Grain Transportation in the Great Plains Region in a Post-Rationalization Environment

Volume 2:

Farm-to-Market Transportation Patterns and Truck Use in the Northern Plains

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by

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Introduction

Much of America's rural economy is based on agricultural production. According to the Census of Agriculture, there were more than 1.9 million farms in the United States in 1997. These farms produced and sold products valued at $196,865 million.[1] More than 300 million acres of cropland were harvested in 1997.

Most agricultural products are delivered from farms to processors, elevators, storage facilities, or final markets. The distribution chain for many agricultural commodities is long and complicated, involving several transportation modes and transfers of cargo. However, regardless of the destination, the first essential link in this chain is the farm-to-market movement.

Many transportation statistics are published annually or in periodic censuses. The Commodity Flow Survey (CFS) provides information on shipments from elevators and processing plants to export locations or final markets. However, farm-to-elevator and farm-to-processing plant movements are not covered in the CFS and are not described in detail in other sources. Most information on farm-to-market movements is derived from special studies.

Survey Objectives

This study provides information about the types of trucks owned and leased by farmers and how these trucks are utilized. It complements other studies of farm-to-market transportation in the Great Plains region, including a study by Baumel (1996) of grain movements in Iowa. The Baumel study provides detailed information about corn and soybean movements in the Western Corn Belt. This study provides detailed information about another important farm-to-market movement: wheat and barley flows in the Northern Plains. The intent is not to duplicate or update studies recently conducted in the Corn Belt or Central Plains region, but to fill a void by providing detailed information about wheat and barley movements in the Northern Plains.[2]

The objectives of the survey are to provide information about:

1. The proportions of wheat and barley delivered to elevators, processing plants, and feed lots
2. The proportions of wheat and barley moved directly to off-farm locations during harvest
3. The proportions of wheat and barley stored on-farm after harvest
4. Average farm-to-market trip distances and average trip distances on paved and unpaved roads
5. Longest farm-to-market trip distances
6. The types and average numbers of trucks owned and leased by farmers in 2000
7. The projected types and numbers of trucks owned and leased by farmers in 2005
8. Average empty and loaded trucks weights

It is expected that different groups will be interested in different aspects of the study. Farm operators may be interested in comparing truck use and delivery practices across states or regions. State and local transportation departments may be interested in the composition and use of the farm truck fleet and the types of highways used for farm-to-market deliveries. Agricultural agencies, processors, and merchandisers may be interested in the delivery practices of farmers — e.g., destinations for wheat and barley, the timing of deliveries, and short-term storage tendencies.

Because of the expected diversity of the audience, an effort is made to present as much detail as possible in this report. Sample statistics are computed by state, crop, truck type, and scale of production (e.g., acres planted). However, statistics are not compiled by small geographic regions or jurisdictions such as counties. The survey data are confidential and the results are presented in such a way that information regarding individual respondents cannot be gleaned from the report.

Agencies Involved

Several agencies were involved in and contributed to this study. The Upper Great Plains Transportation Institute (UGPTI) at North Dakota State University was the lead agency. UGPTI contracted with the North Dakota Office of the Agricultural Statistics Service (NDASS) to help design, coordinate, and administer the survey. NDASS utilized the offices of the Agricultural Statistics Services in Montana and South Dakota and received guidance from the National Agriculture Statistics Service (NASS) of the United States Department of Agriculture (USDA).

In addition to funding the study, the Bureau of Transportation Statistics (BTS) of the United States Department of Transportation and the Office of Agricultural Marketing Service (AMS) of the United States Department of Agriculture provided guidance and input to the study. However, the funding agencies are not responsible for the survey design or contents of the report. These responsibilities fall to the Upper Great Plains Transportation Institute and the North Dakota Office of the Agricultural Statistics Service.

Survey Design and Sampling Approach

The data presented in this report are derived from a survey, not a census. They reflect the responses of a portion of the population of farm operators in the Northern Plains region.

The survey has benefitted from the many collective years of experience of the agencies involved and their detailed knowledge of farm populations. The 45 field offices of the NASS annually collect data on crops, livestock, and related subjects primarily through sample surveys. Many of the techniques utilized by NASS – such as the use of geographic area frames to improve agricultural surveys – have been used for statistical quality control since the early 1960's.

Estimates of crop acreage and production by NASS are based on sample survey data obtained from individual producers, combined with objective yield counts, personal field observations, and other sources. After crop data are collected by the field offices, state estimates and supporting information are sent to the Agricultural Statistics Board of NASS which reviews the estimates. After these reviews, NASS issues reports containing state and national summaries of acres cultivated and yield, by crop category.

Because of their long history of surveying farm operators and the quality control procedures used, the annual crop data published by NASS offices are felt to be reflective of the farm population. According to the U.S. Census Bureau (1999), sampling error for these surveys (i.e., variability in estimates due to sample selection) probably falls into the 3% to 6% range at the state level.[3] The accuracy of the crop survey data is attributable in part to a high response rate.[4] Nonsampling errors (e.g., errors in estimates due to the incompleteness of farm population mailing lists or data transcription/entry errors) are "minimized through rigid quality controls on the collection process and careful review of all reported data."[5]

Target Population

A survey is targeted at a group of individuals or "units of interest." This group is referred to as the *target universe* or *target population*. For most surveys, the NASS target population is all farm operators. The NASS offices maintain a comprehensive list of farm operators. However, it is impossible to know all of the farm operators in existence at the time a survey is administered. New farms are started all of the time. Morever, farm ownership, boundaries, and land uses change regularly.[6]

To help verify population lists and improve the accuracy of data on cultivated acreage, NASS maintains an *area frame*. In this approach, field statisticians contact farm operators directly "by selecting blocks of land, visiting these blocks, and finding any farmers that operate on that land."[7]

There is some uncertainty regarding the population of Northern Plains wheat and barley producers – the target population of this survey. Most of them are known to reside in North Dakota, Montana, South Dakota and western Minnesota. However, because of crop rotations and annual production decisions by farmers, it cannot be known in advance which farmers will produce wheat and barley in a given year.[8] For these reasons, a targeted survey approach was used.

Sample Design

The sample for the transportation survey was derived from a set of known wheat and barley producers. These farmers had responded earlier to a 1999 county crop survey conducted by the NASS field offices. This is the same set of producers used to estimate acreage under cultivation within the four-state area. This set of producers is defined as the *working population*.

A random sample of 6,000 farm operators was drawn from the working population. A questionnaire containing a set of transportation questions was developed and administered to this group. Approximately 78% of the group responded to the transportation survey (Table 1). This response rate resulted in a sample data set of 4,705 observations, which is the primary source of information presented in this report.

Table 1. Farm Operators Surveyed and Survey Response Rate	
Farm Operators Surveyed	6,000
Surveys Returned	4,705
Survey Response Rate	78%

The county crop surveys are non-probability samples. Non-random factors may have influenced which wheat and barley producers responded to the 1999 crop surveys. The transportation survey is a random sample drawn from the working population. Thus, the transportation sample may reflect non-random influences present in the working population. Consequently, confidence intervals based on probability distributions are not shown in the report.

Although the transportation sample may reflect non-random influences, it is quite large. Morever, the response rates were high for both the county acreage and transportation surveys. These high response rates, the familiarity of NASS personnel with agricultural surveying issues, the extensive data quality control procedures used, and the large sample size increase the likelihood that the transportation sample is representative of the target population.

