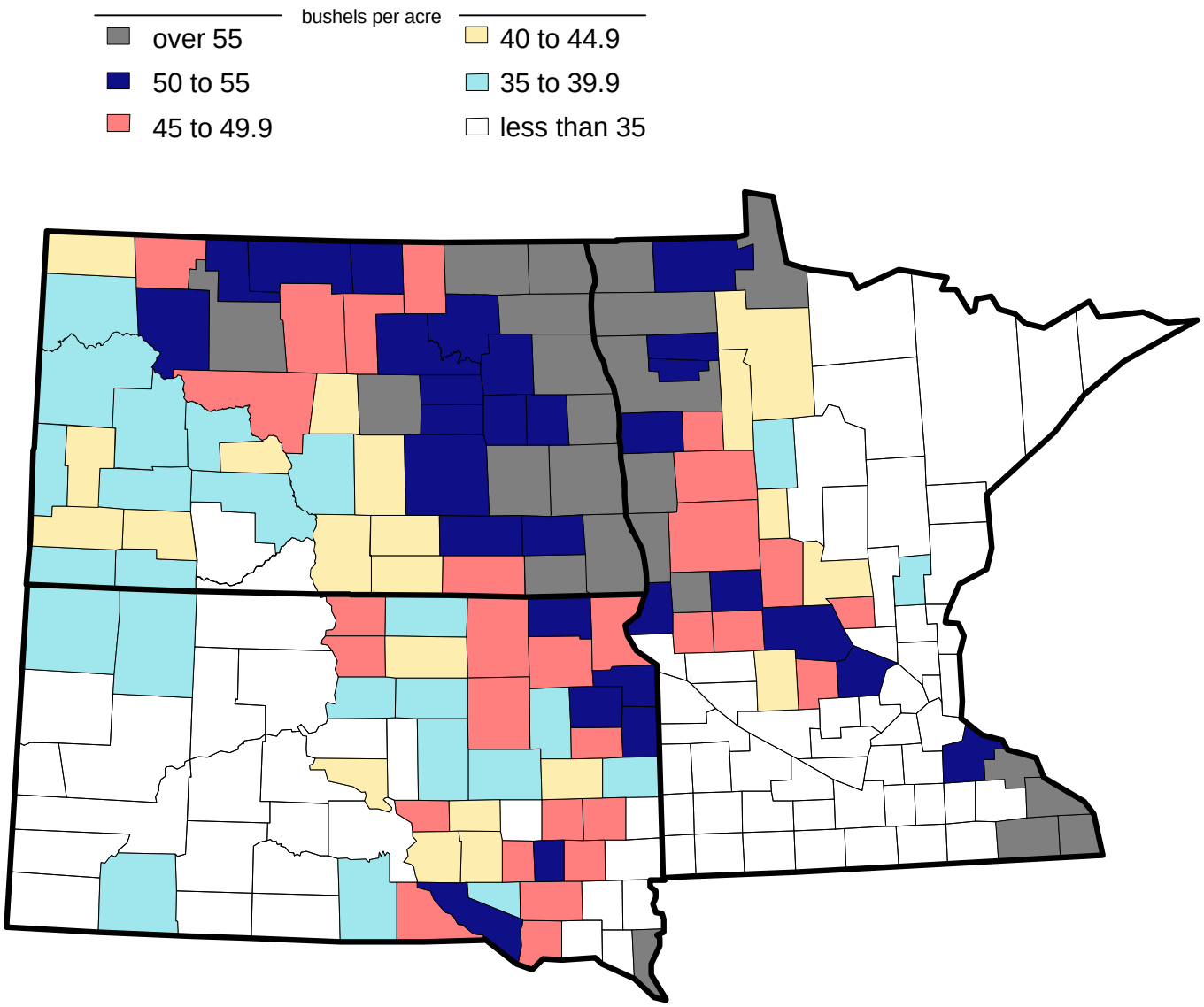


Figure 2. Average Barley Yields in North Dakota, South Dakota, and Minnesota, by County, 1994 to 1996

## Grain Movement

Grain movement was defined to include grain flow (i.e., logistics of grain movement from production to final markets) and grain handling (i.e., cleaning, mixing, storing, loading, and unloading). The following section is divided into (1) grain flow and (2) grain handling.

### Grain Flow

Tracking grain flow is usually complex, involving several modes of transportation (e.g., truck, railroad, barge, vessel) and several possible destinations and handlers (Figure 3). For this study, grain movements were limited to shipments from (1) farms to country (local) elevators, (2) country elevators to out-of-state destinations (i.e., river port, terminal elevator, subterminal elevator, another country elevator, processor), (3) country elevators to in-state processors or final destinations, and (4) Minnesota terminal ports to out-of-the-region destinations (Figure 4).

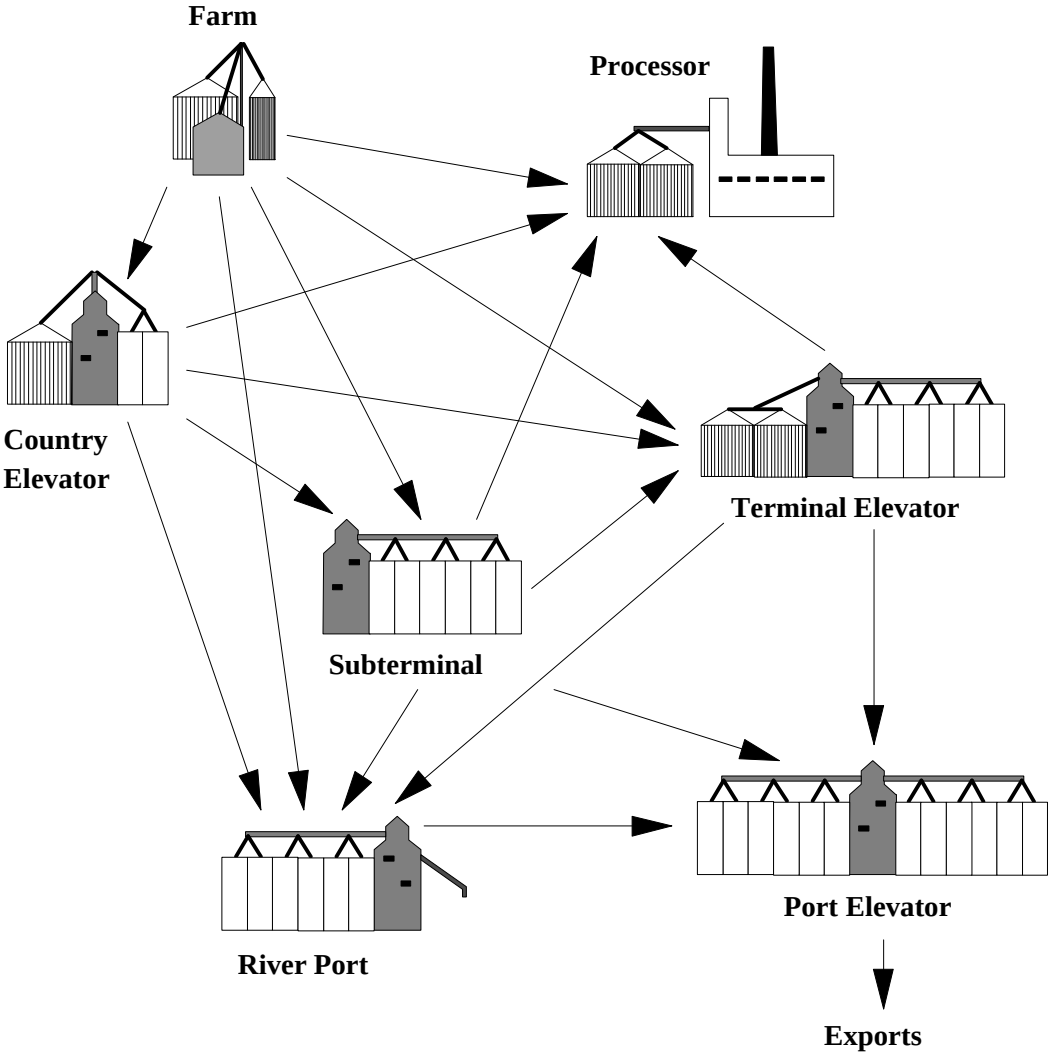


Figure 3. Typical Grain Movements in the United States Grain Marketing System
Source: U.S. Department of Agriculture (1990).

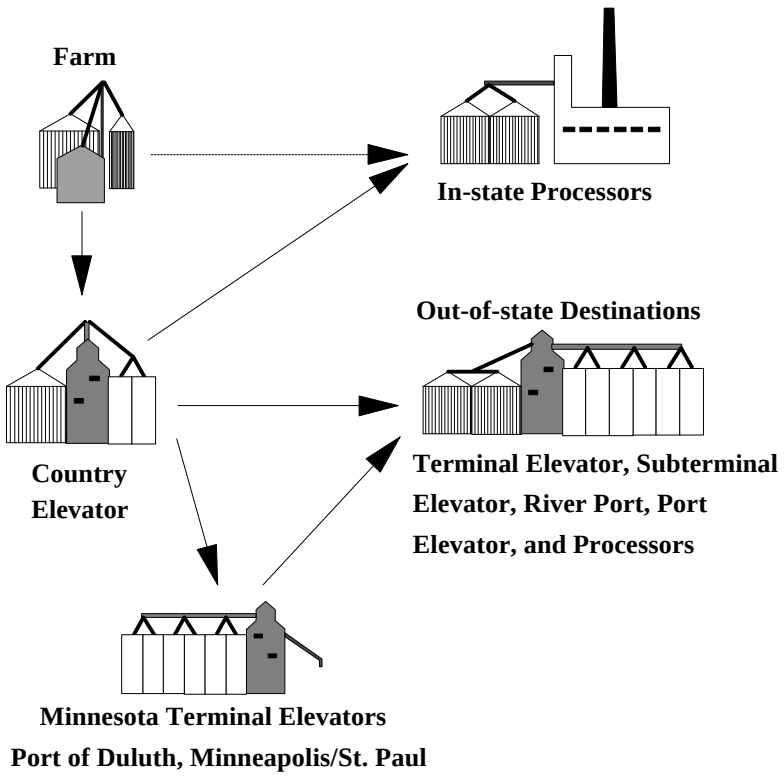


Figure 4. Assumed Barley Movements for Barley Produced in North Dakota, South Dakota, and Minnesota, 1994 Through 1996

Barley shipments from country elevators in North Dakota during the study period averaged 15.5 percent less than total production after adjustments for changes in on-farm and off-farm storage (Appendix C). The 15.5 percentage difference between elevator shipments and total production was assumed to represent barley used for on-farm feed and seed, direct shipments by producers to processors and/or out-of-state destinations, commercial seed production, and barley used by country elevators to produce livestock feed.

This study did not address direct shipments of barley by producers to processors or market destinations other than a country elevator. After delivery to a country elevator, barley was assumed to be delivered by the elevator to either in-state processors or out-of-state market destinations. Grain flow statistics for barley in North Dakota were based on information from the Upper Great Plains Transportation Institute (Dalebout et al. 1997; Andreson and Vachal 1996, 1995; Vachal et al. 1997). Similar information for barley movements in South Dakota were obtained from Qasmi and McDaniel (1997). Barley movements in eastern North Dakota were used as a proxy for barley movements in Minnesota. Estimates of average barley production were used with grain flow statistics to identify the volumes of barley shipped from crop reporting districts in the tri-state region to various destinations. The amount of barley shipped by mode of transportation (i.e., truck and rail) for each destination was obtained from the above sources. Shipping characteristics (i.e., amount shipped by truck and rail to each destination) for each crop reporting district were applied to county-level barley production to estimate grain flow from each county.

Barley produced in the tri-state region is predominately shipped to end users within the Upper Midwest (Table 1). Over 41 percent of barley shipments by country elevators in the tri-state area were to Minneapolis/St. Paul and Wisconsin destinations. Shipments to processors in North Dakota and South Dakota (i.e., commercial feed operations in South Dakota and mostly malting activities in North Dakota) accounted for about one-fifth of all shipments. The Port of Duluth received about 8 percent of the region's barley shipments. Other destinations include the Pacific Northwest (8 percent), Midland/Southern (10 percent), and miscellaneous markets (14 percent). North Dakota shipments, as a percentage of all bushels shipped, accounted for over three-quarters of all barley movements originating from the tri-state region. Minnesota shipments accounted for about 21 percent of all movements. South Dakota only accounted for 2 percent of all barley shipments.

**Table 1. Annual Barley Movements From North Dakota, South Dakota, and Minnesota Country Elevators to various Market Destinations, 1994 Through 1996**

| | Market Destinations | | | | | | |
|---|---|---|---|---|---|---|---|
| State | Duluth | Mpls/ St. Paul | Midland/ Southern | Pacific Northwest | N. Dak. & S. Dak. | Other | Totals |
| | 000s bu | | | | | | |
| N. Dakota | 7,667 | 44,145 | 10,409 | 8,612 | 21,305 | 13,837 | 105,976 |
| % of state | 7.2 | 41.7 | 9.8 | 8.1 | 20.1 | 13.1 | 77.2 |
| S. Dakota | 434 | 1,166 | 0 | 34 | 824 | 345 | 2,803 |
| % of state | 15.5 | 41.6 | 0.0 | 1.2 | 29.4 | 12.3 | 2.0 |
| Minnesota | 2,408 | 11,793 | 3,313 | 2,083 | 3,660 | 5,218 | 28,475 |
| % of state | 8.5 | 41.4 | 11.6 | 7.3 | 12.9 | 18.3 | 20.7 |
| All Shipments | 10,059 | 57,104 | 13,722 | 10,729 | 25,789 | 19,400 | 137,254 |
| % | 7.7 | 41.6 | 10.0 | 7.8 | 18.8 | 14.1 | |

Grain Handling

Grain handling impacts were estimated by determining (1) a typical handling margin for country elevators and terminal elevators in the tri-state area and (2) the amount of barley typically handled by country and terminal elevators. Grain handling budgets were used to allocate the country and terminal elevator returns and expenses for handling barley (Appendix B). Country elevators in North Dakota handled approximately 106 million bushels of North Dakota produced

barley annually[2]. South Dakota elevators handled approximately 2.8 million bushels annually. Minnesota country elevators handled about 28.5 million bushels annually, and terminal or port elevators handled about 27.6 million bushels annually (i.e., barley shipped from country elevators in the tri-state region).

## Transportation

Shipping and hauling costs (i.e., money spent on transporting barley to market destinations) were used to measure the economic impact of barley transportation on the states' economies. To realistically approach the problem of estimating transportation costs for barley in the tri-state region, transportation costs were limited to (1) truck and rail movements from country elevators to in-state and out-of-state destinations and (2) truck and rail shipments from terminal elevators to various destinations. Transportation costs from the Port of Duluth were estimated only for truck and rail, even though lake vessels were the main mode of transportation for grain leaving the Port of Duluth during the study period (Minneapolis Grain Exchange 1996; 1997). Vessel transportation costs were not included in this study because most of the expense of vessel transport occurs outside of the state; however, impacts from maritime activity associated with barley leaving the Port of Duluth were included. The remaining section is divided into transportation by country elevators, terminal elevators, truck transportation, and railroad transportation.

### Transportation from Country Elevators

Transportation costs of shipping barley from local elevators to market destinations required estimating (1) the amount of barley transported from counties to market destinations by mode of transport, (2) per unit expense for truck and rail transportation to move barley to various destinations, and (3) distances from central locations within counties to market destinations. The amount of barley shipped from each county to market destinations (i.e., Duluth, Minneapolis/St. Paul, in-state processors, etc.) was determined by applying grain flow information to county production (Appendix C).

The percentages of grain shipments to market destinations were estimated from Vachal et al. (1997), Andreson and Vachal (1996), Andreson and Vachal (1995), and Qasmi and McDaniel (1997). Percentage movements by rail and truck were obtained from Dalebout et al. (1997) and Qasmi and McDaniel (1997). The percentages of grain hauled by truck and railroad were applied to county grain movements to estimate the amount of grain shipped by each mode of transportation (Appendix C).

Shipping points (i.e., a central town or location) within each county were selected to calculate transportation costs for the entire county. Shipping points for each county were selected based on location within the county and on whether they contained an elevator with access to a major railroad. Shipping points were used to determine transportation distances to market destinations for both truck (highway miles) and rail (rail line miles).

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[2]Barley shipped from neighboring states to country elevators in the region (e.g., barley produced in Montana and marketed in North Dakota) and shipments of barley from Canada were not addressed in this study.