Survey Methods

The Upper Great Plains Transportation Institute and the North Dakota Office of the Agricultural Statistics Service designed the questionnaire shown in the appendix. NDASS utilized and coordinated the efforts of the NASS field offices in Montana and South Dakota.

Training sessions were held for telephone surveyors to familiarize them with the purpose of the transportation survey, the intent of each question, and expected data ranges. For example, telephone surveyors were familiarized with the truck terminology used by farmers and alerted to unusual responses that might need to be verified with a follow-up question.[9]

The questionnaires were mailed in late April of 2000. The telephone non-response follow-up program was initiated about two weeks later and continued into May. Data from the survey have been reviewed and compared to the results of previous studies and likely ranges for key data elements.

Survey Coverage

Geographically, the survey area encompasses Montana, North Dakota, South Dakota, and the three westernmost crop districts of Minnesota. Three types of wheat are commonly produced in this area: spring wheat, winter wheat, and durum wheat. Durum wheat is somewhat of a speciality crop and is grown primarily in North Dakota. Its predominant use is in the production of pasta. Spring and winter wheats are produced throughout much of the study region and serve a wide variety of baking purposes. These two varieties of wheat are destined primarily for domestic mills and export locations. However, they are marketed primarily through an extensive network of elevators. Barley is grown for both feed and malting purposes and is moved to elevators, malt houses, and feed lots in the region.

Size of the Sample in Relation to the Population

The sample was drawn from the same set of respondents that were used to estimate cultivated acreage in each state. Table 2 compares the acres of each target crop planted in North Dakota in 1999 to the acres planted by respondents to the transportation survey. As the table shows, the survey respondents planted 12% to 13% of the estimated barley, spring wheat, and durum wheat acres that were cultivated in North Dakota. In essence, one out of every eight acres of wheat and barley is represented in the North Dakota sample. The proportions are similar for spring wheat and barley produced in South Dakota and Montana.

Table 2. Acres of Wheat and Barley Planted in North Dakota: 1999

Crop	Total Acres Planted in North Dakota	Acres Planted by Survey Respondents in North Dakota	Percent of Acres Attributable to Survey Respondents
Barley	1,350	167	12.37%
Durum Wheat	3,450	451	13.07%
Spring Wheat	5,900	739	12.53%
Winter Wheat	60	9	15.00%

The large sample size and high response rate increase the likelihood that the sample is representative of the target population.

Key Statistical Indicators

Subsequent sections of this report describe the principal findings of the survey for the study region as a whole. Before presenting these highlights, some of the key sample statistics used in the report are reviewed briefly. Readers who are familiar with these topics may wish to jump to the next section of the report.

The Sample Mean

The arithmetic mean or average represents the mathematical center of a set of observations. The arithmetic mean is computed from a sample data set as shown in equation (1):

$$\bar{x} = \frac{\sum_i x_i}{n} \tag{1}$$

Where x_i is the value of x for observation i in the data set and n is the number of observations in the data set.

Although a simple mean is useful, it may not convey important scale effects. Consider the following survey question: What percentage of your barley crop is moved off-farm during harvest? Farmer A may move 90 percent of his barley off-farm during harvest. However, this movement may represent only 30,000 bushels. In comparison, Farmer B may move only 30 percent of his barley directly off-farm at harvest. Yet, this movement may represent 300,000 bushels.

As shown in equation (1), each farmer's response is given the same weight in the computation of a simple mean. In this example, a weighted mean provides a better representation of the mathematical center of the data set. The weighted mean of a sample is computed as:

$$\bar{x}_w = \frac{\sum_i w_i x_i}{\sum_i w_i} \tag{2}$$

Where w_i is the value of the weight variable w for observation i in the data set.

Sample Variance

In addition to measures of central tendency, it is useful to examine the variability within a data set. The sample variance (s^2) and standard deviation (s) are the two most commonly- used measures of variability. The standard deviation is computed from the variance. The variance describes the dispersion of sample values (x) about the sample mean. The sample variance is computed as:

$$s^2 = \frac{\sum_i (x_i - \bar{x})^2}{n-1} \tag{3}$$

When all of the sample values are close to the value of the mean, the variance is small. When the sample values are scattered widely about the mean, the variance is larger. When the mean is weighted, the sample variance is computed as shown in equation (4):

$$s_w^2 = \frac{\sum_i w_i (x_i - \bar{x}_w)^2}{\sum_i w_i - 1} \tag{4}$$

The standard deviation is equal to the square root of the variance; but, unlike the variance, it is expressed in the same units as the mean. For this reason, the standard deviation is easier to interpret. However, the standard deviation is only significant in relation to the mean. For example, a standard deviation of 1,000 may seem large until it is compared to a mean of 500,000. Similarly, a standard deviation of .25 sounds small. However, it may be large in comparison to a mean value of .05.

Standard Error of the Mean

The sample collected in this study is one of many potential samples that could have been drawn from the working population of wheat and barley producers in the Northern Plains. It is very likely that mean values computed from different samples will be different. The standard error of the mean provides information about the likely dispersion of sample means.

Suppose that all possible unique samples of a certain size are drawn from a population and a mean value is computed from each sample. If the sample size is sufficiently large, these sample averages will form a normal distribution. In theory, the mean of the sampling distribution will be equal to the unknown population mean. Moreover, the variance of the sampling distribution will be much smaller than the variance of the population. Based on the normal distribution, it is possible to predict how the means of these samples will be distributed in relation to the population mean.

The standard error of the mean (equation 5) is computed as the standard deviation divided by the square root of the sample size (*n*). The standard error decreases as the size of the sample increases. As noted earlier, more than 4,700 producers participated in the survey. Morever, the sample is large in relation to the population (Table 2). For these reasons, the standard errors of the estimates are expected to be low.

$$s_{\bar{x}} = \frac{s}{\sqrt{n}} \tag{5}$$

In the statistical highlights that follow, the mean and standard error are presented for each sample data item. Some of the responses are weighted by acres planted. Acres planted is a proxy for crop production and an indicator of the relative size of the producer. When a weighted mean is presented, the standard deviation and standard error are derived from the variance as computed in equation (4).

Item Non-Response and Sample Frequency

A random sample of 6,000 wheat and barley producers was drawn from the working population. Ideally, each producer should have responded to the survey and answered all of the questions in the survey. In reality, these lofty goals are rarely realized in large surveys. It is impractical and very costly to continue pursuing non-respondents after multiple calls.

Approximately 78 percent of the sample (4,705 farm operators) responded to the survey. In some cases, the respondents did not answer all of the questions. For this reason, each question in the survey is treated independently. If a farm operator did not respond to question 4, the number of sample observations for question 4 reflects the farmer's non-response. However, an item non-response doesn't invalidate the farmer's responses to other questions in the survey.

In the tables presented in this report, *N* represents the number of responses to a question or part of a question. The value of N always reflects the non-response frequency for the data item.

Item non-responses are most likely to occur when a farmer doesn't have the information readily available, responds "I don't know" to a question, or leaves the item blank on a returned questionnaire. In most of the tables presented in this report, the sample frequencies (N-values) are large. However, the frequencies of response for durum and winter wheat are generally lower than the frequencies of response for spring wheat and barley. Many of the farmers in the survey did not plant durum or winter wheat acres. Responses with lower associated N-values should be viewed with greater caution.

Farm-to-Market Flow Patterns

Seasonal Variance

Farm-to-market shipments are subject to considerable seasonal variance. Peak movements occur during brief harvest periods that may last for a month or less. During these periods, farmers move grains directly to elevators, processing plants, or feed lots. The remaining grain is stored on-farm or consumed immediately for feed or other purposes.

This seasonal pattern is evident in the sample data. Approximately 34 percent of the respondents' 1999 winter wheat crop was shipped off-farm during harvest (Table 3). Approximately 31 percent of the respondents' 1999 barley crop and 27 percent of their 1999 spring wheat crop was shipped off-farm during the harvest period (Table 3). In comparison, only 21 percent of the respondents' 1999 durum crop was shipped directly off-farm during harvest.

Table 3. Percent of 1999 Crop Moved Directly Off-Farm During Harvest: Weighted by Acres Planted

Crop	N	Weighted Mean Percent	Standard Error
Barley	1,462	30.6	1.0
Durum Wheat	935	21.2	1.0
Spring Wheat	3,558	26.5	0.6
Winter Wheat	741	33.6	1.5

Effects of Scale of Production on Peak Period Movements

Spring wheat is the crop planted most frequently by the respondents. Table 4 shows the quantiles of the distribution for cultivated acres of spring wheat. Quantiles include percentiles, quartiles, and the median. When a set of data values is arrayed in ascending order, the 25th percentile is the observation below which 25 percent of the responses fall. In Table 4, the 25th percentile is 110 acres. This means that 25 percent of the respondents planted less than 110 acres of spring wheat in 1999. The median value of 260 means that half of the respondents planted less than 260 acres of spring wheat in 1999.

Table 4. Quantiles of a Sample Distribution for Spring Wheat Acres Planted in 1999

Quantile	Estimate
100%	6,625
99%	2,400
95%	1,350
90%	1,000
75%	550
50%	260

The 25th and 75th percentiles are referred to as the lower and upper quartiles of the distribution – Q1 and Q3, respectively. In this distribution, the 90th percentile is equal to 1000 acres. The 25th, 50th, 75th, and 90th percentiles of the spring wheat distribution are used to stratify the responses to the previous question. This stratification is shown in Table 5.

As shown in Table 5, the percent of spring wheat moved off-farm during harvest is greatest for the smallest producers and increases with the scale of production. This relationship is explained somewhat by the greater on-farm storage capacities of larger producers. On-farm storage has the effect of spreading the peak farm-to-market movement.

Table 5. Percent of 1999 Spring Wheat Crop Moved Directly Off-Farm During Harvest Stratified by Acres Planted

Acres Planted	N	Weighted Mean Percent	Standard Error
Less than 110	806	48.5	1.7
Less than 260	899	33.1	1.4
Less than 550	871	29.9	1.3
Less than 1,000	557	27.2	1.4
1,000 or Greater	385	22.5	1.6

Disposition of 1999 Wheat and Barley Crops

Under typical weather conditions, most of the wheat and barley produced in the Northern Plains is harvested in August. Most of the survey work for this project was conducted in late April and early May of 2000 – approximately 9 months after harvest. About 68 percent of the barley crop reflected in the survey had been transported to off-farm locations at the time the surveys were answered by the respondents (Table 6). Almost all of these barley shipments had been delivered to elevators. As of May 2000, less than five percent of the 1999 barley crop reflected in the survey had been shipped to feed lots or processing plants. About 17 percent of the respondents' barley crop had been stored for later delivery to elevators, processing plants, or other off-farm location. Another 11 percent of the respondents' barley crop had been stored on-farm for the producers' own future use (e.g., for livestock feed).

Table 6. Percentages of 1999 Barley Crop Moved Off-Farm or Stored On-Farm as of May 2000: Weighted by Acres Planted

Disposition of Crop	N	Weighted Mean Percent	Standard Error
Moved to Elevator	1,387	67.7	1.1
Moved to Processor	1,387	2.4	0.4
Moved to Feed Lot	1,387	2.6	0.4
Stored for Later Delivery	1,387	16.8	0.8
Stored for Own Use	1,387	10.6	0.8

As of May 2000, approximately half of the durum wheat crop reflected in the survey had been delivered to elevators (Table 7). In contrast, only 1.4 percent of durum wheat had been delivered to a processing plant or feed lot. As of May 2000, more than 40 percent of the respondents' 1999 durum crop had been stored on-farm for future delivery to an off-farm location.

As of May 2000, two-thirds of the respondents' spring wheat and winter wheat crops had been delivered to elevators (Tables 8 and 9, respectively). As of this date, another 29 percent of the respondents' spring wheat crop and 27 percent of their winter wheat crop had been stored on-farm for future delivery to an off-farm location.

The N-values are large for the responses shown in Tables 6-9. However, the distributions are skewed. In general, only small percentages of each crop grown by the respondents had been delivered to processors or feed lots 9 months after harvest. The predominant off-farm destination was the elevator. Most of the grains stored on-farm were stored in expectation of future deliveries rather than for the farmer's own use.

Table 7. Percentages of 1999 Durum Wheat Crop Moved Off-Farm or Stored On-Farm as of May 2000: Weighted by Acres Planted			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	901	52.7	1.3
Moved to Processor	901	0.8	0.3
Moved to Feed Lot	901	0.6	0.2
Stored for Later Delivery	901	40.8	1.3
Stored for Own Use	901	5.1	0.6

Table 8. Percentages of 1999 Spring Wheat Crop Moved Off-Farm or Stored On-Farm as of May 2000: Weighted by Acres Planted			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	3,490	67.0	0.6
Moved to Processor	3,490	1.2	0.2
Moved to Feed Lot	3,490	0.3	0.1
Stored for Later Delivery	3,490	28.7	0.6
Stored for Own Use	3,490	2.8	0.2

Table 9. Percentages of 1999 Winter Wheat Crop Moved Off-Farm or Stored On-Farm as of May 2000: Weighted by Acres Planted

Disposition of Crop	N	Weighted Mean Percent	Standard Error
Moved to Elevator	702	67.0	1.4
Moved to Processor	702	1.4	0.4
Moved to Feed Lot	702	0.6	0.2
Stored for Later Delivery	702	27.4	1.4
Stored for Own Use	702	3.6	0.5

Truck Fleet Characteristics

Truck Types Owned by Farmers

For many decades, farm operators have delivered grain to market using a variety of truck configurations. One of the earliest and most popular models is the single-unit truck with a single rear axle (Figure 1). This truck is very versatile and maneuverable. It serves many on-farm purposes. It is also used for off-farm deliveries, especially during harvest. Many of these trucks are older models purchased many years ago and are fully depreciated. However, they are still quite functional even though they may not be used as often as in the past.

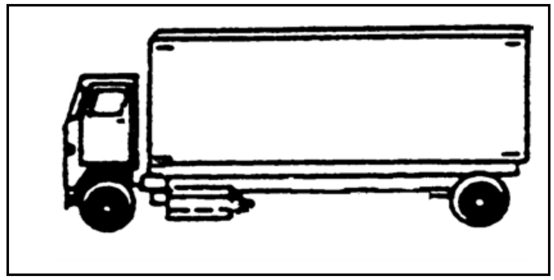

Figure 1 Single-Axle Single-Unit Truck

A 1980 survey by the Upper Great Plains Transportation Institute found that more than 80% of the farm truck fleet in North Dakota consisted of two-axle single-unit trucks (Griffin, 1984). The average farm-to-market trip distance in 1980 was 12 miles (Griffin, 1984). These historical benchmarks will be used later for comparative purposes.

Over time, the single rear axle of the traditional farm truck has become a limitation. Federal weight limits restrict a single-axle weight to 20,000 pounds on the Interstate Highway System. Most states have adopted the same limit for other highways. Thus, a larger box or cargo area may not yield a significant increase in net weight.