Transportation from Terminal Elevators

Transportation costs from terminal elevators in the Port of Duluth and Minneapolis/St. Paul were based on the amount of grain by mode of transportation and the estimated quantities of barley shipped. The ratio of truck and rail transportation was based on shipment statistics from Minneapolis Grain Exchange (1997). Approximate destinations for shipments were obtained from the Upper Great Plains Transportation Institute (1998a). Quantities of barley shipped (attributable to production from the tri-state region) were based on quantities shipped to terminal locations from country elevators and adjusted by quantities of barley used by malting processors in Minnesota.

Truck Transportation

Trucking costs for barley were based on information obtained from Berwick and Dooley (1997). A trucking rate was obtained from the Upper Great Plains Transportation Institute (1998b). The trucking rate was used with truck operating costs to construct a trucking budget to estimate operation expenses and returns (Appendix B). Total trucking costs for each county to each destination were estimated by multiplying mileage by cost per mile by the number of shipments. Economic impacts from truck transportation were estimated based on allocation of expenses incurred in each state (Appendix B).

Railroad Transportation

Railroad transportation costs required estimating the railroad companies' costs of rail shipments, developing a railroad expense budget to allocate shipment costs to expense categories, and estimating charges levied by the railroad companies on elevators for rail car shipments (shipping tariffs). Railroad companies' expenses incurred in rail transport were estimated using the Uniform Railroad Costing System (URCS), a microcomputer model developed by the Interstate Commerce Commission (1990).

URCS estimates variable and total costs (i.e., expenses incurred by the railroad companies, not to be mistaken for the cost incurred by elevators) of railroad transportation based on a data base of financial and rail shipment information obtained from major railroad companies. The proportions of barley shipped by single car, multiple car, and unit train rates in the state were obtained from Andreson and Vachal (1995) and Andreson and Vachal (1996) and were used with URCS and grain flow information to estimate an overall cost structure of rail shipments in North Dakota and Minnesota.

URCS provides an estimate of the total variable costs and total allocated costs for rail shipments; however, the model does not provide an adequate breakdown of the costs. Thus, a railroad budget was developed to allocate the variable and fixed costs obtained from URCS to various expense categories which were subsequently allocated to economic sectors (Appendix B).

After estimating the expenses incurred by the railroad companies, the rates charged elevators for rail shipments were determined. Shipping tariffs are rates charged elevators per rail car to ship grain. Tariffs for rail shipments from North Dakota, South Dakota, and Minnesota

origins to various destinations were obtained from the Upper Great Plains Transportation Institute (1998c). Total railroad costs were subtracted from shipping tariffs to estimate railroad net returns.

Railroad net returns generated from shipments of barley were assumed to leave the region and were not considered part of the economic impact. However, not all of the economic activity of rail transportation leaves the state (e.g., fuel, repairs, track maintenance, property tax, labor, etc.). About 60 percent of the variable and fixed costs was assumed to remain within the state's economy.

## Processing

Barley can be processed into a number of products. The most common are livestock feed and malt. Barley is typically considered an energy component in livestock rations and, depending upon feedstuff availability and price, will substitute for corn in many livestock rations. Livestock feed is the largest end use of barley in the United States (U.S. Department of Agriculture 1997). Malt, a major component in beer, is the second largest end use of the crop. Barley can also be processed into several human food components, although those end uses are minor compared to livestock feed and malt.

Economic impacts from barley processing were limited to malting activities. Although some commercial feed processing activities in the tri-state region use barley, the economic activity attributed to barley from those activities is not clear. The substitutability of barley with corn and sorghum, and the fractional value of any single feed component within a processed ration, make feed impacts difficult to estimate. Unlike feed processing, the economic impacts from malting activities are relatively straightforward and entirely attributable to barley. Processing barley into human food, such as flakes, flour, and other baking ingredients, can be directly linked to barley; however, information necessary to estimate the economic impact from those activities was unavailable. In addition, the ommission of those activities would have little effect on the estimated economic size of the industry. Thus, processing impacts from barley in this study were limited to malting activities. The economic impacts associated with malting activities were limited to the malting activities in North Dakota and Minnesota and limited to the malting of barley produced in the study region. Thus, economic activity generated from (1) barley produced in the region but malted outside the region and (2) barley malted within the region but produced from outside the region was not included. Economic activity from malting activities was estimated with information obtained from secondary sources and industry contacts (Appendix B).

## Input-Output Analysis

Economic activity from a project, program, or policy can be categorized into direct and secondary impacts. Direct impacts are those changes in output, employment, or income that represent the initial or direct effects of the project, program, or event. Secondary impacts (sometimes further categorized into indirect and induced effects) result from subsequent rounds of spending and respending within an economy. This process of spending and respending is sometimes termed the multiplier process, and the resultant secondary effects are sometimes referred to as multiplier effects (Leistritz and Murdock 1981).

Input-output (I-O) analysis is a mathematical tool that traces linkages among sectors of an economy and calculates the total business activity resulting from a direct impact in a basic sector (Coon et al. 1985). The North Dakota I-O Model has 17 economic sectors, is closed with respect to households (households are included in the model), and was developed from primary (survey) data from firms and households in North Dakota. Empirical testing has shown the North Dakota Input-Output Model is sufficiently accurate in estimating economic impacts in neighboring states (Coon and Leistritz 1994; Coon et al. 1984; Leistritz et al. 1990).

## ECONOMIC IMPACTS

The economic contribution from the barley industry was estimated from production, grain handling, transportation, and processing activities. Expenditures and returns from these activities represent direct economic impacts. Subsequently, the direct impacts were used with the North Dakota I-O Model to quantify the secondary impacts. The following section is divided into five major parts: (1) direct impacts, (2) secondary impacts, (3) employment, (4) tax revenue, and (5) total economic impacts.

### Direct Impacts

From an economic perspective, direct impacts are those changes in output, employment, or income that represent the initial or direct effects of a project, program, or activity. The direct impacts from the barley industry on the economies of North Dakota, South Dakota, and Minnesota include (1) expenditures and returns from the production of barley, (2) expenditures and returns from handling barley at local and terminal elevators, (3) economic activity generated from the transportation of barley from local collection points to in-state and out-of-state markets, and (4) expenses and returns from barley processing (malting) activities. The following sections describe these direct economic impacts.

#### Barley Production

Farmers and producers generate direct economic impacts to the area economy through (1) expenditures for production outlays (e.g., fuel, machinery, chemicals, fertilizer) and (2) returns to unpaid labor, management, and equity (e.g., money used to cover family living expenses or reinvestment in the business). Direct economic impacts from barley production (i.e., production outlays and producer returns) were estimated by developing crop production budgets. Barley production budgets, estimated separately for each state, were based on average revenues and expenses in major crop producing regions. Revenues were calculated from average county yields, state-wide prices, and government farm program payments. Expenses were obtained from budgets compiled by Farm Business Management Programs in each state (Appendix B).

Total direct impacts per acre from barley production should be equal to the gross revenue per acre, providing all economic activity (production expenses and net returns) remains in the tri-state economy. All expenses and returns associated with barley production were assumed to remain within the regional economy (i.e., there were no economic leakages associated with the production of barley), even though some inputs, such as fertilizer, seed, and machinery, may be purchased in neighboring states.

Barley production in North Dakota averaged 2.48 million planted acres from 1994 to 1996. The 2.48 million acres of barley generated about $283 million in production expenditures annually and $55 million annually in returns to unpaid labor, management, and equity. Direct impacts (expenditures and returns) from barley production in North Dakota averaged $136 per acre or $338 million annually (Table 2).

Barley production in South Dakota averaged 227,000 planted acres from 1994 to 1996. The 227,000 acres of barley generated about $21 million in annual production expenditures and $5 million annually in returns to unpaid labor, management, and equity. Direct impacts (expenditures and returns) from barley production in South Dakota averaged $116 per acre or $26 million annually (Table 2).

Barley production in Minnesota averaged 603,000 planted acres from 1994 to 1996. The 603,000 acres of barley generated about $76 million in annual production expenditures and $5.5 million annually in returns to unpaid labor, management, and equity. Direct impacts (expenditures and returns) from barley production in Minnesota averaged $135 per acre or about $82 million annually (Table 2).

**Table 2. Average Direct Economic Impacts From Barley Production in North Dakota, South Dakota, and Minnesota, 1994 Through 1996**

| Expenses/Returns[a] | Direct Impacts from Barley Production | | | |
|---|---|---|---|---|
| | North Dakota | South Dakota | Minnesota | Total |
| | ---------- 000s $ ---------- | | | |
| Revenues | | | | |
| Grain Sales | 301,361 | 19,323 | 69,374 | 390,058 |
| Government Payments | 36,616 | 6,868 | 12,224 | 55,709 |
| Total Revenue | 337,977 | 26,191 | 81,598 | 445,767 |
| Variable Expenses | | | | |
| Seed | 17,910 | 1,381 | 5,017 | 24,307 |
| Fertilizer | 46,175 | 3,195 | 13,538 | 62,908 |
| Chemicals | 22,692 | 2,228 | 7,896 | 32,816 |
| Insurance | 12,949 | 220 | 3,280 | 16,449 |
| Fuel and Lubrication | 14,603 | 1,626 | 4,219 | 20,449 |
| Repairs and Maintenance | 24,019 | 2,650 | 6,657 | 33,326 |
| Hired and Custom Work | 5,187 | 177 | 1,294 | 6,658 |
| Interest | 7,590 | 995 | 2,024 | 10,609 |
| Cash Rent | 47,801 | 2,788 | 9,932 | 60,522 |
| Miscellaneous | 1,102 0 | 326 | 1,428 | |
| Overhead | | | | |
| Hired Labor | 9,167 | 789 | 2,048 | 12,004 |
| Machinery/Building | 21,350 | 1,051 | 5,410 | 27,811 |
| Insurance | 4,511 | 268 | 1,272 | 6,052 |
| Utilities | 3,217 | 536 | 1,016 | 4,769 |
| Interest | 27,413 | 1,840 | 8,087 | 37,340 |
| Property Taxes | 8,948 | 948 | 2,362 | 12,259 |
| Miscellaneous | 7,957 279 | 1,726 | 9,963 | |
| Total Expenses | 282,592 | 20,973 | 76,106 | 379,671 |
| Returns to Unpaid Labor, Equity, and Management | 55,385 | 5,218 | 5,492 | 66,097 |
| Total Direct Impacts | 337,977 | 26,191 | 18,598 | 445,767 |

Grain Handling

Country (local) elevators generate direct economic impacts to the area economy through (1) expenditures for grain handling and (2) returns on grain merchandizing. Direct economic impacts from grain handling were estimated by developing a country elevator budget for grain handling operations (Appendix B). The amount of barley produced that was delivered to local elevators varied by state (see Appendix C for explanation).

Local elevators in North Dakota handled approximately 106 million bushels (84.5 percent of production) of barley annually from 1994 through 1996. With a gross margin of about $0.08 per bushel (Appendix B), grain handling at local elevators in North Dakota generated about $8.5 million in annual direct impacts to the economy of North Dakota (Table 3).

Country elevators in South Dakota handled about 2.8 million bushels (33 percent of production) of barley annually from 1994 through 1996. Total direct impacts from grain handling activities in South Dakota were estimated at $223,000 annually (Table 3).

Grain handling impacts in Minnesota included economic activity at country elevators, terminal elevator activity in the Port of Duluth and Minneapolis/St. Paul, and maritime activity in the Port of Duluth. Country elevators in Minnesota handled about 28 million bushels annually (93 percent of production) and, multiplied by a gross handling margin of $0.08 per bushel, generated $2.2 million in annual direct impacts. Terminal elevators in Minnesota handled 27.6 million bushels of barley produced in the tri-state region annually and generated $1.9 million in annual direct impacts. Averaged from 1994 through 1996, about 4.9 million bushels of barley were transported out of the Port of Duluth by vessel. The maritime activity created by the barley shipments was estimated at $361,000 annually or $3.36 per metric ton. Total grain handling impacts in Minnesota were estimated at $4.6 million annually. Collectively, grain handling activities generated $13.3 million in direct economic impacts in the tri-state region annually from 1994 through 1996 (Table 3).

**Table 3. Average Direct Economic Impacts in North Dakota, South Dakota, and Minnesota From Barley Handling Activities, 1994 Through 1996**

| | Annual Direct Impacts from Grain Handling | | | |
|---|---|---|---|---|
| Expenses | North Dakota | South Dakota | Minnesota | Total |
| | ---------- 000s $ ---------- | | | |
| Labor | 3,028 | 80 | 1,759 | 4,867 |
| Utilities | 432 | 11 | 445 | 888 |
| Interest | 778 | 21 | 406 | 1,205 |
| Equip. Depr. and Repairs | 1,298 | 34 | 567 | 1,899 |
| Taxes and Licenses | 433 | 11 | 200 | 644 |
| Insurance | 779 | 21 | 209 | 1,009 |
| General Expenses | 1,644 | 43 | 684 | 2,371 |
| Services | 87 | 2 | 95 | 184 |
| Net Returns | 0 | 0 | 218 | 218 |
| Total Direct Impacts | 8,479 | 223 | 4,583 | 13,285 |

## Transportation

Truck and rail transportation generates direct economic impacts to the area economy through (1) expenditures for operating inputs and (2) operator returns. Direct economic impacts from grain hauling were estimated separately for truck and rail transportation.

### Truck Transportation

A trucking rate was used in conjunction with hauling distances and the number of loads to develop an estimate of the economic impacts from truck transportation. Economic activity from intrastate (e.g., shipments that start and end within the same state) and interstate (e.g., shipments that start and end in different states) truck shipments was allocated differently. All trucking costs associated with intrastate shipments were assumed to remain within the respective state's economy. Fuel is an important portion of the expense in trucking, but on interstate shipments some fuel would be purchased in other states. Also, some repairs are incurred on out-of-state trips. Furthermore, some trucking is conducted by out-of-state trucking firms, which incur most of their expenses in other states. Thus, 80 percent of the interstate trucking expenses was assumed to remain in the originating state's economy.

Country elevators in North Dakota and South Dakota and country and terminal elevators in Minnesota collectively spent about $27 million to ship about 37.5 million bushels of barley by truck to various destinations; 92 percent of those expenses were allocated as direct impacts in the tri-state region. Total direct economic impacts from truck transportation of barley in the tri-state region were about $24.4 million annually (Table 4). About 26 percent of all barley shipped by country elevators was shipped by truck to market destinations. Trucking expenditures and returns accounted for about 52 percent of the direct impacts from barley transportation in the tri-state region.

Country elevators in North Dakota spent about $23.8 million annually to move barley by truck to various market destinations. Direct economic impacts in North Dakota from truck movements of barley were estimated to be $19.4 million, which included allocations of truck expenses for shipments of barley by truck from neighboring states to market destinations within North Dakota. From 1994 through 1996, about 26 percent (27.6 million bushels) of all barley shipped by country elevators in North Dakota was transported by truck to market destinations.

Country elevators in South Dakota spent about $218,000 annually to move barley by truck to various destinations. Direct economic impacts in South Dakota from truck movements of barley were estimated at $195,000 annually. South Dakota received no allocation of truck expenses for shipments of barley by truck from neighboring states since South Dakota provided no direct markets for shipments of barley from North Dakota and Minnesota. Miscellaneous market destinations for North Dakota and Minnesota shipments could contain South Dakota destinations although those possibilities were not addressed. From 1994 through 1996, about 37

percent (1 million bushels) of all barley shipped from country elevators in South Dakota was transported by truck.

Country elevators in Minnesota spent about $2.2 million annually to move barley by truck to various market destinations. Direct economic impacts in Minnesota from truck movements of barley by country elevators were estimated at $4.4 million, which included roughly $2.5 million in allocated expenses for shipments of barley by truck from North Dakota and South Dakota to market destinations within Minnesota. From 1994 through 1996, about 26 percent (7.3 million bushels) of all barley shipped by country elevators in Minnesota was transported by truck.

Terminal elevators in Minnesota spent about $400,000 annually to move barley by truck to various market destinations. Direct economic impacts in Minnesota from truck movements of barley by terminal elevators were estimated at $311,000 annually. From 1994 through 1996, about 6 percent (1.5 million bushels) of all barley (related to barley entering the marketing system from the tri-state region and weighted by shipment quantities from the Port of Duluth and Minneapolis/St. Paul markets) shipped by terminal elevators in Minnesota was transported by truck to various destinations. Truck transportation impacts generated by country and terminal elevators in Minnesota were estimated at $4.8 million annually.