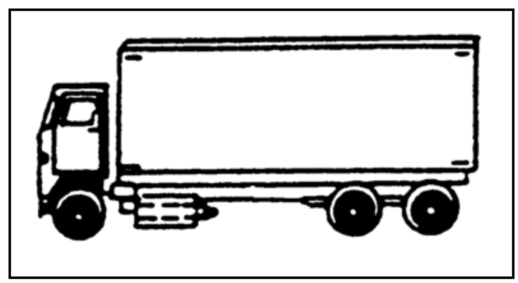

Figure 2 Tandem-Axle Single-Unit Truck

The tandem-axle single-unit truck (Figure 2) allows higher gross weights without a large increase in wheel base. Federal regulations allow tandem-axle weights of 34,000 pounds on the Interstate Highway System. Most states have adopted the same limit for other highways.

A third truck type – the tridem axle – allows even more weight on a single-unit truck frame (Figure 3). On interstate highways, the maximum weight on a tridem or triple axle is restricted by the federal bridge formula (Bridge Formula B). A tridem axle with a length of 8 feet (as measured between the centers of the outer or extreme axles in the set) can weigh 42,000 pounds. Thus, a larger cargo area allows greater net loads. However, the tridem-axle truck weighs more when empty and costs more than the tandem-axle truck.

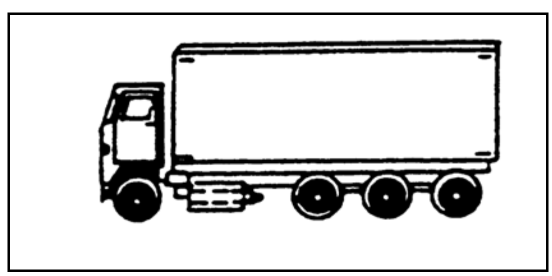

Figure 3 Tridem-Axle Single-Unit Truck

It should be noted that the federal bridge formula also restricts the gross weights of trucks. Thus, a tridem-axle truck with an overall spread of 21 feet from the center of the front steering axle to the center of the last (fourth) axle is restricted to 56,000 pounds under Bridge Formula B. The same formula also restricts the gross weights of tandem- and single-axle trucks.

The tractor-semitrailer ("semi") is the most popular type of truck in the United States. More than one axle configuration is included in this group. However, the combination 5-axle truck (Figure 4) is the most common type. It can operate at 80,000 pounds on the Interstate Highway System provided that the overall distance between the extreme axle centers is 51 feet or greater. Each tandem axle usually weighs 34,000 pounds while the front steering axle weighs 12,000 pounds. Although the empty weight of the tractor and semi-trailer is greater than the empty weight of a single-unit truck, the 5-axle semi can haul more than 54,000 pounds of wheat in a single trip.

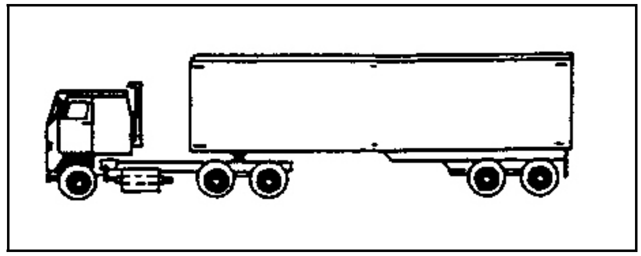

Figure 4 Five-Axle "Semi"

Instead of the trailer depicted in Figure 4, many farmers own specialized "hopper" trailers. These trailers have two large hopper bins that allow for gravity-propelled discharge over unloading pits at elevators and plants.

Another popular "semi" configuration is the tridem-axle trailer (Figure 5). This truck may be restricted in some states and on some highways. Most county roads have 80,000-pound load limits, thus reducing the incremental benefits of these trucks for farm-to-market movements. When farmers use the term "semi" to describe trucks which they own or lease, they are probably referring to the combination five-axle truck.

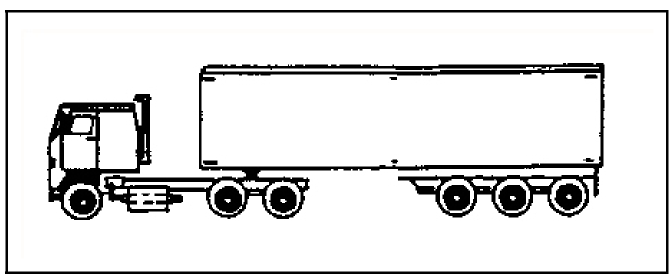

Figure 5 Six-Axle "Semi"

In some areas of the Northern Plains, farmers use "gravity wagons." Other truck configurations – such a tractor-semitrailer combination pulling a pup trailer – may be used on certain state highways with special permits. However, access to and from farms is frequently provided by county or local roads, many of which are restricted to 80,000-pound loads regardless of the truck configuration.

Truck Ownership by Farm Operators in the Northern Plains

Approximately 90% of the respondents to the survey owned at least one type of truck in 2000. Only 4 percent of these producers leased trucks in 2000. Presumably, those farmers who didn't own or lease a truck utilized commercial (custom-hauling) services.

Collectively, the 4,705 respondents reported owning 11,185 trucks (Table 10) and leasing another 261 units. Table 11 shows the projected number of trucks owned by the respondents in 2005. As the comparison shows, they expect to own 7 percent fewer trucks in 2005 than in 2000. Apparently, this change will result from a substitution of semi and tridem-axle trucks for single-axle trucks. As the comparison shows, the respondents expect to own 17 percent fewer single-axle trucks in 2005 than in 2000.[10]

As will be illustrated later in the report, about three times more wheat can be moved in a semi-truck in one trip than in a single-axle truck. Moreover, the cargo capacity of a tridem-axle truck is more than twice that of a single-axle truck. Thus, when replacing trucks, producers can increase cargo capacity per trip and own fewer trucks.

Table 10. Number of Trucks Owned by Survey Respondents in 2000

Truck Type	N	Total Trucks
All	6,969	11,185
Other	114	132
Semi	756	1,000
Single Axle	3,418	5,862
Tandem Axle	1,816	2,812
Tridem Axle	257	387
Wagon	608	992
All		11,185

Table 11. Projected Number of Trucks Owned by Survey Respondents in 2005		
Truck Type	**N**	**Total Trucks**
Other	94	114
Semi	942	1,270
Single Axle	2,802	4,886
Tandem Axle	1,783	2,786
Tridem Axle	317	488
Wagon	509	845
All		10,389

Table 12 shows the average number of trucks owned by this sample of farmers in 2000, stratified by truck type. The mean value for each row reflects the average for "N" respondents. Zero or missing values are not reflected in the mean.

For example, 3,418 farm operators said they owned at least one single-axle truck in 2000 (Table 12). On average, the 3,418 farm operators owned 1.7 single-axle trucks. More than 1800 of the respondents owned tandem-axle trucks in 2000 (Table 12). On average, these operators owned 1.5 tandem-axle trucks. More than 750 respondents said they owned a semi. On average, these operators owned 1.3 semi-trucks. Approximately 600 respondents owned gravity wagons. These 600 respondents owned 1.6 gravity wagons each.