**Table 4. Annual Direct Economic Impacts From Truck Transportation of North Dakota, South Dakota, and Minnesota Barley to Market Destinations, 1994 Through 1996**

| | Annual Direct Impacts from Truck Transportation | | | |
|---|---|---|---|---|
| Expenses | North Dakota | South Dakota | Minnesota | Total |
| | ---------- 000s $ ---------- | | | |
| Fuel and Lubrication | 2,604 | 26 | 638 | 3,268 |
| Labor | 4,904 | 49 | 1,200 | 6,153 |
| Tires | 710 | 7 | 174 | 891 |
| Repairs and Maintenance | 1,420 | 14 | 348 | 1,782 |
| Equipment | 4,566 | 46 | 1,118 | 5,730 |
| License and Taxes | 507 | 5 | 124 | 636 |
| Insurance | 1,606 | 16 | 394 | 2,016 |
| Mngt., Admin., and Comm. | 2,283 | 23 | 560 | 2,866 |
| Net Returns | 846 | 8 | 208 | 1,062 |
| Total Direct Impacts | 19,448 | 194 | 4,764 | 24,406 |

## Railroad Transportation

Railroads and rail transportation play major roles in the economies of most western states; the tri-state region is no exception. The availability and use of railroads are important to most industries, especially agriculture. Railroads can provide economical transportation of production inputs and commodities. Their impacts can be felt by the service they provide (i.e., the complex movement of production inputs and shipment of commodities to and from all areas of the United States) and by the economic activity they create in operation. The economic impacts of railroad transportation were estimated by determining expenses and returns generated in the transportation process.

Country elevators in North Dakota and South Dakota and country and terminal elevators in Minnesota spent about $70 million to ship about 129 million bushels of barley (101.3 million by country elevators and 17.8 million by terminal elevators) by rail to various destinations. Roughly one-third of all rail expenditures (i.e., dollars spent by country and terminal elevators) was allocated as direct impacts in the tri-state region. Total direct economic impacts from rail transportation of barley in the tri-state region were about $22.7 million annually (Table 4). About 74 percent of all barley shipped by country elevators was shipped by rail to market destinations. From 1994 through 1996, about 73 percent (17.8 million bushels) of all barley (only barley entering the marketing system from the tri-state region and weighted by shipment quantities from the Port of Duluth and Minneapolis/St. Paul markets) shipped by terminal elevators in Minnesota was transported by rail to market destinations. Railroad expenditures accounted for 48 percent of the direct impacts from barley transportation in the tri-state region.

Country elevators in North Dakota spent about $46 million annually to move barley by rail to various market destinations. Direct economic impacts in North Dakota from rail movements of barley were estimated at $14.3 million, which included minor allocations of railroad expenditures for shipments of barley by rail from neighboring states to market destinations within North Dakota and for shipments of barley by rail traveling through North Dakota (e.g., movements from Minnesota to the Pacific Northwest). From 1994 through 1996, about 74 percent (78.4 million bushels) of all barley shipped by country elevators in North Dakota was transported by rail to market destinations.

Country elevators in South Dakota spent about $1.2 million annually to move barley by rail to various market destinations. Direct economic impacts in South Dakota from rail movements of barley were estimated at $365,000 annually. South Dakota received no allocation of rail expenses for shipments of barley by rail from neighboring states since South Dakota provided no direct markets for shipments of barley from North Dakota and Minnesota. Also, shipments from other states through South Dakota were considered unlikely. Miscellaneous market destinations for North Dakota and Minnesota shipments could contain South Dakota destinations, although those possibilities were not addressed. From 1994 through 1996, about 63 percent (1.8 million bushels) of all barley shipped by country elevators in South Dakota was transported by rail to market destinations.

Country elevators in Minnesota spent about $13.3 million annually to move barley by rail to various market destinations. Direct economic impacts in Minnesota from rail movements of barley by country elevators were estimated at $5 million annually, which included allocations of rail expenses for shipments of barley by rail from North Dakota and South Dakota to market destinations within Minnesota. From 1994 through 1996, about 74 percent (21.1 million bushels) of all barley shipped by country elevators in Minnesota was transported by rail to market destinations.

Terminal elevators in Minnesota spent about $10 million annually to move barley by rail to additional market destinations (related to barley entering the marketing system which was produced in the tri-state region). Direct economic impacts in Minnesota from rail movements of barley by terminal elevators were estimated at $3 million annually.

**Table 5. Annual Direct Economic Impacts From Rail Transportation of Barley From North Dakota, South Dakota, and Minnesota Elevators to Market Destinations, 1994 Through 1996**

| | Annual Direct Impacts from Rail Transportation | | | |
|---|---|---|---|---|
| Expenses | North Dakota | South Dakota | Minnesota | Total |
| | ---------- 000s $ ---------- | | | |
| Train Crew | 4,512 | 115 | 2,456 | 7,083 |
| Locomotive | 2,413 | 62 | 1,313 | 3,788 |
| Rail Car | 2,209 | 56 | 1,202 | 3,467 |
| Transportation Charge | 1,183 | 30 | 644 | 1,857 |
| Maintenance of Way | 1,820 | 46 | 1,068 | 2,934 |
| Net Liquidation Value | 1,820 | 46 | 1,068 | 2,934 |
| Central Administration | 81 | 2 | 48 | 131 |
| Insurance | 48 | 1 | 28 | 77 |
| Property Taxes | 236 | 6 | 138 | 380 |
| Total Direct Impacts | 14,322 | 364 | 7,965 | 22,651 |

Processing

Agricultural processing is a key component of the farm-to-consumer food chain. In the case of barley, processing can include livestock feed, malt, and various human consumption products. This study limited the analysis of processing impacts to malting activities involving barley produced within the region. To aviod disclosing activities of any single malting plant, economic impacts from malt processing have been presented as a multi-state estimate.

Revenues and expenditures for malting activities in North Dakota and Minnesota were developed through industry sources and secondary data (U.S. Department of Commerce 1995; 1996; 1997) (Appendix B). Malting firms in the tri-state region processed about 69.1 million bushels of barley annually from 1994 through 1996, which represented about 93 percent of regional processing capacity. Average malting capacity from 1994 through 1996 in North Dakota and Minnesota was estimated at 956,000 metric tons of malt or about 74.4 million bushels of barley annually (Appendix B). Of the 69.1 million bushels malted annually from 1994 through 1996, about 73 percent or 50.3 million bushels was produced within the region (i.e., grown in one of the three study states). Direct economic impacts from malting activities, attributable to barley produced within the study region, were estimated at $58.3 million annually or about $1.16 per bushel malted (Table 6).

**Table 6. Annual Direct Economic Impacts From Barley Processing Activities in North Dakota and Minnesota, 1994 Through 1996**

| Budget Items[a] | Direct Impacts From Malting Activities |
|---|---|
| | --- 000s $ --- |
| Gross Revenue | 199,230 |
| Expenses: | |
| Barley Purchases | 140,884 |
| Utilities | 11,034 |
| Labor | 10,593 |
| Administrative Overhead | 7,945 |
| Depreciation | 7,503 |
| Plant & Equipment Maintenance | 3,972 |
| Property Tax | 2,207 |
| Manufacturing Expenses | 883 |
| Insurance | 883 |
| Contract Work | 804 |
| Lease/Rent Arrangements | 262 |
| Total Expenses (excluding barley) | 46,086 |
| Total Expenses (including barley) | 186,970 |
| Net Returns | 12,260 |
| Total Direct Impacts[b] | 58,346 |

[a] See Appendix B for complete budget.
[b] Net returns plus expenses (excluding barley purchases).

## Secondary Impacts

Secondary economic impacts result from subsequent rounds of spending and respending within an economy. Input-output (I-O) analysis traces linkages (i.e., the amount of spending and respending) among sectors of an economy and calculates the total business activity resulting from a direct impact in a basic sector (Coon et al. 1985). An economic sector is a group of similar economic units (e.g., communications and public utilities, retail trade, construction).

This process of spending and respending can be explained by using an example. A single dollar from an area wheat producer (**Households** sector) may be spent for a loaf of bread at the local store (**Retail Trade** sector); the store uses part of that dollar to pay for the next shipment of bread (**Transportation** and **Agricultural Processing** sectors) and part to pay the store employee (**Households** sector) who shelved or sold the bread; the bread supplier uses part of that dollar to

pay for the grain used to make the bread (**Agriculture-Crops** sector) ... and so on (Hamm et al. 1993).

Secondary economic impacts were estimated separately for barley production, grain handling, transportation, and processing. The following sections discuss the allocation of direct impacts to various economic sectors of the North Dakota Input-Output Model and the amount of secondary impacts generated in those economic sectors.

Barley Production

Barley production expenditures and returns were allocated to various economic sectors of the North Dakota Input-Output Model. Seed, herbicide, chemicals, fertilizer, fuel, lubrication, repairs, equipment expenses (depreciation and leases), building depreciation, and miscellaneous expenses were allocated to the **Retail Trade** sector. Insurance and interest expenses were allocated to the **Finance, Insurance, and Real Estate** (FIRE) sector. Custom hire expenses were allocated to the **Business and Personal Services** sector. The **Communication and Public Utilities** sector contained utility expenses. Dues and professional fees were allocated to the **Professional and Social Services** sector. Property taxes were allocated to the **Government** sector. Hired labor, cash rent, and returns to unpaid labor, management, and equity were allocated to the **Households** sector.

Total direct impacts of $445.8 million from barley production generated about $730.9 million in secondary impacts in the tri-state region (Table 7). Secondary impacts were greatest in the **Retail Trade** ($426 million) and **Households** ($396 million) sectors, followed by **Finance, Insurance, and Real Estate** ($117 million), **Government** ($44 million), and **Communication and Public Utilities** ($41 million) sectors. For every dollar in direct economic activity from barley production, another $1.64 was generated in secondary economic activity. Total economic impacts from barley production were about $1.176 billion and included the indirect support of 13,810 secondary full-time equivalent (FTE) jobs. Secondary jobs represent employment outside of those activities and services directly involved with barley production, but employment that is dependent on the existence of those activities.

**Table 7. Annual Direct, Secondary, and Total Economic Impacts of Barley Production in North Dakota, South Dakota, and Minnesota, by Economic Sector, 1994 Through 1996**

| Economic Sectors | Economic Impacts From Barley Production | | |
|---|---|---|---|
| | Direct | Secondary | Total |
| | ---------- 000s $ ---------- | | |
| Agriculture-Livestock | 0 | 33,014 | 33,104 |
| Agriculture-Crops | 0 | 13,193 | 13,193 |
| Nonmetal Mining | 0 | 1,701 | 1,701 |
| Construction | 0 | 25,879 | 25,879 |
| Transportation | 60 | 4,491 | 4,551 |
| Comm and Pub Util | 4,775 | 36,536 | 41,311 |
| Ag Proc and Misc Mnfg | 0 | 20,630 | 20,630 |
| Retail Trade | 211,128 | 215,047 | 426,175 |
| Fin, Ins, and R Estate | 70,450 | 47,062 | 117,512 |
| Bus and Pers Service | 6,199 | 18,471 | 24,670 |
| Prof and Soc Service | 1,954 | 25,982 | 27,936 |
| Households | 138,942 | 256,909 | 395,851 |
| Government | 12,258 | 32,013 | 44,271 |
| Total Impacts | 445,766 | 730,928 | 1,176,694 |
| Secondary Employment (full-time equivalent jobs) | | | 13,810 |

Grain Handling

Grain handling expenditures and returns were allocated to various economic sectors. Office supplies, equipment depreciation and repairs, supplies, crew expenditures, bunkers, general expenses, and 25 percent of dock transshipment expenses were allocated to the **Retail Trade** sector. Taxes and licenses, customs fees, and sanitary inspections were allocated to the **Government** sector. Insurance and interest expense were allocated to the **Finance, Insurance, and Real Estate** sector. Utilities and communication expenses were allocated to the **Communications and Public Utilities** sector. Expenses for tugs, mooring fees, garbage, cleaning, agency commission, and grain inspection services were allocated to the **Business and Personal Services** sector. Professional services expense was allocated the **Professional and Social Services** sector. Wharfage expense was allocated to the **Transportation** sector. Labor, stevedoring, 75 percent of dock transshipment, and line handling expenses were allocated to the **Households** sector.

Total direct impacts of $13.3 million from handling activities generated about $24.1 million in secondary impacts (Table 8). Secondary impacts were greatest in the **Households** ($8.4 million) and **Retail Trade** ($7.1 million) sectors. Secondary impacts from barley handling also affected the **Agriculture-Crops**, **Agriculture-Livestock**, and **Construction** sectors, three

sectors that had no direct impacts but had substantial secondary impacts. For every dollar in direct economic activity from grain handling, another $1.81 was generated in secondary economic activity. Total economic impacts from grain handling were about $37.4 million annually and included about 460 secondary FTE jobs.

Transportation

Expenditures and returns associated with barley transportation were allocated to various economic sectors. Fuel, lubrication, tires, repairs and maintenance, equipment, locomotive operation, rail car expenses, rail car and locomotive depreciation, food, supplies, and other expenses were allocated to the **Retail Trade** sector. Labor and central administration expenses were allocated to the **Households** sector. Property taxes and licenses were allocated to the **Government** sector. Insurance expense was allocated to the **Finance, Insurance, and Real Estate** sector. Communication expenses were allocated to the **Communications and Public Utilities** sector. General transportation expenses, maintenance-of-way costs, and net returns from truck transportation were allocated to the **Transportation** sector.

**Table 8. Annual Direct, Secondary, and Total Economic Impacts of Grain Handling Activities in North Dakota, South Dakota, and Minnesota, by Economic Sector, 1994 Through 1996**

| | Economic Impacts From Grain Handling | | |
|---|---|---|---|
| Economic Sectors | Direct | Secondary | Total |
| | ---------- 000s $ ---------- | | |
| Agriculture-Livestock | 0 | 905 | 905 |
| Agriculture-Crops | 0 | 500 | 500 |
| Nonmetal Mining | 0 | 57 | 57 |
| Construction | 0 | 857 | 857 |
| Transportation | 28 | 135 | 163 |
| Comm and Public Utilities | 1,001 | 1,206 | 2,207 |
| Ag Proc and Misc Mnfg | 218 | 738 | 956 |
| Retail Trade | 3,652 | 7,096 | 10,748 |
| Fin, Ins, and R Estate | 2,325 | 1,582 | 3,907 |
| Business and Pers Service | 550 | 623 | 1,173 |
| Prof and Social Service | 2 | 870 | 872 |
| Households | 4,945 | 8,400 | 13,345 |
| Government | 564 | 1,096 | 1,660 |
| Total Impacts | 13,285 | 24,065 | 37,350 |
| Secondary Employment (full-time equivalent jobs) | | | 460 |

Total direct impacts of $47.1 million from barley transportation generated about $74.9 million in secondary impacts (Table 9). Secondary impacts were greatest in the **Households** ($25.2 million) and **Retail Trade** ($22.4 million) sectors. Secondary impacts from transportation also affected the **Agriculture-Livestock**, **Construction**, and **Professional and Social Service** sectors, three sectors that had no direct impacts but had substantial secondary impacts. For every dollar in direct economic activity from transportation activities, another $1.59 was generated in secondary economic activity. Total economic impacts from barley transportation were about $122 million annually and included about 1,836 secondary FTE jobs.

**Table 9. Annual Direct, Secondary, and Total Economic Impacts of Barley Transportation in North Dakota, South Dakota, and Minnesota, by Economic Sector, 1994 Through 1996**

| | Economic Impacts From Grain Transportation | | |
|---|---|---|---|
| Economic Sectors | Direct | Secondary | Total |
| | ---------- 000s $ ---------- | | |
| Agriculture-Livestock | 0 | 3,406 | 3,406 |
| Agriculture-Crops | 0 | 1,295 | 1,295 |
| Nonmetal Mining | 0 | 208 | 208 |
| Construction | 0 | 2,645 | 2,645 |
| Transportation | 5,854 | 459 | 6,313 |
| Comm and Public Utilities | 981 | 3,634 | 4,615 |
| Ag Proc and Misc Mnfg | 0 | 1,958 | 1,958 |
| Retail Trade | 21,863 | 22,406 | 44,269 |
| Fin, Ins, and R Estate | 2,094 | 4,942 | 7,036 |
| Business and Pers Service | 0 | 1,812 | 1,812 |
| Prof and Social Service | 0 | 2,629 | 2,629 |
| Households | 15,252 | 25,175 | 40,427 |
| Government | 1,017 | 4,346 | 5,363 |
| Total Impacts | 47,061 | 74,915 | 121,976 |
| Secondary Employment (full-time equivalent jobs) | | | 1,836 |

Processing

Expenditures and returns were estimated using budgets developed from industry sources and secondary information. Contract work was allocated to the **Construction** sector. Processor net returns, 50 percent of manufacturing expenses, and 20 percent of plant and equipment maintenance expenses were allocated to the **Agricultural Processing and Miscellaneous Manufacturing** sector. Lease and rental arrangements, 40 percent of plant and equipment maintenance, and 15 percent of administrative overhead were allocated to the **Business and Personal Services** sector. Depreciation, 50 percent of manufacturing expenses, and 40 percent of

plant and equipment maintenance were allocated to the **Retail Trade** sector. Utilities and 5 percent of administrative overhead were allocated to the **Communications and Public Utilities** sector. Insurance and 10 percent of administrative overhead were allocated to the **Finance, Insurance, and Real Estate** sector. Labor and 70 percent of administrative overhead were allocated to the **Households** sector. Property taxes were allocated to the **Government** sector.

Total direct impacts of $58.3 million from barley processing activities generated about $121.8 million in secondary impacts (Table 10). Secondary impacts were greatest in the **Households** ($37.1 million) and **Retail Trade** ($30.7 million) sectors. For every dollar in direct economic activity from barley processing, another $2.09 was generated in secondary economic activity. Total economic impacts from barley processing were about $180 million and included about 2,348 secondary FTE jobs.

**Table 10. Annual Direct, Secondary, and Total Economic Impacts of Barley Processing Activities in North Dakota, South Dakota, and Minnesota, by Economic Sector, 1994 Through 1996**

| | Economic Impacts From Barley Processing | | |
|---|---|---|---|
| Economic Sectors | Direct | Secondary | Total |
| | ---------- 000s $ ---------- | | |
| Agriculture-Livestock | 0 | 5,196 | 5,196 |
| Agriculture-Crops | 0 | 9,778 | 9,778 |
| Nonmetal Mining | 0 | 294 | 294 |
| Construction | 804 | 3,699 | 4,503 |
| Transportation | 0 | 641 | 641 |
| Comm and Public Utilities | 11,432 | 4,999 | 16,431 |
| Ag Proc and Misc Mnfg | 13,495 | 11,572 | 25,067 |
| Retail Trade | 9,533 | 30,662 | 40,195 |
| Fin, Ins, and R Estate | 1,677 | 6,975 | 8,652 |
| Business and Pers Service | 3,043 | 2,559 | 5,602 |
| Prof and Social Service | 0 | 3,487 | 3,487 |
| Households | 16,154 | 37,148 | 53,302 |
| Government | 2,206 | 4,793 | 6,999 |
| Total Impacts | 58,344 | 121,803 | 180,147 |
| Secondary Employment (full-time equivalent jobs) | | | 2,348 |

## Employment

The barley industry benefits the economy by creating and supporting direct and secondary employment. Direct employment is a measure of the number of full-time jobs within an industry. Secondary jobs are an estimate of employment outside of an industry, but employment that is created from the industry's economic activity.

### Direct Employment

Direct employment in the barley industry is extremely difficult to quantify. Many of the positions (employment) affiliated with the barley industry (i.e., those outside of production) exist in other industries. Employment at local elevators is part of the grain handling business; jobs in shipping and hauling barley are part of the transportation industry. In each case, some jobs might disappear without the barley industry, while others may not be affected. For example, an elevator that relies on barley for a major portion of its grain handling activities might reduce its work force if it no longer handled barley, providing it could not make up for the loss in grain handling with other commodities or agricultural activities.

However, the issue is not that simple. If barley were no longer produced, some alternative commodity likely would be raised in its place and likely would be marketed and handled by grain elevators. Thus, local elevators would change from handling and shipping barley to handling and shipping the alternative commodity. The effects on employment are unclear.

Employment-related questions in transportation are similar. For example, independently employed truck drivers who haul farm commodities likely would remain employed in the absence of barley, but seek alternative hauling opportunities with other commodities. Even in the case where barley is the only commodity hauled, alternative commodities raised in the place of barley likely would provide similar shipping opportunities. Thus, most of the jobs outside of barley production are within industries that are supported only in part by the barley industry. This makes estimating direct employment extremely difficult. The barley industry does directly affect jobs in grain handling and transportation; however, no strong basis exists for quantification of those jobs.

Direct employment (full-time equivalent jobs) in barley production is also difficult to quantify. Approximately 22,480 farms or 16 percent of the 140,260 farms in the tri-state region raised some barley in 1992 (U.S. Department of Commerce 1994a; 1994b; 1994c). Of the 105,200 farms in the region having sales over $10,000, 17 percent (18,240 farms) raised some barley in 1992.

In North Dakota, about 13,980 farms or 45 percent of all farms raised some barley in 1992. Of the 25,430 farms in North Dakota that had sales over $10,000 in 1992, about 12,130 farms (48 percent) raised some barley (U.S. Department of Commerce 1994b). In Minnesota, about 5,200 farms or 7 percent of all farms raised some barley in 1992. Of the 52,940 farms in Minnesota that had sales over $10,000 in 1992, about 3,870 farms (7 percent) raised some barley (U.S. Department of Commerce 1994a). In South Dakota, about 3,290 farms or 10 percent of all farms raised some barley in 1992. Of the 26,830 farms in South Dakota that had sales over

$10,000 in 1992, about 2,240 farms (8 percent) raised some barley (U.S. Department of Commerce 1994c).

The number of full-time equivalent (FTE) positions that could be attributable to barley production from the 140,260 farms in the tri-state region is nearly impossible to estimate, given the scope of this study. Unless those farms raised only barley each year, the time spent raising barley usually would be less than a full-time job. The degree of time or fraction of employment for any particular farmer raising barley varies nearly every year. An estimate of the number of full-time jobs would require knowing the number of people employed by those farms and the fraction of employment devoted to barley production for each worker. Also, many farmers, even in the absence of barley, likely would remain employed raising other crops.

Employment in malting activities and processing of barley into human food was obtained from processing companies. Barley processors were estimated to employ 431 FTE positions in the tri-state region. Employment by state was withheld to avoid disclosing activities of individual firms.

Secondary Employment

Secondary employment estimates represent the number of full-time jobs generated based on the volume of business activity created by an industry. Productivity ratios[3] were used with estimates of business activity to obtain secondary employment. Barley production indirectly supported about 13,810 FTE secondary jobs in the tri-state region. Grain handling activities indirectly supported about 460 FTE secondary jobs. Transportation of barley in the study region generated about 1,836 FTE secondary jobs. Barley processing in the region indirectly supported about 2,348 FTE secondary jobs. All barley activities combined in the tri-state region supported about 18,454 FTE secondary jobs.

## Tax Revenue

Tax collections are another important measure of the economic impact of an industry on an economy. Tax implications are an increasingly important measure of local and state-level impacts. Some of the interest in estimating tax revenue generated by an industry stems from public awareness of the importance of tax revenue to local and state governments. In an era of reduced federal funding, revenue shortfalls, and growing public demand on governments to balance their budgets while providing constant or increased levels of services and benefits, tax collections are an important factor in assessing economic impacts.

Business activity alone does not directly support local government functions; however, taxes on personal income, retail trade, real estate property, and corporate income are important revenue sources for local and state governments. Total economic impacts in the **Retail Trade** sector were used to estimate revenue from sales and use taxes. Economic activity in the **Households** sector was used to estimate personal income tax collections. Similarly, corporate

[3]A measure of the amount of economic activity needed in an economic sector to support one full-time job within that sector.

income tax revenue was estimated from the economic activity in all business sectors (excluding the **Households**, **Government**, and **Agriculture** sectors).

Input-output analysis was used to estimate personal income, retail trade, and other business activity, which was used to estimate tax revenue. Estimated tax revenue generated by the barley industry in the tri-state region included $20.7 million in sales and use taxes, $8.7 million in personal income taxes, and $2.5 million in corporate income taxes annually from 1994 through 1996 (Table 11). Total collections from sales and use, personal income, and corporate income taxes in the region were about $32 million annually. Barley production also was directly responsible for about $12.3 million in property taxes annually in the region. Property tax collections from transportation and processing activities were estimated at $2.6 million annually. When property tax collections and revenues from sales and use, personal income, and corporate income taxes are combined, the barley industry generated $46.8 million in annual tax revenues in the region. Property taxes were included as part of the direct impacts.

**Table 11. Estimated Annual Tax Collections Generated From the Economic Activity Created by the Barley Industry in North Dakota, South Dakota, and Minnesota, 1994 Through 1996**

| Tax | Estimated Tax Collections |
|---|---|
| | ------ 000s $ ------ |
| Sales and Use | 20,740 |
| Personal Income | 8,690 |
| Corporate Income | 2,540 |
| Total Taxes | 31,970 |

## Total Economic Impacts

The general objective of the study was to measure the economic activity of the barley industry in the tri-state region of North Dakota, South Dakota, and Minnesota and estimate the impacts in each study state. The following section is divided into cumulative impacts by industry activity and total impacts in each individual state.

### Cumulative Industry Impacts

Total annual direct impacts from barley production in the tri-state region were estimated at $445.8 million annually from 1994 through 1996. Grain handling, transportation, and processing activities generated an additional $118.7 million in annual direct impacts. The barley industry generated about $564.5 million in annual direct impacts in North Dakota, South Dakota,

and Minnesota from 1994 through 1996. Business activity was greatest in the **Retail Trade** ($246 million), **Households** ($175 million), **Finance, Insurance, and Real Estate** ($76 million), **Communication and Public Utilities** ($18 million), and **Government** ($16 million) sectors (Table 12).

**Table 12. Direct Impacts of the Barley Industry to the Regional Economy of North Dakota, South Dakota, and Minnesota, by Economic Sector and Industry Activity, 1994 Through 1996**

| | Total Direct Impacts by Industry Activity | | | | |
|---|---|---|---|---|---|
| Economic Sector | Barley Production | Transpor-tation | Grain Handling | Proc-essing | Total Direct |
| | 000s $ | | | | |
| Agriculture-Livestock | 0 | 0 | 0 | 0 | 0 |
| Agriculture-Crops | 0 | 0 | 0 | 0 | 0 |
| Nonmetal Mining | 0 | 0 | 0 | 0 | 0 |
| Construction | 0 | 0 | 0 | 804 | 804 |
| Transportation | 60 | 5,854 | 28 | 0 | 5,942 |
| Comm and Pub Util | 4,775 | 981 | 1,001 | 11,432 | 18,189 |
| Ag Proc and Misc Mnfg | 0 | 0 | 218 | 13,495 | 13,713 |
| Retail Trade | 211,128 | 21,863 | 3,652 | 9,533 | 246,176 |
| Fin, Ins, and R Estate | 70,450 | 2,094 | 2,325 | 1,677 | 76,546 |
| Bus and Pers Service | 6,199 | 0 | 550 | 3,043 | 9,792 |
| Prof and Soc Service | 1,954 | 0 | 2 | 0 | 1,956 |
| Households | 138,942 | 15,252 | 4,945 | 16,154 | 175,293 |
| Government | 12,258 | 1,017 | 564 | 2,206 | 16,045 |
| Total Direct Impacts | 445,766 | 47,061 | 13,285 | 58,344 | 564,456 |

Annual secondary impacts from barley production in the tri-state region from 1994 through 1996 were estimated at $731 million (Table 13). Grain handling, transportation, and processing activities generated an additional $221 million in annual secondary impacts. The barley industry generated about $952 million in annual secondary impacts in North Dakota, South Dakota, and Minnesota from 1994 through 1996. The economic areas of the regional economy with the greatest secondary impacts included the **Households** ($328 million), **Retail Trade** ($275 million), **Finance, Insurance, and Real Estate** ($61 million), **Communication and Public Utilities** ($46 million), **Agriculture-Livestock** ($43 million), and **Government** ($42 million) sectors (Table 13). Overall, each dollar of direct impacts from the barley industry generated about $1.69 in secondary impacts.

Secondary employment estimates represent the number of full-time jobs generated based on the volume of business activity created by the industry. Barley activities in the region indirectly supported about 18,450 FTE secondary jobs. In addition to direct employment in barley processing and secondary employment, the barley industry directly influences employment in grain handling and transportation. Direct employment from barley processing was estimated at 431 FTE jobs.

Annual total (direct and secondary) economic impacts from barley production expenditures and returns in the tri-state region were estimated at $1.2 billion. Grain handling, transportation, and processing activities generated an additional $339 million in annual economic impacts. All barley industry activities generated a total economic impact of $1.5 billion annually in the region from 1994 through 1996 (Table 14).

The economic sectors with the greatest impacts included **Retail Trade** ($521 million), **Households** ($503 million), **Finance, Insurance, and Real Estate** ($137 million), **Communication and Public Utilities** ($65 million), and **Government** ($58 million) (Table 14).

**Table 13. Secondary Impacts of the Barley Industry to the Regional Economy of North Dakota, South Dakota, and Minnesota, by Economic Sector and Industry Activity, 1994 Through 1996**

| | Total Secondary Impacts by Industry Activity | | | | |
|---|---|---|---|---|---|
| Economic Sector | Barley Production | Transpor-tation | Grain Handling | Proc-essing | Total Secondary |
| | 000s $ | | | | |
| Agriculture-Livestock | 33,014 | 3,406 | 905 | 5,196 | 42,521 |
| Agriculture-Crops | 13,193 | 1,295 | 500 | 9,778 | 24,766 |
| Nonmetal Mining | 1,701 | 208 | 57 | 294 | 2,260 |
| Construction | 25,879 | 2,645 | 857 | 3,699 | 33,080 |
| Transportation | 4,491 | 459 | 135 | 641 | 5,726 |
| Comm and Pub Util | 36,536 | 3,634 | 1,206 | 4,999 | 46,375 |
| Ag Proc and Misc Mnfg | 20,630 | 1,958 | 738 | 11,572 | 34,898 |
| Retail Trade | 215,047 | 22,406 | 7,096 | 30,662 | 275,211 |
| Fin, Ins, and R Estate | 47,062 | 4,942 | 1,582 | 6,975 | 60,561 |
| Bus and Pers Service | 18,471 | 1,812 | 623 | 2,559 | 23,465 |
| Prof and Soc Service | 25,982 | 2,629 | 870 | 3,487 | 32,968 |
| Households | 256,909 | 25,175 | 8,400 | 37,148 | 327,632 |
| Government | 32,013 | 4,346 | 1,096 | 4,793 | 42,248 |
| Total Secondary Impacts | 730,928 | 74,915 | 24,065 | 121,803 | 951,711 |

**Table 14. Total (Direct and Secondary) Impacts of the Barley Industry to the Regional Economy of North Dakota, South Dakota, and Minnesota by Economic Sector and Industry Activity, 1994 Through 1996**

| | Total Economic Impacts by Industry Activity | | | | |
|---|---|---|---|---|---|
| Economic Sector | Barley Production | Transpor-tation | Grain Handling | Proc-essing | Total Impacts |
| | ---------- 000s $ ---------- | | | | |
| Agriculture-Livestock | 33,014 | 3,406 | 905 | 5,196 | 42,521 |
| Agriculture-Crops | 13,193 | 1,295 | 500 | 9,778 | 24,766 |
| Nonmetal Mining | 1,701 | 208 | 57 | 294 | 2,260 |
| Construction | 25,879 | 2,645 | 857 | 4,503 | 33,884 |
| Transportation | 4,551 | 6,313 | 163 | 641 | 11,668 |
| Comm and Pub Util | 41,311 | 4,615 | 2,207 | 16,431 | 64,564 |
| Ag Proc and Misc Mnfg | 20,630 | 1,958 | 956 | 25,067 | 48,611 |
| Retail Trade | 426,175 | 44,269 | 10,748 | 40,195 | 521,387 |
| Fin, Ins, and R Estate | 117,512 | 7,036 | 3,907 | 8,652 | 137,107 |
| Bus and Pers Service | 24,670 | 1,812 | 1,173 | 5,602 | 33,257 |
| Prof and Soc Service | 27,936 | 2,629 | 872 | 3,487 | 34,294 |
| Households | 395,851 | 40,427 | 413,345 | 53,302 | 502,293 |
| Government | 44,271 | 5,363 | 1,660 | 6,999 | 58,293 |
| Total Economic Impacts | 1,176,694 | 121,976 | 37,350 | 180,147 | 1,516,167 |
| Secondary Employment | 13,810 | 1,836 | 460 | 2,348 | 18,454 |
| Share of Total Economic Activity | 77.6% | 8.0% | 2.5% | 11.9% | |

Each acre of barley planted in the tri-state region (1994 through 1996) generated about $458 in total economic activity (direct and secondary economic impacts) or, expressed alternatively, each bushel of barley produced resulted in $9.21 in total business activity in the region. For every 180 acres of barley planted or 8,923 bushels of barley harvested, one secondary FTE job was supported within the tri-state region. On average, each acre of barley planted generated about $13.35 in tax revenue within the region ($3.70 in property tax and $9.65 in combined sales and use, personal income, and corporate income taxes).