Table 12. Average Trucks Currently Owned by Farm Operators			
Truck Type	**N**	**Mean**	**Standard Error**
Other	114	1.2	0.041
Semi	756	1.3	0.033
Single Axle	3,418	1.7	0.016
Tandem Axle	1,816	1.5	0.023
Tridem Axle	257	1.5	0.068
Wagon	608	1.6	0.039

Use of Farm Trucks in the Northern Plains

Table 13 shows the average annual miles per truck for the wheat and barley producers reflected in the sample. It isn't surprising that the highest annual mileage shown in Table 13 is for the semi-truck. This truck type is more expensive to purchase than most other trucks. Thus, when farm operators purchase tractors and semi-trailers, they expect to utilize them intensively.

The tridem-axle truck shows the next highest utilization rate, followed by the tandem-axle and single-axle trucks, in that order. Much of the difference in annual use can be explained by the greater payload capacities of the semi, tridem, and tandem-axle trucks, in comparison to the single-axle truck.

Table 13. Average Annual Miles Per Truck for Survey Respondents Weighted by Total Acres Planted

Truck Type	N	Weighted Mean	Standard Error
Other	77	1,886	305
Semi	744	8,035	509
Single Axle	2,598	2,059	46
Tandem Axle	1,596	3,507	85
Tridem Axle	237	4,970	306
Wagon	331	764	142

Another important factor in farm truck use is the proportion of truck-miles consumed in hauling the farmer's own commodities, as opposed to providing custom-hauling services for others, or using the truck for general business purposes. The semi is the only type of truck with any significant use in custom-hauling. Approximately six percent of the respondents' annual semi truck-miles were accumulated in providing services for others. About two percent of the tridem-axle truck-miles were devoted to the same purpose. For other truck types, one percent or less of the annual truck-miles were attributed to hauling products for others.

The wheat and barley farmers represented in this sample primarily use their trucks to haul their own commodities to market (Table 14). As Table 15 shows, the single-axle truck is the one used most often for other purposes. This truck has many general farm and business purposes.

Table 14. Percent of Truck-Miles Hauling Owned Commodities: Weighted by Total Acres Planted			
Truck Type	**N**	**Weighted Mean Percent**	**Standard Error**
Other	79	85	3.5
Semi	738	86	1.0
Single Axle	2,589	71	0.7
Tandem Axle	1,595	86	0.6
Tridem Axle	236	86	1.7
Wagon	338	63	2.5

Table 15. Percent of Truck-Miles for Other Uses: Weighted by Total Acres Planted			
Truck Type	**N**	**Weighted Mean Percent**	**Standard Error**
Other	79	14.5	3.5
Semi	738	7.9	0.7
Single Axle	2,589	28.6	0.7
Tandem Axle	1,595	13.0	0.6
Tridem Axle	236	11.8	1.5
Wagon	338	36.7	2.5

Farm Truck Weights

The next set of tables describe the producers' responses to questions about truck weights. The average truck weight in pounds for each type of truck used to haul wheat is shown in Table 16. All three varieties of wheat are of the same density (60 pounds per bushel). Thus, the net load in a given type of truck should be the same for spring, winter, and durum wheat.

The data presented in Table 16 underscore the relative load capacities of the truck types. Essentially, it takes three single-axle truck trips to move the same amount of wheat that can be moved in a single semi-truck trip. Moreover, the cargo capacity of a tridem-axle truck is more than twice that of a single-axle truck.

Table 16. Average Net Truck Weights (in Pounds) for Wheat Movements: Weighted by Acres Planted			
Truck Type	**N**	**Mean Net Load (lb)**	**Standard Error**
Other	52	53,862	6,042
Semi	1,388	54,156	201
Single Axle	1,706	18,886	70
Tandem Axle	1,551	31,006	91
Tridem Axle	252	38,286	380
Wagon	103	18,991	916

Unlike wheat, barley weighs 48 pounds per bushel. Generally, this difference in commodity density results in lighter payloads as shown in Table 17.

Table 17. Average Net Truck Weights (in Pounds) for Barley Movements: Weighted by Acres Planted			
Truck Type	**N**	**Mean Empty Weight (lb)**	**Standard Error**
Other	12	23,695	2,039
Semi	227	27,292	233
Single Axle	362	10,049	88
Tandem Axle	339	16,774	151
Tridem Axle	49	21,938	406

The empty weights of trucks are independent of the commodity transported. Table 18 shows the average empty or tare weights of the trucks used by wheat and barley producers.

Table 18. Average Empty Truck Weights (in Pounds): Weighted by Acres Planted

Truck Type	N	Mean Empty Weight (lb)	Standard Error
Other	49	22,529	1,196
Semi	1,126	28,077	176
Single Axle	1,907	9,925	35
Tandem Axle	1,745	16,439	62
Tridem Axle	271	22,046	170
Wagon	83	3,748	312

Farm-to-Market Trip Distances

Average One-Way Distances

In the early 1980s, the average farm-to-market trip distance in North Dakota was about 12 miles (Griffin, 1984). In 2000, the average trip distance for wheat movements in a semi-truck, as computed from the sample data, was: 7 miles on unpaved roads and 25 miles on paved roads (Tables 2.19 and 2.20). The average wheat shipment in a tridem-axle truck traveled 5 miles on unpaved roads and 15 miles on paved roads. In comparison, the average wheat shipment in a single-axle truck traveled 6 miles over unpaved roads and 8 miles over paved roads. These results are specific to the sample of wheat and barley producers drawn from the Northern Plains region.

Table 19. Average Loaded Trip Distance for Wheat Movements on Paved Roads: Weighted by Acres Planted

Truck Type	N	Mean One-Way Distance (Miles)	Standard Error
Other	58	19.2	3.28
Semi	1,473	25.2	0.97
Single Axle	1,727	8.1	0.26
Tandem Axle	1,608	10.6	0.34
Tridem Axle	262	13.5	0.87
Wagon	103	11.3	2.59

Average farm-to-market trip distances tend to be greater for barley than for wheat (Tables 2.21 and 2.22). This difference reflects a greater share of movements to processing plants and feed lots. For example, the average loaded semi-truck movement of barley traveled 6 miles on unpaved roads and 38 miles on paved roads in 2000. The average shipment of barley in a tridem-axle truck traveled more than 24 miles from farm to market. Again, these results are specific to the sample of wheat and barley producers in the Northern Plains region.

Table 20. Average Loaded Trip Distance for Wheat Movements on Unpaved Roads (in Miles): Weighted by Acres Planted			
Truck Type	**N**	**Mean One-Way Distance (Miles)**	**Standard Error**
Other	58	6.5	0.74
Semi	1,473	7.2	0.22
Single Axle	1,727	5.7	0.14
Tandem Axle	1,608	5.3	0.14
Tridem Axle	262	4.8	0.39
Wagon	103	4.0	0.53

Table 21. Average Loaded Trip Distance for Barley Movements on Paved Roads: Weighted by Acres Planted			
Truck Type	**N**	**Mean One-Way Distance (Miles)**	**Standard Error**
Other	15	42.6	15.24
Semi	352	38.3	4.53
Single Axle	393	7.6	0.47
Tandem Axle	379	11.0	0.70
Tridem Axle	59	17.4	2.64
Wagon	10	5.2	1.04

Table 22. Average Loaded Trip Distance for Barley Movements on Unpaved Roads (in Miles) Weighted by Acres Planted			
Truck Type	**N**	**Mean One-Way Distance (Miles)**	**Standard Error**
Other	15	5.0	1.80
Semi	352	5.7	0.36
Single Axle	393	5.4	0.27
Tandem Axle	379	4.9	0.26
Tridem Axle	59	6.7	0.81
Wagon	10	1.6	0.76

Longest Delivery Trips

The average trip distances provide important information. However, it is also interesting to examine the longest farm-to-market trip. A set of survey questions asked producers about their longest one-way trips to deliver their 1999 crops. For some producers, this response may represent a single trip. For others, it may represent the distance to a frequent destination (e.g., the farthest elevator or a processing plant). Consequently, for this set of questions, average distances may be misleading. Instead of averages, the quantiles of the distributions are examined.