Impacts by State

Economic activity created by the barley industry was compiled for each state. Of the annual economic activity generated by the barley industry in the tri-state region from 1994 through 1996, North Dakota had over 70 percent of the total. The total economic activity from the barley industry in North Dakota was estimated to exceed $1 billion annually (Table 15). North Dakota accounted for 75 percent of the planted barley acreage in the tri-state region. Minnesota, averaging 18 percent of the planted barley acreage in the region, had nearly 25 percent of the industry's total economic activity. The total economic activity from the barley industry in Minnesota was estimated at $370 million annually (Table 15). South Dakota, which contained the least amount of barley acreage (7 percent), also had the least amount of economic activity from the barley industry ($70 million annually) (Table 15).

**Table 15. Average Annual Economic Impacts of the Barley Industry, by State, 1994 Through 1996**

| Economic Indicators | North Dakota | South Dakota | Minnesota |
|---|---|---|---|
| Planted Acreage | 2,483,333 | 226,667 | 603,333 |
| % of Total Acreage | 74.9 | 6.8 | 18.2 |
| | ---------- | 000s $ | ---------- |
| Direct Impacts | 401,492 | 26,974 | 135,990 |
| Total Impacts | 1,074,603 | 70,236 | 371,328 |
| % of Total Impacts | 70.9 | 4.6 | 24.5 |
| Tax Revenue[a] | | | |
| Sales and Use | 17,300 | 760 | 2,680 |
| Individual Income | 4,700 | na | 3,990 |
| Corporate Income | 1,900 | na | 640 |
| Total | 23,900 | 760 | 7,310 |
| | ---------- | FTE | ---------- |
| Secondary Employment | 12,953 | 825 | 4,676 |

[a] Property tax collections were included as direct impacts.
na--not applicable.

## SUMMARY

The contribution of agriculture to the economy of the upper Great Plains has been well documented; however, the economic significance of specific economic activities within the agricultural sector are less understood. Barley, a crop well suited to the general growing conditions of the upper Great Plains, is an important regional crop. Based on acreage planted, barley is the fourth most important crop in the region. In North Dakota, barley is second only to wheat in acreage planted and crop value. North Dakota also has been the predominate barley

producing state over the last 50 years. In South Dakota, barley is much less important than in North Dakota and Minnesota; however, the crop still plays a role providing feed to the state's livestock industry. In Minnesota, barley is the fourth most important crop, based on acreage planted. Unlike South Dakota and North Dakota, production in Minnesota is largely concentrated in the northwestern part of the state, intensifying its economic importance to the economy of that region. The tri-state region of North Dakota, South Dakota, and Minnesota accounted for nearly 44 percent of U.S. barley production from 1994 through 1996. In addition to being an important source of barley production in the U.S., processing facilities in Minnesota and North Dakota account for about 40 percent of the industry's total processing capacity in the United States.

An analysis of the economic impacts from the barley industry was limited to barley produced in the tri-state region and included in-state expenditures and returns from barley transportation, handling, and processing. Barley acreage and yields and production expenses and returns were used to estimate the economic activity from barley production. Commodity flow information was used to determine the amount of barley shipped to various market destinations. Barley movements were combined with truck and rail transportation costs and returns to estimate the economic impacts from barley shipments. Grain handling costs and returns were estimated to determine the economic activity from barley handling activities. Economic impacts from barley processing were limited to malting activities in the region.

Barley production in the region averaged 3.3 million acres and 165 million bushels from 1994 through 1996. Barley yields, averaged across the three states, were about 52 bushels per planted acre. Annual direct impacts (producer expenditures and returns) from barley production were estimated at $446 million or about $135 per acre. The $446 million in direct impacts from barley production generated another $731 million in secondary economic impacts.

Annual direct impacts from handling barley at country (local) and terminal elevators in the region were estimated at about $13 million. Secondary impacts resulting from grain handling activities were estimated at $24 million.

Annual regional expenditures and returns from transporting barley from country and terminal elevators to various market destinations were estimated at $47 million. The direct economic impacts from transportation activities generated another $75 million in secondary impacts.

Annual direct economic impacts generated by malting activities in North Dakota and Minnesota were estimated at about $58 million. Malting activities, limited to barley produced in the region, generated another $122 million in secondary economic impacts.

Annual economic impacts from all barley activities were estimated at $1.5 billion in the tri-state region. Barley production accounted for 78 percent, grain handling accounted for 2 percent, transportation accounted for about 8 percent, and processing activities accounted for 12 percent of all economic impacts.

The barley industry, through economic activity created by barley production, handling, transportation, and processing, indirectly supported about 18,450 full-time equivalent secondary

jobs. Secondary jobs represent employment outside the barley industry, but employment that is dependent on the existence of the barley industry. Barley processing activities directly support about 431 full-time equivalent jobs annually.

In addition to secondary employment, economic activity associated with the barley industry generated annual tax revenues of $20.7 million, $8.7 million, and $2.5 million from sales and use, personal income, and corporate income taxes, respectively. The barley industry also was estimated to be directly responsible for about $14.8 million in property tax collections. Total taxes generated by the barley industry, including property taxes, were estimated at $46.8 million annually.

The amount of economic activity in North Dakota, South Dakota, and Minnesota paralleled the amount of barley acreage in each state. Nearly 75 percent of the region's barley acreage was in North Dakota. Total economic impacts from the barley industry in North Dakota were $1.075 billion annually, which represented 71 percent of the industry's regional impact. Similarly, Minnesota accounted for about 18 percent of the region's barley acreage and generated 25 percent of the industry's regional impact. The barley industry in Minnesota was estimated to generate $371 million annually in economic activity. Minnesota's share of the regional impact was higher than its share of acreage since the state captured extra economic activity at terminal ports and processing facilities in the state. South Dakota accounted for 7 percent of total barley acreage in the region, but only generated 4 percent ($70 million) of the industry's regional impact.

## CONCLUSIONS

Barley is an important crop in the upper Great Plains, especially throughout North Dakota and in northwestern Minnesota. Barley in Minnesota is a regional crop, which concentrates the economic impacts in one geographic area. Thus, even though the state-level impacts are not as large as those in North Dakota, barley is of equal importance in the northwest region of the state. To a lesser extent, other areas of Minnesota benefit from the barley industry as well, such as Duluth and Minnesota/St. Paul. Minnesota benefits from having a substantial portion of the U.S. malting industry's processing activities located within the state.

In North Dakota, barley is not a regional crop, but rather is one that is produced in substantial quantities throughout the state. The statewide nature of barley production in North Dakota changes the complexion of the impacts. Barley is a bigger component (measured both in absolute terms and relative share) of the crop mix in North Dakota than in Minnesota or South Dakota. Thus, barley activities have added importance to the composition of the agriculture sector. Given that North Dakota is dependent upon agriculture for much of its economic livelihood, the barley industry plays a key role in the state's economy.

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# APPENDIX A

## Barley Production, Yield, and Acreage by County, North Dakota, South Dakota, and Minnesota, 1994 Through 1996

**Appendix Table A1. Barley Production, by County and Production Region, North Dakota, Average 1994 Through 1996**

| County/Production Region | Acres Planted | Acres Harvested | Production | Yield per Planted Acre |
|---|---|---|---|---|
| | | | bu | |
| Burke | 30,333 | 29,933 | 1,405,000 | 46.9 |
| Divide | 16,333 | 15,767 | 652,333 | 41.4 |
| Mountrail | 25,000 | 24,900 | 1,331,667 | 53.5 |
| Renville | 87,000 | 86,367 | 4,675,333 | 54.1 |
| Ward | 87,633 | 86,633 | 4,844,833 | 55.9 |
| Williams | 20,300 | 19,333 | 749,000 | 38.7 |
| NORTHWEST | 266,600 | 262,933 | 13,658,167 | 51.9 |
| Benson | 97,300 | 96,033 | 4,929,000 | 51.3 |
| Bottineau | 131,667 | 131,400 | 6,922,000 | 52.7 |
| McHenry | 48,667 | 47,800 | 2,378,000 | 49.7 |
| Pierce | 54,333 | 53,100 | 2,556,000 | 48.1 |
| Rolette | 58,000 | 55,633 | 2,819,667 | 50.7 |
| NORTH CENTRAL | 389,967 | 383,967 | 19,604,667 | 51.1 |
| Cavalier | 185,000 | 182,700 | 10,298,000 | 56.4 |
| Grand Forks | 106,667 | 104,967 | 5,989,000 | 57.1 |
| Nelson | 73,333 | 72,133 | 3,656,667 | 50.7 |
| Pembina | 68,000 | 66,467 | 4,145,667 | 62.4 |
| Ramsey | 114,000 | 110,800 | 5,609,667 | 50.6 |
| Towner | 94,667 | 93,167 | 4,530,667 | 48.6 |
| Walsh | 71,633 | 71,067 | 4,208,167 | 59.2 |
| NORTHEAST | 713,300 | 701,300 | 38,437,833 | 54.8 |
| Dunn | 21,000 | 19,300 | 767,000 | 39.7 |
| McKenzie | 22,600 | 20,300 | 790,000 | 38.9 |
| McLean | 46,967 | 46,367 | 2,206,500 | 47.6 |
| Mercer | 7,667 | 7,433 | 289,333 | 38.9 |
| Oliver | 15,000 | 14,500 | 642,000 | 44.3 |
| WEST CENTRAL | 113,233 | 107,900 | 4,694,833 | 43.5 |
| Eddy | 21,967 | 21,433 | 1,089,500 | 50.8 |
| Foster | 28,333 | 26,833 | 1,444,333 | 53.8 |
| Kidder | 11,000 | 10,367 | 417,667 | 40.3 |
| Sheridan | 30,000 | 29,200 | 1,255,000 | 43.0 |
| Stutsman | 70,333 | 68,167 | 3,642,667 | 53.4 |
| Wells | 75,000 | 73,967 | 4,215,333 | 57.0 |
| CENTRAL | 236,633 | 229,967 | 12,064,500 | 52.5 |
| Barnes | 115,000 | 113,567 | 6,256,000 | 55.1 |
| Cass | 91,633 | 89,933 | 5,521,667 | 61.4 |
| Griggs | 56,000 | 54,733 | 2,872,000 | 52.5 |
| Steele | 67,333 | 64,500 | 3,448,667 | 53.5 |
| Traill | 83,333 | 80,233 | 4,619,000 | 57.6 |
| Other | 33 | 33 | 2,667 | 80.0 |
| EAST CENTRAL | 413,333 | 403,000 | 22,720,000 | 56.4 |

- continued -

**Appendix Table A1. Continued**

| County/Production Region | Acres Planted | Acres Harvested | Production | Yield per Planted Acre |
|---|---|---|---|---|
| | | | bu | |
| Adams | 12,667 | 10,300 | 373,333 | 36.2 |
| Billings | 3,333 | 3,133 | 134,667 | 43.0 |
| Bowman | 13,000 | 11,133 | 415,333 | 37.3 |
| Golden Valley | 19,967 | 17,233 | 618,667 | 35.9 |
| Hettinger | 17,000 | 16,600 | 721,667 | 43.5 |
| Slope | 12,000 | 11,567 | 502,667 | 43.5 |
| Stark | 28,667 | 28,000 | 1,041,667 | 37.2 |
| SOUTHWEST | 106,633 | 97,967 | 3,808,000 | 38.9 |
| Burleigh | 14,133 | 12,833 | 495,500 | 38.6 |
| Emmons | 25,667 | 22,733 | 975,667 | 42.9 |
| Grant | 23,967 | 21,767 | 704,167 | 32.4 |
| Morton | 37,133 | 33,667 | 1,301,333 | 38.7 |
| Sioux | 2,333 | 1,900 | 56,333 | 29.6 |
| SOUTH CENTRAL | 103,233 | 92,900 | 3,533,000 | 38.0 |
| Dickey | 16,967 | 16,900 | 794,667 | 47.0 |
| LaMoure | 33,667 | 32,600 | 1,770,667 | 54.3 |
| Logan | 20,833 | 20,233 | 858,000 | 42.4 |
| McIntosh | 16,500 | 15,400 | 616,000 | 40.0 |
| Ransom | 21,333 | 21,133 | 1,093,667 | 51.8 |
| Richland | 15,800 | 15,567 | 930,000 | 59.7 |
| Sargent | 14,667 | 14,267 | 785,667 | 55.1 |
| Other | 233 | 233 | 18,000 | 77.1 |
| SOUTHEAST | 140,000 | 136,333 | 6,866,667 | 50.4 |
| Other | 400 | 400 | 29,000 | 72.5 |
| STATE | 2,483,333 | 2,416,667 | 125,416,667 | 51.9 |

Source: North Dakota Agricultural Statistics Service.

**Appendix Table A2. Barley Production, by County and Production Region, South Dakota, Average 1994 Through 1996**

| County/Production Region | Acres Planted | Acres Harvested | Production | Yield per Planted Acre |
|---|---|---|---|---|
| | | | bu | |
| Butte | 1,400 | 1,067 | 28,067 | 26.3 |
| Corson | 6,033 | 5,167 | 167,833 | 32.5 |
| Dewey | 2,500 | 1,933 | 65,800 | 34.0 |
| Harding | 8,600 | 6,567 | 235,700 | 35.9 |
| Perkins | 17,200 | 15,933 | 584,000 | 36.7 |
| Ziebach | 1,967 | 1,833 | 52,333 | 28.5 |
| Other | 1,800 | 1,300 | 28,600 | 22.0 |
| NORTHWEST | 39,500 | 33,800 | 1,162,333 | 34.4 |
| Brown | 15,133 | 13,733 | 651,067 | 47.4 |
| Campbell | 10,300 | 9,933 | 452,800 | 45.6 |
| Edmunds | 11,867 | 10,667 | 435,833 | 40.9 |
| Faulk | 8,400 | 7,900 | 303,400 | 38.4 |
| McPherson | 15,533 | 14,033 | 535,367 | 38.1 |
| Potter | 8,033 | 7,467 | 288,967 | 38.7 |
| Spink | 5,100 | 4,900 | 228,267 | 46.6 |
| Walworth | 6,467 | 5,533 | 259,433 | 46.9 |
| NORTH CENTRAL | 80,833 | 74,167 | 3,155,133 | 42.5 |
| Clark | 1,667 | 1,333 | 48,533 | 36.4 |
| Codington | 7,267 | 7,067 | 356,667 | 50.5 |
| Day | 11,700 | 10,967 | 536,700 | 48.9 |
| Deuel | 1,933 | 1,733 | 86,967 | 50.2 |
| Grant | 833 | 800 | 44,000 | 55.0 |
| Hamlin | 733 | 700 | 32,900 | 47.0 |
| Marshall | 5,400 | 5,100 | 256,567 | 50.3 |
| Roberts | 17,300 | 16,833 | 822,933 | 48.9 |
| Other | 833 | 800 | 43,000 | 53.8 |
| NORTHEAST | 47,667 | 45,333 | 2,228,267 | 49.2 |
| Haakon | 1,033 | 800 | 27,167 | 34.0 |
| Meade | 4,267 | 3,900 | 85,533 | 21.9 |
| Pennington | 1,367 | 1,267 | 35,733 | 28.2 |
| Stanley | 433 | 267 | 6,933 | 26.0 |
| Other | 1,233 | 1,067 | 31,100 | 29.2 |
| WEST CENTRAL | 8,333 | 7,300 | 186,467 | 25.5 |

- continued -

**Appendix Table A2. Continued**

| County/Production Region | Acres Planted | Acres Harvested | Production | Yield per Planted Acre |
|---|---|---|---|---|
| | | | bu | |
| Aurora | 3,033 | 2,833 | 119,633 | 42.2 |
| Beadle | 800 | 733 | 28,600 | 39.0 |
| Brule | 2,567 | 2,433 | 101,833 | 41.8 |
| Buffalo | 500 | 467 | 22,867 | 49.0 |
| Hand | 9,433 | 7,567 | 297,933 | 39.4 |
| Hughes | 200 | 100 | 4,000 | 40.0 |
| Hyde | 3,133 | 3,033 | 95,333 | 31.4 |
| Jerauld | 1,800 | 1,633 | 65,433 | 40.1 |
| Sully | 700 | 667 | 20,667 | 31.0 |
| Other | 2,833 | 2,600 | 82,400 | 31.7 |
| CENTRAL | 25,000 | 22,067 | 838,700 | 38.0 |
| Brookings | 1,500 | 1,233 | 46,333 | 37.6 |
| Davison | 1,267 | 1,233 | 55,767 | 45.2 |
| Hanson | 1,567 | 1,467 | 76,600 | 52.2 |
| Kingsbury | 1,700 | 1,633 | 68,600 | 42.0 |
| Lake | 633 | 533 | 24,000 | 45.0 |
| McCook | 933 | 700 | 32,900 | 47.0 |
| Miner | 1,467 | 1,433 | 67,400 | 47.0 |
| Sanborn | 500 | 467 | 15,400 | 33.0 |
| Other | 1,700 | 1,500 | 62,767 | 41.8 |
| EAST CENTRAL | 11,267 | 10,200 | 449,767 | 44.1 |
| Bennett | 767 | 700 | 20,300 | 29.0 |
| Shannon | 267 | 233 | 8,633 | 37.0 |
| Other | 2,367 | 1,933 | 50,733 | 26.2 |
| SOUTHWEST | 3,400 | 2,867 | 79,667 | 27.8 |
| Gregory | 1,267 | 1,167 | 55,533 | 47.6 |
| Todd | 267 | 233 | 7,467 | 32.0 |
| Tripp | 1,233 | 1,167 | 43,000 | 36.9 |
| Other | 1,567 | 1,033 | 30,767 | 29.8 |
| SOUTH CENTRAL | 4,333 | 3,600 | 136,767 | 38.0 |
| Bon Homme | 300 | 267 | 12,533 | 47.0 |
| Charles Mix | 1,167 | 1,100 | 55,500 | 50.5 |
| Douglas | 1,600 | 1,500 | 55,500 | 37.0 |
| Hutchinson | 1,067 | 1,000 | 46,200 | 46.2 |
| Union | 200 | 167 | 10,000 | 60.0 |
| Other | 2,000 | 1,633 | 76,500 | 46.8 |
| SOUTHEAST | 6,333 | 5,667 | 256,233 | 45.2 |
| STATE | 226,667 | 205,000 | 8,493,333 | 41.4 |

Source: South Dakota Agricultural Statistics Service.

**Appendix Table A3. Barley Production, by County and Production Region, Minnesota, Average 1994 Through 1996**

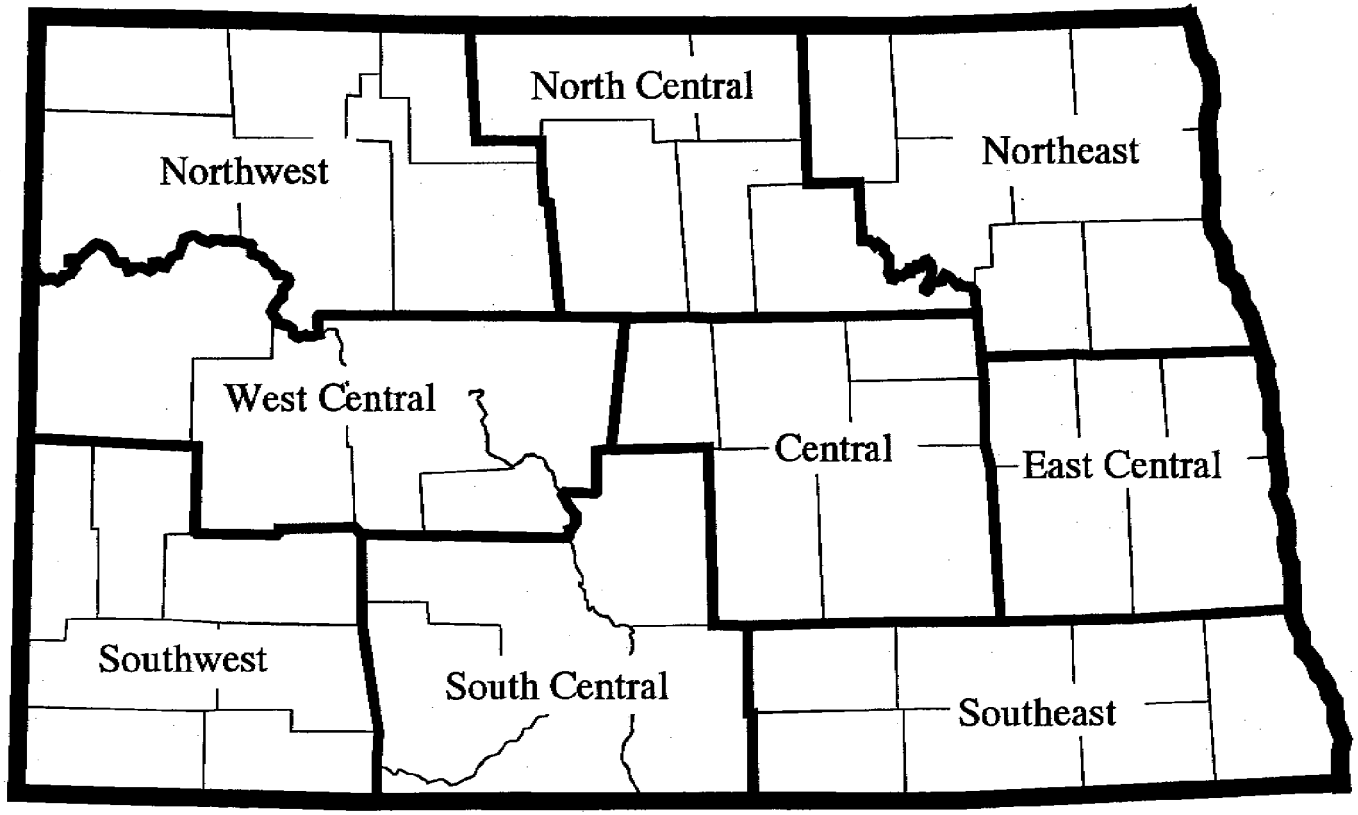
| County/Production Region | Acres Planted | Acres Harvested | Production | Yield per Planted Acre |
|---|---|---|---|---|
| | | | bu | |
| Becker | 16,467 | 15,533 | 704,467 | 45.4 |
| Clay | 40,100 | 38,300 | 2,300,300 | 60.1 |
| Clearwater | 3,167 | 2,833 | 124,733 | 44.0 |
| Kittson | 28,767 | 26,933 | 1,609,267 | 59.8 |
| Mahnomen | 31,100 | 29,700 | 1,450,933 | 48.9 |
| Marshall | 70,900 | 67,767 | 3,943,600 | 58.2 |
| Norman | 69,700 | 67,167 | 3,544,033 | 52.8 |
| Pennington | 38,300 | 36,467 | 1,910,867 | 52.4 |
| Polk | 112,200 | 106,400 | 5,982,400 | 56.2 |
| Red Lake | 26,100 | 25,000 | 1,274,567 | 51.0 |
| Roseau | 37,567 | 34,600 | 1,860,267 | 53.8 |
| NORTHWEST | 474,367 | 450,700 | 24,705,433 | 54.8 |
| Beltrami | 3,267 | 2,933 | 130,400 | 44.5 |
| Hubbard | 1,033 | 900 | 32,367 | 36.0 |
| Lake of the Woods | 3,600 | 3,367 | 197,433 | 58.6 |
| Other | 1,367 | 1,333 | 52,200 | 39.2 |
| NORTH CENTRAL | 9,267 | 8,533 | 412,400 | 48.3 |
| Douglas | 5,033 | 4,567 | 235,300 | 51.5 |
| Grant | 7,733 | 7,333 | 412,967 | 56.3 |
| Otter Tail | 15,333 | 14,400 | 674,433 | 46.8 |
| Pope | 867 | 767 | 34,500 | 45.0 |
| Stevens | 1,100 | 1,067 | 48,200 | 45.2 |
| Traverse | 5,967 | 5,067 | 256,933 | 50.7 |
| Wilkin | 24,933 | 23,600 | 1,501,067 | 63.6 |
| Other | 2,533 | 2,367 | 111,967 | 47.3 |
| WEST CENTRAL | 63,500 | 59,167 | 3,275,367 | 55.4 |
| Benton | 1,367 | 1,200 | 56,800 | 47.3 |
| Kandiyohi | 833 | 767 | 33,433 | 43.6 |
| Meeker | 1,967 | 1,700 | 78,633 | 46.3 |
| Morrison | 3,100 | 2,600 | 105,200 | 40.5 |
| Stearns | 10,467 | 9,267 | 486,733 | 52.5 |
| Todd | 9,433 | 8,633 | 391,467 | 45.3 |
| Wadena | 2,600 | 2,333 | 104,467 | 44.8 |
| Wright | 1,600 | 1,333 | 68,533 | 51.4 |
| Other | 2,567 | 2,033 | 106,300 | 52.3 |
| CENTRAL | 33,933 | 29,867 | 1,431,567 | 47.9 |
| Kanabec | 1,167 | 1,000 | 38,200 | 38.2 |
| Other | 3,333 | 2,933 | 124,833 | 42.6 |
| EAST CENTRAL | 4,500 | 3,933 | 163,033 | 41.4 |
| SOUTHWEST | 2,533 | 1,900 | 94,800 | 49.9 |

- continued -

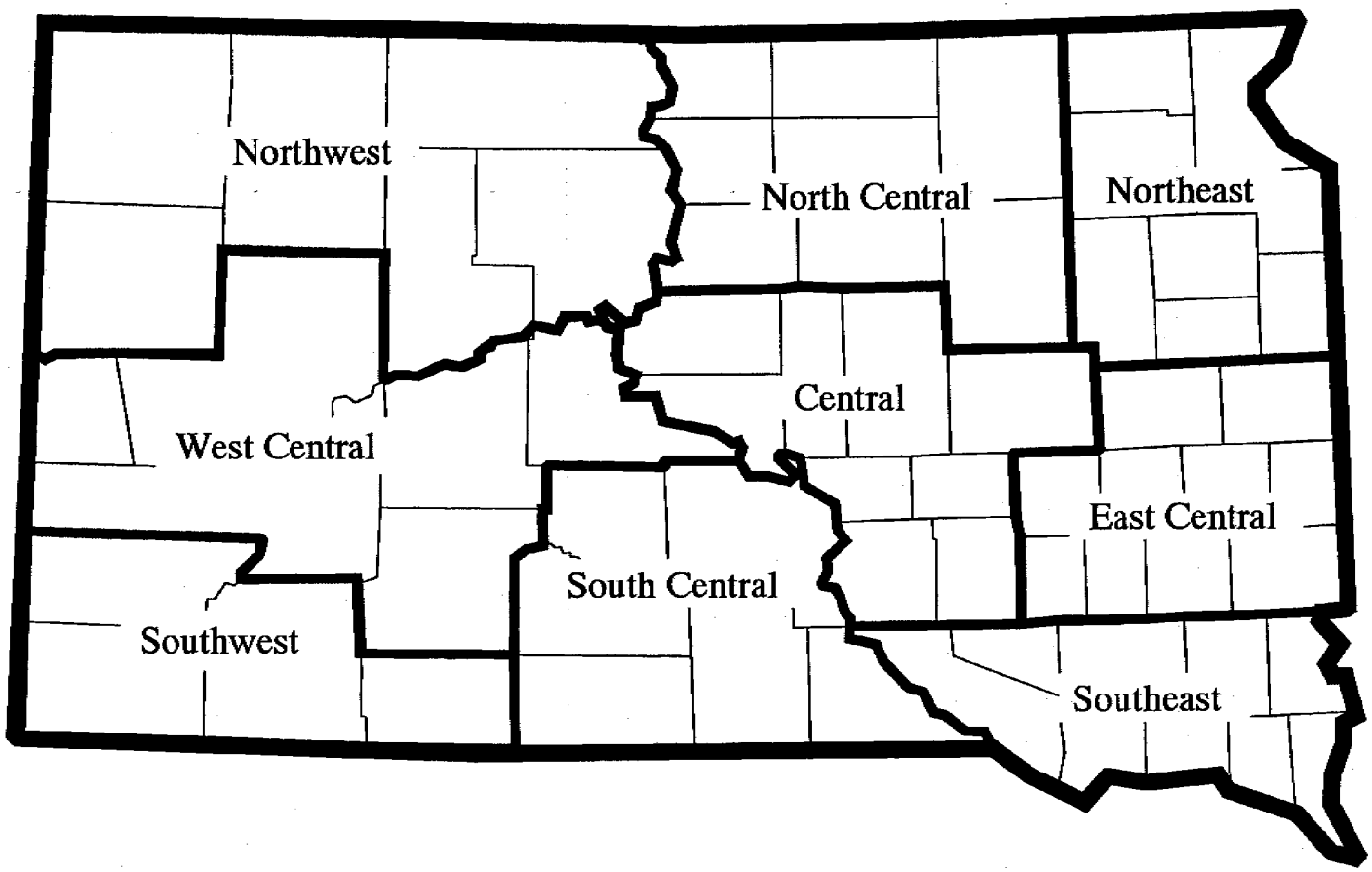
**Appendix Table A3. Continued**

| County/Production Region | Acres Planted | Acres Harvested | Production | Yield per Planted Acre |
|---|---|---|---|---|
| | | | bu | |
| Fillmore | 2,467 | 2,233 | 130,467 | 58.4 |
| Goodhue | 3,033 | 2,533 | 136,300 | 53.8 |
| Houston | 800 | 700 | 40,600 | 58.0 |
| Wabasha | 2,067 | 1,667 | 96,333 | 57.8 |
| Winona | 1,900 | 1,367 | 76,800 | 56.2 |
| Other | 2,467 | 2,033 | 99,767 | 49.1 |
| SOUTHEAST | 12,733 | 10,533 | 580,267 | 55.1 |
| Other Districts | 2,500 | 2,033 | 97,133 | 47.8 |
| STATE | 603,333 | 566,667 | 30,760,000 | 54.3 |

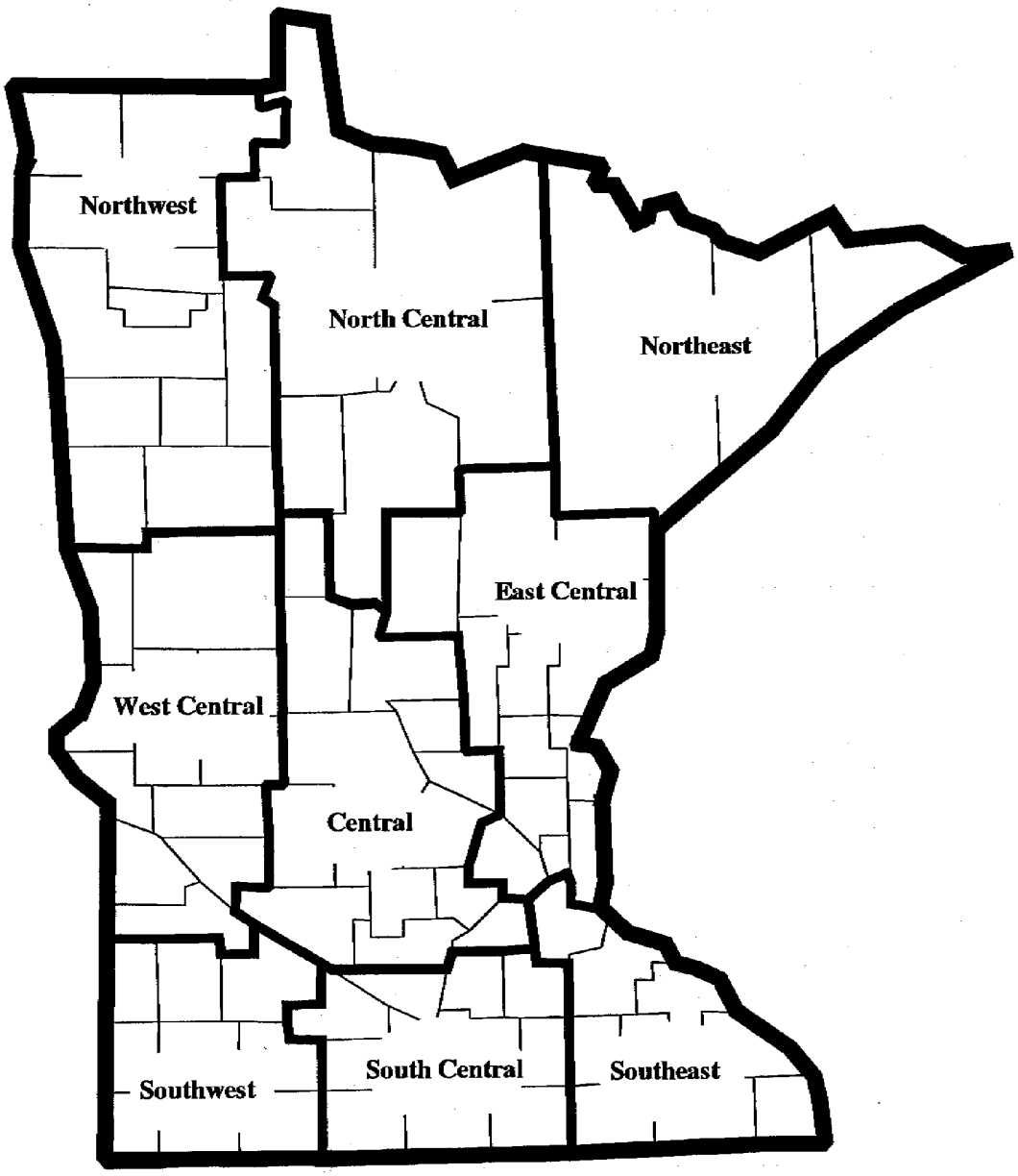
Source: Minnesota Agricultural Statistics Service.