Table 23 shows the quartiles of the distributions for each commodity. The lower quartile value (or 25th percentile) indicates that for 25 percent of the respondents, the longest one-way trip to deliver any commodity was less than 10 miles. The median longest trip ranged from 16 to 20 miles. The upper quartile values (or 75th percentile) ranged from 30 to 35 miles for the four commodities. In other words, for 75 percent of the respondents, the longest trip to deliver spring wheat was less than 30 miles, and the longest trip to deliver any commodity was less than 35 miles.

Table 23. Longest One Way Trip to Deliver Grain (in Miles) Quartiles of Distribution				
Crop	**N**	**Lower Quartile**	**Median Value**	**Upper Quartile**
Barley	1,219	10	18	32
Durum Wheat	851	10	18	35
Spring Wheat	3,372	9	16	30
Winter Wheat	683	10	20	35

Table 24 shows the higher percentiles and extreme values of the distributions. The 90th percentile is the value on or above which 10 percent of the responses fall. As the table shows, 10 percent of the producers delivered barley to destinations at least 70 miles away from their farms. Moreover, 5 percent of the producers delivered barley to destinations at least 130 miles away from their farms.

Table 24. Longest One-Way Trip to Deliver Grain (in Miles) Extreme Percentiles of Distribution				
Crop	**N**	**90th Percentile**	**95th Percentile**	**Maximum Value**
Barley	1,219	70	130	2,002
Durum Wheat	851	65	100	450
Spring Wheat	3,372	52	80	2,500
Winter Wheat	683	68	90	400

One of the most extreme values in a distribution is the maximum or greatest value. It may represent a very unusual situation that faces a single producer only once. Too much significance should not be attributed to these values. Nevertheless, they illustrate the limits of a producer’s willingness to delivery at least one truck load of commodity.

The maximum distances for spring wheat and barley shown in Table 24 make sense only for direct deliveries from the Northern Plains to southern California or southeast coastal locations. The maximum distances for durum and winter wheat may represent direct deliveries to inland mills. The 95th percentile values show that the longest trip to deliver wheat was 100 miles or less for 95 percent of the respondents.

Conclusion

This report has presented the results of a survey of farm-to-market transportation characteristics in the Northern Plains region. The survey results are specific to producers of wheat and barley. The survey results show that:

- Wheat and barley producers own and operate a sizable fleet of trucks and deliver much of their products to market.
- These farm operators use their trucks primarily to haul their own commodities to markets and not for commercial purposes.
- The trucks owned most frequently by wheat and barley producers are the single-axle and tandem-axle models. However, the frequencies of tridem-axle and semi trucks are expected to increase during the next five years.
- Although the wheat and barley producers that responded to this survey expect to own fewer trucks in 2005 than in 2000, their aggregate transportation capacity may increase as a result of more tridem-axle and semi trucks in the fleet.
- Wheat and barley producers are delivering longer distances today than the average trip distances shown in earlier studies. The elevator is the most common destination. However, longer trips are occurring to processing plants and mills.
- A significant peak movement occurs during harvest. However, on-farm storage is helping spread farm-to-market flows over many months.

The mean or average values presented in this report relate only to the sample population of 4,705 wheat and barley producers. The sample is thought to be representative of wheat and barley producers in the region. However, the data presented in this report should not be used to estimate population values such as truck-miles of travel or total trucks owned in the region. Detailed results for each state are shown in the appendix.

Select References

Baumel C. Phillip, J. Gervias, H. Hommes, and C. O'Riley. *The Iowa Grain Flow Survey*. Iowa State University, September, 1996.

Griffin, Gene C., W.W. Wilson, and K. Casavant. Characteristics and Costs of Operation of North Dakota's Farm Trucks, Upper Great Plains Transportation Institute, 1984.

Notes

1.The source of this information is U.S. Census Bureau, *Statistical Abstract of the United States: 1999*, page 676.

2.Although there are similarities in grain marketing channels, farm-to-market transportation in the Northern Plains is different from corn and soybean movements in the Central Plains. Wheat and barley producers in the Northern Plains have relatively few transportation options. Most of the producers are located considerable distances from the Mississippi River. Wheat and barley producers are served by a large number of small and mid-sized "country" elevators. For example, North Dakota alone has more than 400 elevators that serve as destinations for farm-to-market movements. In contrast, much of the corn and soybean traffic is destined for a limited number of inland terminals and river ports. These factors may result in differences in the delivery practices of farmers, the types of vehicles used, and patterns of vehicle utilization.

3. U.S. Census Bureau, *Statistical Abstract of the United States: 1999*, Appendix III, page 936.

4.U.S. Census Bureau, *Statistical Abstract of the United States: 1999*, Appendix III, page 936.

5.U.S. Census Bureau, *Statistical Abstract of the United States: 1999*, Appendix III, page 936.

6.Such uncertainties exist for most target populations. Farm populations are not unusual in this regard.

7.NASS description of area frame concept displayed at agency website: www.usda.gov/nass.

8. The fact that a farmer produced a crop in a previous year is not an assurance that the same farmer will produce the same crop in the current (survey) year. Moreover, a farmer who didn't produce barley last year may plant barley in the survey year.

9.However, a respondent's answer to a question was always accepted after a clarifying question was asked.

10.The trend in truck ownership may also reflect the fact that a greater number of farm operators will own no trucks at all in 2005 (and presumably relying on custom haulers completely).

Appendix A. Detailed State and Crop Reports

Table A.1-Percent of 1999 Minnesota Crop Moved Directly Off-Farm During Harvest Weighted by Acres Planted

Crop	N	Weighted Mean Percent	Standard Error
Barley	82	16.5	3.7
Spring Wheat	418	25.6	1.7
Winter Wheat	46	31.4	6.7

Table A.2-Percent of 1999 Montana Crop Moved Directly Off-Farm During Harvest Weighted by Acres Planted

Crop	N	Weighted Mean Percent	Standard Error
Barley	475	29.4	1.8
Durum Wheat	82	16.0	3.3
Spring Wheat	966	20.2	1.1
Winter Wheat	307	24.8	2.1

Table A.3-Percent of 1999 North Dakota Crop Moved Directly Off-Farm During Harvest Weighted by Acres Planted

Crop	N	Weighted Mean Percent	Standard Error
Barley	821	33.1	1.4
Durum Wheat	842	21.6	1.1
Spring Wheat	1,670	29.6	0.9
Winter Wheat	47	26.9	6.1

Table A.4-Percent of 1999 South Dakota Crop Moved Directly Off-Farm During Harvest Weighted by Acres Planted

Crop	N	Weighted Mean Percent	Standard Error
Barley	84	13.9	3.7
Spring Wheat	504	38.9	1.9
Winter Wheat	341	46.8	2.2

Table A.5-Percentages of 1999 Minnesota Barley Crop Moved Off-Farm or Stored On-Farm as of May 2000 Weighted by Acres Planted			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	86	59.1	5.0
Moved to Processor	86	3.8	1.9
Moved to Feed Lot	86	0.1	0.3
Stored for Later Delivery	86	21.5	36.2
Stored for Own Use	86	8.6	2.7