Appendix Figure A1. North Dakota Agricultural Crop Production Regions
Source: North Dakota Agricultural Statistics Service.




Appendix Figure A2. South Dakota Agricultural Crop Production Regions
Source: South Dakota Agricultural Statistics Service.




Appendix Figure A3. Minnesota Agricultural Crop Production Regions
Source: Minnesota Agricultural Statistics Service.

# APPENDIX B

## Crop Production, Truck, Railroad, County and Terminal Elevator, Port Activity, and Barley Processing Budgets

Barley production budgets were compiled from a variety of secondary sources. Acreage and yields were averaged from 1994 through 1996 (North Dakota Agricultural Statistics Service *various years*, South Dakota Agricultural Statistics Service *various years*, and Minnesota Agricultural Statistics Service *various years*). Average marketing-year prices were obtained from each state's agricultural statistics service and weighted by production each year from 1994 through 1996. Farm program payments, averaged from 1994 through 1996, were collected from North Dakota Consolidated Farm Services (1998), South Dakota Consolidated Farm Services (1998), and Minnesota Consolidated Farm Services (1998).

Crop expenses were obtained from Farm Business Management Programs in each state (North Dakota Farm and Ranch Business Management 1995, 1996, 1997; South Dakota Farm and Ranch Business Management 1996, 1995; and Minnesota Farm Business Management 1995, 1996, 1997). Budgets obtained were divided into operations on owned land and rented land. Expenses were first averaged between budgets for barley produced on owned land and rented land by the ratio of owned and rented farm land in each state (U.S. Department of Commerce 1994a, 1994b, 1994c). Budgets representing average yearly expenses (owned and rented operations) were then averaged (weighted by acreage planted each year) from 1994 through 1996.

**Appendix Table B1. Barley Production Budgets, North Dakota 1994 Through 1996**

| Budget Items | Region: Northwest, West Central, Southwest & South Central | North Central | Northeast & East Central | Central & Southeast |
|---|---|---|---|---|
| Acreage | 589,700 | 389,967 | 1,126,633 | 377,033 |
| Yield (bu/acre) | 29.5 | 50.3 | 54.3 | 50.3 |
| Price ($/bu) | $2.40 | $2.40 | $2.40 | $2.40 |
| Farm Program Pmnt ($/acre) | $13.48 | $9.74 | $17.10 | $14.86 |
| Total Revenue ($/acre) | $84.46 | $130.54 | $147.53 | $135.70 |
| Variable Expenses ($/acre) | | | | |
| Seed | 4.91 | 6.52 | 8.72 | 7.03 |
| Fertilizer | 11.83 | 15.82 | 23.94 | 16.07 |
| Crop Chemicals | 2.98 | 7.80 | 13.39 | 7.45 |
| Crop Insurance | 3.45 | 5.61 | 5.73 | 6.02 |
| Fuel and Oil | 5.19 | 6.80 | 5.73 | 6.47 |
| Repairs | 8.51 | 9.92 | 10.10 | 9.96 |
| Custom Hire | 1.54 | 1.10 | 2.25 | 2.41 |
| Hired Labor | 0.00 | 0.04 | 0.33 | 0.02 |
| Cash Rent | 9.37 | 13.20 | 27.83 | 15.31 |
| Machinery Leases | 0.00 | 0.18 | 0.20 | 0.04 |
| Hauling and Trucking | 0.00 | 0.00 | 0.02 | 0.06 |
| Interest | 2.14 | 2.66 | 3.75 | 2.82 |
| Miscellaneous | 0.14 | 0.26 | 0.45 | 0.15 |
| Total Variable | 50.06 | 69.92 | 102.44 | 73.80 |
| Fixed Expenses ($/acre) | | | | |
| Hired Labor | 3.02 | 2.69 | 4.88 | 2.22 |
| Machinery Leases | 0.51 | 1.09 | 1.89 | 1.75 |
| Property Taxes | 1.13 | 1.90 | 6.02 | 2.03 |
| Insurance | 0.89 | 1.34 | 2.66 | 1.23 |
| Utilties | 0.85 | 1.31 | 1.57 | 1.16 |
| Professional Dues/Fees | 0.20 | 0.44 | 0.95 | 0.13 |
| Interest | 4.87 | 8.22 | 16.20 | 8.18 |
| Machinery Depreciation | 5.97 | 6.45 | 7.39 | 9.21 |
| Miscellaneous | 3.36 | 2.25 | 2.58 | 2.08 |
| Total Fixed | 20.80 | 25.69 | 44.14 | 27.99 |
| Returns to Unpaid Labor, Management, and Equity ($/acre) | 13.60 | 34.94 | 0.95 | 33.91 |

Sources: North Dakota Agricultural Statistics Service; North Dakota Farm and Ranch Business Management (1997), (1996), (1995); and North Dakota Consolidated Farm Services (1998).

**Appendix Table B2. Barley Production Budget, South Dakota, 1994 Through 1996**

| Budget Items | State |
|---|---|
| Acreage | 226,667 |
| Yield (bu/acre) | 37.5 |
| Price ($/acre) | $2.28 |
| Farm Program Pmnt ($/acre) | $30.30 |
| Total Revenue ($/acre) | $115.55 |
| Variable Expenses ($/acre) | |
| Seed | 6.09 |
| Fertilizer | 14.10 |
| Crop Chemicals | 9.83 |
| Crop Insurance | 0.97 |
| Machinery Operating | 18.87 |
| Custom Hire | 0.78 |
| Interest | 4.39 |
| Total Variable | 55.03 |
| Fixed Expenses ($/acre) | |
| Hired Labor | 3.48 |
| Machinery Leases | 4.64 |
| Insurance | 1.18 |
| Utilties | 2.37 |
| Land Cost | 24.60 |
| Miscellaneous | 1.23 |
| Total Fixed | 37.50 |
| Returns to Unpaid Labor, Management, and Equity ($/acre) | 23.03 |

Sources: South Dakota Agricultural Statistics Service; South Dakota Farm Business Management (1996), (1995); and South Dakota Consolidated Farm Services (1998).

**Appendix Table B3. Barley Production Budgets, Minnesota, 1994 Through 1996**

| Budget Items | Region | |
|---|---|---|
| | Northwest | Others |
| Acreage | 474,367 | 128,967 |
| Yield (bu/acre) | 52.1 | 46.9 |
| Price ($/bu) | $2.26 | $2.26 |
| Farm Program Pmnt ($/acre) | $21.72 | $14.89 |
| Total Revenue ($/acre) | $139.18 | $120.77 |
| Variable Expenses ($/acre) | | |
| Seed | 8.58 | 7.34 |
| Fertilizer | 23.44 | 18.77 |
| Crop Chemicals | 13.48 | 11.65 |
| Insurance | 5.97 | 3.47 |
| Drying Fuel | 0.25 | 0.12 |
| Fuel and Oil | 6.72 | 6.95 |
| Repairs | 10.96 | 11.32 |
| Custom Hire | 2.20 | 1.49 |
| Hired Labor | 0.11 | 0.06 |
| Cash Rent | 18.43 | 9.22 |
| Machinery Leases | 0.24 | 0.12 |
| Utilities | 0.01 | 0.01 |
| Marketing | 0.03 | 0.01 |
| Interest | 3.23 | 3.81 |
| Miscellaneous | 0.33 | 0.16 |
| Total Variable | 93.97 | 74.50 |
| Fixed Expenses ($/acre) | | |
| Hired Labor | 3.38 | 3.43 |
| Machinery | 1.59 | 3.11 |
| Property Taxes | 4.38 | 2.19 |
| Farm Insurance | 2.22 | 1.70 |
| Utilities | 1.60 | 1.98 |
| Professional Fees/Dues | 0.76 | 0.38 |
| Interest | 12.06 | 18.33 |
| Mach/Bldg Depreciation | 7.89 | 3.95 |
| Miscellaneous | 2.30 | 1.77 |
| Total Fixed | 36.19 | 36.85 |
| Returns to Unpaid Labor, Management, and Equity ($/acre) | 9.02 | 9.42 |

Sources: Minnesota Agricultural Statistics Service; Minnesota Farm Business Management (1997), (1996), (1995); and Minnesota Consolidated Farm Services (1998).

**Appendix Table B4. Truck Transportation Budget, Grain Shipments, Upper Great Plains, 1994 Through 1996**

| | $/mile[a] |
|---|---|
| Gross Revenue[b] | 1.15 |
| | |
| Variable Costs | |
| Tires | 0.042 |
| Labor | 0.290 |
| Maintenance and Repairs | 0.084 |
| Fuel | 0.154 |
| Total Variable Costs | 0.57 |
| | |
| Fixed Costs | |
| Equipment Costs/Tractor | 0.270 |
| License and Taxes/Tractor | 0.030 |
| Insurance | 0.098 |
| Mgmt and Overhead | 0.0054 |
| Total Fixed Costs | 0.53 |
| Total Costs | 1.10 |
| | |
| Net Returns | 0.05 |

[a] Developed from Berwick and Dooley (1997).
[b] Upper Great Plains Transportation Institute (1998a). Rate per mile traveled.

Total trucking revenues (i.e., expenses incurred by country and terminal elevators) were estimated by multiplying total trip mileage by trucking rate per mile by the number of shipments. Because some trucking expenses are incurred in other states on interstate shipments and because some barley is shipped by out-of-state trucking firms (which incur most of their operating expenses in other states), only 80 percent of the economic activity generated from interstate shipments of barley was allocated as direct impacts to the state in which the shipment originated. The remaining expenses were either allocated to neighboring states, such as shipments from North Dakota to Minnesota, or treated as economic leakages, such as shipments of grain from North Dakota to the Pacific Northwest. All economic activity from truck shipments of barley to in-state destinations was included as direct impacts.

**Appendix Table B5. Railroad Cost Breakdown, Grain Shipments, Upper Great Plains, 1994 Through 1996**

| Variable Expenses | Percent of Variable Costs |
|---|---|
| Train Crew[a] | 43.73 |
| Locomotive[b] | 23.39 |
| Railroad Car[c] | 21.41 |
| Transportation Charge[d] | 11.47 |
| Total Variable | 100.00 |

| Fixed Expenses | Percent of Fixed Costs |
|---|---|
| Maintenance-of-Way | 45.44 |
| Net Liquidation Value | 45.44 |
| Central Administration | 2.03 |
| Insurance and Other | 1.20 |
| Property Tax | 5.89 |
| Total Fixed | 100.00 |

[a] Includes wages, fringe benefits, and crew overnight costs.
[b] Includes locomotive repairs, depreciation/rent/leases, return on investment, servicing, fuel, and machinery overhead.
[c] Includes car-day and car-mile costs.
[d] Includes train inspection/lubrication, dispatching, crossing protection, and signal/interlockers costs.

Source: Tolliver et al. (1987).

Rail shipment expenditures (expenses incurred by railroad companies) vary by shipment size, carrier, distance, cargo type, and shipment type (Bangsund et al. 1994). Shipment costs for elevators also vary by cargo type, distance, carrier, and size. However, the expense incurred or paid by shippers on rail lines are usually based on shipping tariffs that are set by railroad companies. Shipping tariffs do not correspond with shipping expenditures incurred by railroad companies.

The amount of variable and fixed costs for rail shipments of barley in the tri-state region was determined using the Uniform Railroad Costing Model (URCS). Grain flow statistics (i.e., amounts of barley shipped to various destinations from various points in the region) were used in conjunction with URCS to generate an estimate of overall railroad company expenditures by variable and fixed cost categories. The railroad operating budget above was used to divide costs obtained from URCS into expense categories and subsequently allocate those expenditures to various economic sectors. The cost structure (total variable and fixed costs) of barley shipments

was subtracted from shipping tariffs to determine railroad company net returns. Railroad net returns were not allocated as direct impacts, since they were assumed to leave the regional economy. Sixty percent of the variable and fixed costs of rail shipments were assumed to remain within the originating state's economy and resulted in direct economic impacts to that state's economy. The remaining 40 percent was handled two ways. First, some of the unallocated expenses were distributed as direct impacts to neighboring states for shipments that either (1) pass through a neighboring state on route to a market destination (e.g., shipments from origins in Minnesota to the Pacific Northwest) or (2) contain an end-destination market (e.g., shipments from origins in North Dakota to Minneapolis/St. Paul). The remaining transportation expenses were not allocated as direct impacts and represented an economic leakage from the region.

**Appendix Table B6. Country Elevator Grain Handling Budget, Upper Great Plains, 1994 Through 1996**

| Expenses | --$/bu-- |
|---|---|
| Labor | 0.029 |
| Taxes and Licenses | 0.004 |
| Insurance | 0.007 |
| Utilities | 0.005 |
| Services | 0.002 |
| Interest | 0.007 |
| Equip. Depr. and Repairs | 0.012 |
| General Expense | 0.014 |
| Gross Margin | 0.080 |

**Appendix Table B7. Terminal Elevator Grain Handling Budget, Minnesota, 1994 Through 1996**

| Expenses | --$/bu-- |
|---|---|
| Labor | 0.036 |
| Utilities | 0.0135 |
| Interest | 0.008 |
| Depreciation | 0.009 |
| General Overhead | 0.0045 |
| Net Margin | 0.009 |
| Gross Margin | 0.08 |

Country elevators typically handle grain and provide a variety of agricultural services; however, the above budget only represents likely expenses and returns for barley handling activities for country elevators in North Dakota, South Dakota, and Minnesota. Expense

categories and percentages of gross margin were obtained from Bangsund and Leistritz (1995a). The gross margin was based upon information received from Wilson (1998), Johnson (1998), and Wilson and Johnson (1995).

Terminal elevator handling margins were obtained from Wilson (1998), Johnson (1998), and Wilson and Johnson (1995). Expenses by category were adapted from Bangsund et al. (1994).

**Appendix Table B8. Maritime Activity Budget, Barley, Port of Duluth, 1994 Through 1996**

| Expenses | --$/mt-- |
|---|---|
| Tugs | 0.1291 |
| Supplies and Repairs | 0.0815 |
| Stevedoring | 0.5600 |
| Mooring Fee | 0.0081 |
| Dock Transshipment[a] | 0.9700 |
| Line Handling | 0.0297 |
| Wharfage/dockage | 0.2608 |
| Garbage | 0.0221 |
| Cleaning | 0.0162 |
| Agency Commission | 0.1172 |
| Pilots | 0.0724 |
| Professional Services | 0.0200 |
| Crew Expenditures | 0.1814 |
| National Cargo Bureau | 0.0113 |
| Grain Inspection Fees | 0.6399 |
| Customs Fees | 0.0076 |
| Customs Tonnage Tax | 0.0032 |
| Sanitary Inspection | 0.0119 |
| Launch Service | 0.0113 |
| Communications | 0.0092 |
| Fresh Water | 0.0032 |
| Bunkers | 0.1852 |
| Total | 3.3562 |

[a] Dock transshipment costs included grain handling expenses for terminal elevators with harbor unloading facilities. Grain handling costs for terminal elevators were subtracted from original dock transshipment costs to avoid double counting of terminal elevator expenditures. Thus, dock transshipment expenses were for costs other than those covered by terminal elevator grain handling expenditures. The above expenses represent those that were assumed to remain within the Minnesota economy.