Table A.6-Percentages of 1999 Crop Moved Off-Farm or Stored On-Farm as of May 2000 Weighted by Acres Planted			
Spring Wheat Produced in Minnesota			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	451	71.1	1.7
Moved to Processor	451	1.1	0.4
Moved to Feed Lot	451	0.0	0.0
Stored for Later Delivery	451	20.4	31.4
Stored for Own Use	451	1.6	0.4

Table A.7-Percentages of 1999 Crop Moved Off-Farm or Stored On-Farm as of May 2000 Weighted by Acres Planted			
Winter Wheat Produced in Minnesota			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	50	45.0	6.9
Moved to Processor	50	0.0	0.0
Moved to Feed Lot	50	0.0	0.0
Stored for Later Delivery	50	35.3	46.2
Stored for Own Use	50	6.2	3.0

Table A.8-Percentages of 1999 Crop Moved Off-Farm or Stored On-Farm as of May 2000 Weighted by Acres Planted			
Barley Produced in Montana			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	574	55.6	1.9
Moved to Processor	574	4.6	0.9
Moved to Feed Lot	574	4.7	0.8
Stored for Later Delivery	574	15.1	31.3
Stored for Own Use	574	8.9	1.1

Table A.9-Percentages of 1999 Crop Moved Off-Farm or Stored On-Farm as of May 2000 Weighted by Acres Planted			
Durum Wheat Produced in Montana			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	87	54.0	4.3
Moved to Processor	87	2.4	1.6
Moved to Feed Lot	87	0.0	0.0
Stored for Later Delivery	87	27.3	33.5
Stored for Own Use	87	8.1	2.5

Table A.10-Percentages of 1999 Crop Moved Off-Farm or Stored On-Farm as of May 2000 Weighted by Acres Planted			
Spring Wheat Produced in Montana			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	1,030	62.4	1.2
Moved to Processor	1,030	1.6	0.3
Moved to Feed Lot	1,030	0.3	0.1
Stored for Later Delivery	1,030	28.6	35.3
Stored for Own Use	1,030	2.4	0.3

Table A.11-Percentages of 1999 Crop Moved Off-Farm or Stored On-Farm as of May 2000 Weighted by Acres Planted			
Winter Wheat Produced in Montana			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	330	59.9	2.3
Moved to Processor	330	2.0	0.7
Moved to Feed Lot	330	0.6	0.3
Stored for Later Delivery	330	24.4	34.2
Stored for Own Use	330	2.3	0.6

Table A.12-Percentages of 1999 Crop Moved Off-Farm or Stored On-Farm as of May 2000 Weighted by Acres Planted			
Barley Produced in North Dakota			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	841	70.3	1.4
Moved to Processor	841	0.4	0.2
Moved to Feed Lot	841	0.5	0.2
Stored for Later Delivery	841	15.8	29.3
Stored for Own Use	841	8.7	0.9

Table A.13-Percentages of 1999 Crop Moved Off-Farm or Stored On-Farm as of May 2000 Weighted by Acres Planted			
Durum Wheat Produced in North Dakota			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	890	49.5	1.3
Moved to Processor	890	0.6	0.2
Moved to Feed Lot	890	0.6	0.2
Stored for Later Delivery	890	39.6	38.5
Stored for Own Use	890	4.4	0.5

Table A.14-Percentages of 1999 Crop Moved Off-Farm or Stored On-Farm as of May 2000 Weighted by Acres Planted			
Spring Wheat Produced in North Dakota			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	1,722	65.7	0.9
Moved to Processor	1,722	0.8	0.2
Moved to Feed Lot	1,722	0.2	0.1
Stored for Later Delivery	1,722	27.6	34.4
Stored for Own Use	1,722	2.9	0.2

Table A.15-Percentages of 1999 Crop Moved Off-Farm or Stored On-Farm as of May 2000 Weighted by Acres Planted		
Winter Wheat Produced in North Dakota		
Disposition of Crop	**N**	**Weighted Mean Percent**
Moved to Elevator	51	46.3
Moved to Processor	51	0.7
Moved to Feed Lot	51	0.5
Stored for Later Delivery	51	22.8
Stored for Own Use	51	2.2

Table A.16-Percentages of 1999 Crop Moved Off-Farm or Stored On-Farm as of May 2000 Weighted by Acres Planted			
Barley Produced in South Dakota			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	81	31.3	4.8
Moved to Processor	81	1.3	1.3
Moved to Feed Lot	81	1.1	1.1
Stored for Later Delivery	81	9.8	27.4
Stored for Own Use	81	53.6	5.3

Table A.17-Percentages of 1999 Crop Moved Off-Farm or Stored On-Farm as of May 2000 Weighted by Acres Planted			
Durum Wheat Produced in South Dakota			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	10	31.5	13.3
Moved to Processor	10	0.0	0.0
Moved to Feed Lot	10	0.0	0.0
Stored for Later Delivery	10	37.7	31.4
Stored for Own Use	10	24.0	9.3

Table A.18-Percentages of 1999 Crop Moved Off-Farm or Stored On-Farm as of May 2000 Weighted by Acres Planted			
Spring Wheat Produced in South Dakota			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	535	56.1	1.9
Moved to Processor	535	1.1	0.4
Moved to Feed Lot	535	0.6	0.3
Stored for Later Delivery	535	32.0	40.7
Stored for Own Use	535	4.8	0.7

Table A.19-Percentages of 1999 Crop Moved Off-Farm or Stored On-Farm as of May 2000 Weighted by Acres Planted			
Winter Wheat Produced in South Dakota			
Disposition of Crop	**N**	**Weighted Mean Percent**	**Standard Error**
Moved to Elevator	357	64.6	2.0
Moved to Processor	357	0.3	0.3
Moved to Feed Lot	357	0.6	0.2
Stored for Later Delivery	357	26.7	36.2
Stored for Own Use	357	4.9	0.8

Table A.20-Average Trucks Currently Owned by Farm Operators			
Minnesota			
Truck Type	**N**	**Mean**	**Standard Error**
Semi	55	1.3	0.096
Single Axle	279	1.5	0.051
Tandem Axle	242	1.8	0.066
Tridem Axle	45	1.6	0.136
Wagon	139	1.9	0.102

Table A.21-Average Trucks Currently Owned by Farm Operators			
Montana			
Truck Type	**N**	**Mean**	**Standard Error**
Semi	176	1.4	0.077
Single Axle	916	1.9	0.037
Tandem Axle	366	1.5	0.043
Tridem Axle	37	1.4	0.202
Wagon	10	1.3	0.300

Table A.22-Average Trucks Currently Owned by Farm Operators			
North Dakota			
Truck Type	**N**	**Mean**	**Standard Error**
Other	34	1.2	0.082
Semi	399	1.4	0.050
Single Axle	1,745	1.7	0.020
Tandem Axle	995	1.6	0.034
Tridem Axle	156	1.6	0.092
Wagon	257	1.3	0.036

Table A.23-Average Trucks Currently Owned by Farm Operators			
South Dakota			
Truck Type	**N**	**Mean**	**Standard Error**
Other	69	1.1	0.046
Semi	126	1.2	0.039
Single Axle	478	1.4	0.027
Tandem Axle	213	1.3	0.038
Tridem Axle	19	1.2	0.086
Wagon	202	1.9	0.074

Table A.24-Projected Number of Trucks Owned by Farm Operators in 2005			
Minnesota			
Truck Type	**N**	**Mean**	**Standard Error**
Semi	77	1.4	0.066
Single Axle	223	1.5	0.052
Tandem Axle	225	1.9	0.070
Tridem Axle	53	1.7	0.133
Wagon	114	2.0	0.118

Table A.25-Projected Number of Trucks Owned by Farm Operators in 2005			
Montana			
Truck Type	**N**	**Mean**	**Standard Error**
Semi	180	1.4	0.073
Single Axle	798	1.9	0.040
Tandem Axle	367	1.5	0.042
Tridem Axle	38	1.5	0.213

Table A.26-Projected Number of Trucks Owned by Farm Operators in 2005			
North Dakota			
Truck Type	**N**	**Mean**	**Standard Error**
Other	33	1.2	0.098
Semi	518	1.4	0.040
Single Axle	1,405	1.8	0.023
Tandem Axle	972	1.6	0.033
Tridem Axle	203	1.6	0.081
Wagon	245	1.3	0.040

Table A.27-Projected Number of Trucks Owned by Farm Operators in 2005			
South Dakota			
Truck Type	N	Mean	Standard Error
Other	50	1.2	0.064
Semi	167	1.2	0.042
Single Axle	376	1.4	0.032
Tandem Axle	219	1.3	0.055
Tridem Axle	23	1.1	0.060
Wagon	146	2.0	0.098

Table A.28-Average Loaded Trip Distance on Paved Roads Weighted by Acres Planted			
Barley Produced in Minnesota			
Truck Type	**N**	**Mean One-Way Distance (Miles)**	**Standard Error**
Semi	12	36.5	16.16
Single Axle	14	6.4	1.50
Tandem Axle	19	8.7	1.91

Table A.29-Average Loaded Trip Distance on Paved Roads Weighted by Acres Planted			
Wheat Produced in Minnesota			
Truck Type	N	Mean One-Way Distance (Miles)	Standard Error
Semi	73	29.7	6.56
Single Axle	128	5.9	0.45
Tandem Axle	184	7.5	0.51
Tridem Axle	39	10.5	1.85
Wagon	45	3.2	0.67

Table A.30-Average Loaded Trip Distance on Paved Roads Weighted by Acres Planted			
Barley Produced in Montana			
Truck Type	N	Mean One-Way Distance (Miles)	Standard Error
Semi	134	36.4	9.38
Single Axle	112	8.2	1.03
Tandem Axle	92	12.4	1.13
Tridem Axle	12	26.3	8.29

Table A.31-Average Loaded Trip Distance on Paved Roads Weighted by Acres Planted			
Wheat Produced in Montana			
Truck Type	N	Mean One-Way Distance (Miles)	Standard Error
Other	10	23.2	5.16
Semi	508	32.5	2.08
Single Axle	372	10.1	0.84
Tandem Axle	314	15.6	1.16
Tridem Axle	42	22.1	2.85

Table A.32-Average Loaded Trip Distance on Paved Roads Weighted by Acres Planted			
Barley Produced in North Dakota			
Truck Type	**N**	**Mean One-Way Distance (Miles)**	**Standard Error**
Other	12	51.0	18.75
Semi	198	39.2	4.02
Single Axle	258	7.2	0.46
Tandem Axle	260	9.9	0.77
Tridem Axle	39	14.8	2.76

Table A.33-Average Loaded Trip Distance on Paved Roads Weighted by Acres Planted			
Wheat Produced in North Dakota			
Truck Type	**N**	**Mean One-Way Distance (Miles)**	**Standard Error**
Other	26	16.2	4.22
Semi	573	18.1	0.93
Single Axle	988	7.3	0.25
Tandem Axle	895	8.4	0.31
Tridem Axle	164	11.6	0.93
Wagon	13	4.5	1.11

Table A.34-Average Loaded Trip Distance on Paved Roads Weighted by Acres Planted			
Barley Produced in South Dakota			
Truck Type	**N**	**Mean One-Way Distance (Miles)**	**Standard Error**
Semi	8	107.1	21.77
Single Axle	9	12.5	9.67
Tandem Axle	8	43.2	20.69

Table A.35-Average Loaded Trip Distance on Paved Roads Weighted by Acres Planted			
Wheat Produced in South Dakota			
Truck Type	**N**	**Mean One-Way Distance (Miles)**	**Standard Error**
Other	18	25.9	9.54
Semi	319	22.9	1.44
Single Axle	239	8.8	0.57
Tandem Axle	215	15.4	1.01
Tridem Axle	17	11.6	2.75
Wagon	42	3.8	0.52

Table A.36- Average Loaded Trip Distance on Unpaved Roads (in Miles) Weighted by Acres Planted			
Barley Produced in Minnesota			
Truck Type	**N**	**Mean One-Way Distance (Miles)**	**Standard Error**
Semi	12	1.2	0.36
Single Axle	14	2.9	0.50
Tandem Axle	19	2.3	0.53

Table A.37- Average Loaded Trip Distance on Unpaved Roads (in Miles) Weighted by Acres Planted			
Wheat Produced in Minnesota			
Truck Type	**N**	**Mean One-Way Distance (Miles)**	**Standard Error**
Semi	73	2.9	0.35
Single Axle	128	1.9	0.18
Tandem Axle	184	2.2	0.17
Tridem Axle	39	3.5	0.47
Wagon	45	1.3	0.17

Table A.38- Average Loaded Trip Distance on Unpaved Roads (in Miles) Weighted by Acres Planted			
Barley Produced in Montana			
Truck Type	**N**	**Mean One-Way Distance (Miles)**	**Standard Error**
Semi	134	6.6	0.65
Single Axle	112	6.8	0.67
Tandem Axle	92	5.5	0.53
Tridem Axle	12	10.6	2.65

Table A.39- Average Loaded Trip Distance on Unpaved Roads (in Miles) Weighted by Acres Planted			
Barley Produced in North Dakota			
Truck Type	**N**	**Mean One-Way Distance (Miles)**	**Standard Error**
Other	10	8.6	1.92
Semi	508	8.8	0.40
Single Axle	372	8.1	0.35
Tandem Axle	314	7.7	0.39
Tridem Axle	42	9.0	1.82

Table A.40- Average Loaded Trip Distance on Unpaved Roads (in Miles) Weighted by Acres Planted			
Wheat Produced in Montana			
Truck Type	**N**	**Mean One-Way Distance (Miles)**	**Standard Error**
Other	12	5.0	2.54
Semi	198	5.1	0.42
Single Axle	258	4.7	0.25
Tandem Axle	260	4.7	0.32
Tridem Axle	39	5.7	0.71

Table A.41- Average Loaded Trip Distance on Unpaved Roads (in Miles) Weighted by Acres Planted			
Wheat Produced in North Dakota			
Truck Type	**N**	**Mean One-Way Distance (Miles)**	**Standard Error**
Other	26	5.8	1.12
Semi	573	6.2	0.33
Single Axle	988	5.0	0.17
Tandem Axle	895	4.7	0.16
Tridem Axle	164	3.8	0.27
Wagon	13	3.5	0.97

Table A.42- Average Loaded Trip Distance on Unpaved Roads (in Miles) Weighted by Acres Planted			
Wheat Produced in South Dakota			
Truck Type	**N**	**Mean One-Way Distance (Miles)**	**Standard Error**
Other	18	6.7	1.00
Semi	319	7.0	0.42
Single Axle	239	4.9	0.31
Tandem Axle	215	5.0	0.32
Tridem Axle	17	3.3	1.00
Wagon	42	3.1	0.42