Sources: Klaers, Powers, and Associates (1992) and Bangsund et al. (1994).

**Appendix Table B9. Malting Activity, Average Values, North Dakota and Minnesota, 1994 Through 1996**

| | |
|---|---|
| Industry Capacity (mt of malt)* | 956,667 |
| Industry Capacity (bu of barley)** | 74,437,671 |
| Barley Malted (bu)* | 69,104,354 |
| Capacity Utilization | 92.8% |
| Barley Malted from the Tri-state Region (bu)* | 50,315,793 |
| Utilization from Region | 72.8% |

Malt Plants Included in the Study***

| Owner/Operator | Location |
|---|---|
| Ladish (Cargil) | Spiritwood, ND |
| Archer Daniels Midland | Red Wing, MN |
| Froedtert | Winona, MN |
| Anheuser-Busch | Moorhead, MN |
| Rahr | Shakapee, MN |
| Strohs | St. Paul, MN |
| Minnesota Malting | Cannon Falls, MN |

*Plant capacities, utilization, and barley sources were estimated separately for each plant and then totaled for the industry.

** Based on converting metric tons of malt to bushels of unclean barley. Approximately 64.841 bushels of malt per metric ton of malt. About 1.14 bushels of clean barley to make one bushel of malt. About 5 percent of unclean barley is removed to arrive at bushels of clean barley.

*** Strohs malting plant is currently closed; however, the plant was operational during the study period. Malting plants at Shakapee and Spiritwood expanded capacity from 1994 through 1996. Thus, industry capacity represents approximate average capacity over the 1994 to 1996 period.

Source: Industry sources.

**Appendix Table B10. Barley Malting Budget, North Dakota and Minnesota, 1994 Through 1996**

General Production Information for Malting Industry

| | Units | Quantity | Explanation |
|---|---|---|---|
| Barley malted--unclean | bu | 50,315,793 | see Appendix Table B9 |
| Barley malted--clean | bu | 47,800,004 | 95% of unclean barley |
| Malt produced | bu | 41,929,828 | 1.14 to 1, conversion of clean barley to malt |
| Value of Malt | $/bu | $4.61 | 3-yr average price, The Brewers Bulletin |
| Sales of Malt | | $193,296,506 | |
| Malt Sprouts | sh tons | 35,640 | (5% x bu of malt x 34lbs/bu ) / 2000 lbs |
| Value of Malt Sprouts | $/sh ton | $50.00 | industry sources |
| Sales of Malt Sprouts | | $1,782,018 | |
| Thin Barley | bu | 2,515,790 | uncleaned barley less cleaned barley |
| Value of Thin Barley | $/bu | $1.65 | value from industry sources |
| Sales of Thin Barley | | $4,151,053 | |

Budget Calculations

| | $/bu of unclean barley | | |
|---|---|---|---|
| Gross Revenue | $3.96 | $199,229,577 | sales of malt, thin barley, and malt sprouts |
| Barley Purchases | $2.80 | $140,884,221 | 3-yr avg Mpls price, malting barley, MGE |
| Gross Margin | $1.16 | $58,345,355 | gross revenue less barley purchases |
| Listed Expenses | | | |
| Utilities | $0.22 | $11,034,165 | listed expenses were estimated from |
| Labor | $0.21 | $10,592,799 | industry sources and Census of Manufacturers |
| Property tax | $0.04 | $2,206,833 | |
| Manufacturing supplies | $0.02 | $882,733 | |
| Insurance | $0.02 | $882,733 | |
| Administrative overhead | $0.16 | $7,944,599 | |
| Depreciation | $0.15 | $7,503,232 | |
| Plant & equip repair | $0.08 | $3,972,299 | |
| Contract work | $0.02 | $804,222 | |
| Rental payments | $0.01 | $262,413 | |
| Total | $0.92 | $46,086,029 | |
| Net Margin | $0.24 | $12,259,327 | gross margin less listed expenses |

Sources: Minneapolis Grain Exchange (1996), (1997); The Brewers Bulletin (1998); U.S. Department of Commerce (1995), (1996), (1997); and various industry sources.

# APPENDIX C

## Grain Flow Statistics

**Appendix Table C1. Average Annual Barley Shipments from Country Elevators to Market Destinations, North Dakota, South Dakota, and Minnesota, 1994 Through 1996**

| | Market Destinations | | | | | |
|---|---|---|---|---|---|---|
| State | Duluth | Minneapolis St. Paul | Midland/ Southern | Pacific Northwest | N. Dakota/ S. Dakota* | Other |
| North Dakota | 7,667,126 | 44,145,352 | 10,409,110 | 8,612,194 | 21,305,051 | 13,837,168 |
| % of state | 7.2% | 41.7% | 9.8% | 8.1% | 20.1% | 13.1% |
| South Dakota | 434,434 | 1,165,965 | 0 | 33,634 | 824,023 | 344,744 |
| % of state | 15.5% | 41.6% | 0.0% | 1.2% | 29.4% | 12.3% |
| Minnesota | 2,408,265 | 11,793,261 | 3,313,040 | 2,082,515 | 3,659,726 | 5,218,356 |
| % of state | 8.5% | 41.4% | 11.6% | 7.3% | 12.9% | 18.3% |
| Total | 10,509,825 | 57,104,578 | 13,722,150 | 10,728,342 | 25,788,800 | 19,400,268 |
| % of total | 7.7% | 41.6% | 10.0% | 7.8% | 18.8% | 14.1% |
| | State Share of Regional Shipments Received by Destination | | | | | |
| North Dakota | 73.0% | 77.3% | 75.9% | 80.3% | 82.6% | 71.3% |
| South Dakota | 4.1% | 2.0% | 0.0% | 0.3% | 3.2% | 1.8% |
| Minnesota | 22.9% | 20.7% | 24.1% | 19.4% | 14.2% | 26.9% |

Bushels Shipped by State and Percentage of Total Shipments

| | | |
|---|---|---|
| North Dakota | 105,976,000 | 77.2% |
| South Dakot | 2,802,800 | 2.0% |
| Minnesota | 28,475,162 | 20.7% |
| Total | 137,253,962 | |

* Locations in North Dakota were the market destinations for shipments originating within North Dakota and Minnesota. Locations in South Dakota were the market destinations for shipments originating in South Dakota.

**Appendix Table C2. Mode of Tranportation for Barley Shipments to Market Destinations by Country Elevators, Average of North Dakota, South Dakota, and Minnesota Shipments, 1994 Through 1996**

| Market Destination | Mode of Transportation | | Ratio of Mode | |
|---|---|---|---|---|
| | Truck | Rail | Truck | Rail |
| | bu | | | |
| Duluth | 3,831,000 | 6,679,000 | 36.5% | 63.5% |
| Minneapolis/St. Paul | 11,677,000 | 45,428,000 | 20.4% | 79.6% |
| Midland/Southwest | 1,161,000 | 12,561,000 | 8.5% | 91.5% |
| Pacific Northwest | 321,000 | 10,408,000 | 3.0% | 97.0% |
| North and South Dakot | 11,016,000 | 14,772,000 | 42.7% | 57.3% |
| Other | 7,987,000 | 11,413,000 | 41.2% | 58.8% |
| Total Shipments | 35,993,000 | 101,261,000 | 26.2% | 73.8% |

**Appendix Table C3. Mode of Transportation for Barley Shipments to Market Destinations by Country Elevators, North Dakota, 1994 Through 1996**

| Market Destination | Mode of Transportation | | Ratio of Mode | |
|---|---|---|---|---|
| | Truck | Rail | Truck | Rail |
| | bu | | | |
| Duluth | 2,913,000 | 4,754,000 | 38.0% | 62.0% |
| Minneapolis/St. Paul | 9,213,000 | 34,933,000 | 20.9% | 79.1% |
| Midland/Southwest | 881,000 | 9,528,000 | 8.5% | 91.5% |
| Pacific Northwest | 258,000 | 8,354,000 | 3.0% | 97.0% |
| North Dakota | 8,698,000 | 12,607,000 | 40.8% | 59.2% |
| Other | 5,649,000 | 8,188,000 | 40.8% | 59.2% |
| Total Shipments | 27,612,000 | 78,364,000 | 26.1% | 73.9% |

**Appendix Table C4. Mode of Transportation for Barley Shipments to Market Destinations by Country Elevators, South Dakota, 1994 Through 1996**

| Market Destination | Mode of Transportation | | Ratio of Mode | |
|---|---|---|---|---|
| | Truck | Rail | Truck | Rail |
| | bu | | | |
| Duluth | 3,000 | 432,000 | 0.7% | 99.3% |
| Minneapolis/St. Paul | 3,000 | 1,163,000 | 0.3% | 99.7% |
| Midland/Southwest | 0 | 0 | 0.0% | 0.0% |
| Pacific Northwest | 0 | 34,000 | 0.0% | 100.0% |
| South Dakota | 824,000 | 0 | 100.0% | 0.0% |
| Other | 207,000 | 137,000 | 60.2% | 39.8% |
| Total Shipments | 1,037,000 | 1,766,000 | 37.0% | 63.0% |

**Appendix Table C5. Mode of Transportation for Barley Shipments to Market Destinations by Country Elevators, Minnesota, 1994 Through 1996**

| Market Destination | Mode of Transportation | | Ratio of Mode | |
|---|---|---|---|---|
| | Truck | Rail | Truck | Rail |
| | bu | | | |
| Duluth | 915,000 | 1,493,000 | 38.0% | 62.0% |
| Minneapolis/St. Paul | 2,461,000 | 9,332,000 | 20.9% | 79.1% |
| Midland/Southwest | 280,000 | 3,033,000 | 8.5% | 91.5% |
| Pacific Northwest | 62,000 | 2,020,000 | 3.0% | 97.0% |
| South Dakota | 1,494,000 | 2,166,000 | 40.8% | 59.2% |
| Other | 2,130,000 | 3,088,000 | 40.8% | 59.2% |
| Total Shipments | 7,342,000 | 21,132,000 | 25.8% | 74.2% |

**Appendix Table C6. Characteristics of Barley Shipments for Terminal Elevators in Minneapolis/St. Paul, River Ports, Winona Area, and the Port of Duluth**

| Mode | Year | Minneapolis/St. Paul* In | Minneapolis/St. Paul* Out | Port of Duluth In | Port of Duluth Out | Total In | Total Out |
|---|---|---|---|---|---|---|---|
| | | ----- | ----- | ----- 000s bu | ------ | ----- | ----- |
| Rail | 1994 | 30,270 | 31,767 | 26,046 | 28,544 | 56,316 | 60,311 |
| | 1995 | 40,716 | 40,036 | 9,169 | 23,307 | 49,885 | 63,343 |
| | 1996 | 33,310 | 39,242 | 7,255 | 20,123 | 40,565 | 59,365 |
| Truck | 1994 | 7,601 | 2,579 | 28,617 | 854 | 36,218 | 3,433 |
| | 1995 | 10,270 | 3,750 | 6,101 | 207 | 16,371 | 3,957 |
| | 1996 | 9,288 | 4,642 | 785 | 702 | 10,073 | 5,344 |
| Barge/ Vessel | 1994 | 0 | 1,459 | 24,155 | 51,501 | 24,155 | 52,960 |
| | 1995 | 107 | 0 | 18,284 | 8,193 | 18,391 | 8,193 |
| | 1996 | 0 | 0 | 12,622 | 5,838 | 12,622 | 5,838 |
| All modes | 1994 | 37,871 | 35,805 | 78,818 | 80,899 | 116,689 | 116,704 |
| | 1995 | 51,093 | 43,786 | 33,554 | 31,707 | 84,647 | 75,493 |
| | 1996 | 42,598 | 43,884 | 20,662 | 26,663 | 63,260 | 70,547 |
| | Total | 131,562 | 123,475 | 133,034 | 139,269 | 264,596 | 262,744 |

| | Outshipments by Mode of Transportation | | |
|---|---|---|---|
| Truck | 9% | 1% | 5% |
| Rail | 90% | 52% | 70% |
| Vessel/barge | 1% | 47% | 25% |

* Shipments from river ports and Winona area elevators were included in the Minneapolis/St. Paul category.

Source: Minneapolis Grain Exchange (1996), (1997).

Qasmi and McDaniel (1997) reported that only one-third of the barley produced in South Dakota was delivered to a country elevator. Overall about 84.5 percent of annual barley production moved through a country elevator in North Dakota to marketing channels (Vachal et al. 1997) (Appendix Table C7). However, marketing practices, end uses, and the volume of barley production differ greatly within North Dakota. In the western half of the state, only 53 percent of barley production moves into the marketing channels from a local elevator, whereas, nearly 93 percent of barley production is shipped from a country elevator in the eastern half of the state. Grain flow statistics for the eastern half of North Dakota were used to estimate the percentage of barley marketed in country elevators in Minnesota.

Reported yearly barley shipments from country elevators by crop production regions in North Dakota were obtained from Dalebout et al. (1997) and Vachal et al. (1997). However, those shipments did not account for the source of the barley shipped. Barley delivered to country elevators in North Dakota from out-of-state sources (neighboring states or Canada) was not addressed by Dalebout et al. (1997) and Vachal et al. (1997) and was not addressed in this study. Changes in on-farm and off-farm barley storage in North Dakota were used to adjust the volume of barley shipped from country elevators.

Barley stocks in North Dakota decreased by about 15.5 million bushels from the beginning of 1994 to the end of 1996 (North Dakota Agricultural Statistics Service). Average annual reduction in barley stocks was estimated at 5.166 million bushels. The reduction in storage stocks of barley was assumed to enter the marketing system and was subtracted from the shipments of barley from country elevators. Because barley storage information was only available as a state-wide estimate, storage changes by region were allocated based on regional crop production.

Barley shipments from country elevators, after adjusting from changes in barley storage, were compared to average barley production in the western and eastern regions of the state. The difference between barley produced and barley shipped from country elevators was used to determine the amount of barley entering the marketing system. A number of factors could account for differences in barley production and barley shipments. These factors, in addition to storage changes, could include barley used directly on-farm as livestock feed, barley raised for seed, barley processed by a local elevator into livestock feed (formulated ration), barley shipped directly by producer to processor/final market, delivery of barley from out-of-state sources to local elevators in North Dakota, and delivery of barley produced in North Dakota by producers to out-of-state elevators. The above factors were not addressed in this study.

**Appendix Table C7. Bushels of Barley Shipped by Country Elevators in North Dakota, Average 1994 Through 1996**

| Crop Production Regions | Reported Shipments From Elevators | Storage Changes | Shipments Corrected for Storage Changes | Barley Production | Difference Between Shipments & Production | Amount of Production Not Marketed |
|---|---|---|---|---|---|---|
| Western half | | | | | | |
| Northwest | 11,293,532 | (525,000) | 10,768,532 | 13,658,167 | | |
| West Central | 1,804,851 | (83,902) | 1,720,950 | 4,694,833 | | |
| South Central | 613,135 | (28,503) | 584,632 | 3,533,000 | | |
| Southwest | 615,167 | (28,597) | 586,570 | 3,808,000 | | |
| Sub-total | | | 13,660,684 | 25,694,000 | 12,033,316 | 46.8% |
| Eastern half | | | | | | |
| North Central | 16,019,411 | (744,691) | 15,274,720 | 19,604,667 | | |
| Northeast | 33,477,825 | (1,556,277) | 31,921,548 | 38,437,833 | | |
| Central | 11,078,088 | (514,985) | 10,563,103 | 12,064,500 | | |
| East Central | 29,831,538 | (1,386,773) | 28,444,765 | 22,720,000 | | |
| Southeast | 6,409,119 | (297,939) | 6,111,180 | 6,895,667 | | |
| Sub-total | | | 92,315,316 | 99,722,667 | 7,407,350 | 7.4% |
| State Total | 111,142,667 | (5,166,667) | 105,976,000 | 125,416,667 | 19,440,667 | 15.5% |

Sources: Dalebout et al. (1997), Vachal et al. (1997), and North Dakota Agriculture Statistics Service.

**Appendix Table C8. Market Destinations for Rail Shipments from Terminal Elevators in the Port of Duluth and Minneapolis/St. Paul**

| Origin | Destination | Breakdown |
|---|---|---|
| Duluth | Milwaukee, WI | 32.6% |
| | Minneapolis/St Paul, MN | 32.9% |
| | PNW/West | 27.9% |
| | Miscellaneous | 6.5% |
| Minneapolis/St Paul | Milwaukee | 52.9% |
| | PNW/West | 47.1% |

Source: Upper Great Plains Transportation Institute (1998a).