NDSU UPPER GREAT PLAINS TRANSPORTATION INSTITUTE

Department Publication No. 284
October 2015

Northern Plains Grain Farm Truck Fleet & Marketing Patterns

prepared by Kimberly Vachal, Ph.D.

ABSTRACT

A survey of farm operators in the Northern Plains Region of North Dakota, northern South Dakota, western Minnesota and eastern Montana was conducted to gather information about transportation of crops, the inventory and characteristics of the farmer-owned truck fleet and on-farm storage capacity. The objective of the study is to provide information about farm truck inventory and grain marketing patterns in the Northern Plains. There is no other source for this information and it should be unique and complementary to other farm-to-market information and national commodity flow publications. Farmers may use the results for their own investment and productivity assessments. Local and regional planners and policy makers can use the information in calibrating travel demand and freight flow models for investment and asset management choices.

Preferred Citation:
Vachal, Kimberly, Northern Plains Grain Farm Truck Fleet & Marketing Patterns. Upper Great Plains Transportation Institute, North Dakota State University, Fargo, September 2015, DP-284.

Acknowledgement
The author would like to acknowledge contribution to the project by Darin Janzi, North Dakota Field Office, U.S. Department of Agriculture's National Statistics Service and Mark Berwick, Upper Great Plains Transportation Institute, North Dakota State University, for their contribution to the project.

Disclaimer
This research was supported by the U.S. Department of Transportation's Office of the Assistant Secretary for Research & Technology under Grant DTOS59-06-G-00046. The contents presented in this report are the sole responsibility of the Upper Great Plains Transportation Institute, North Dakota State University, and its authors.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Agriculture, including traditional grain markets and value-added activities such as food processing, biofuels production, and specialty grains, plays a large role in the economy of North Dakota and neighboring states. The 2012 Agricultural Census shows that farms in these states had crop sales of $32 billion (U.S. Department of Agriculture 2014a). In terms of private income for 2013, North Dakota generated 14.5% of its state gross domestic product from agriculture. That figure was similar in surrounding states: 15.3% in South Dakota, 7.4% in Montana and 5.0% in Minnesota. The share of economic activity attributed to agriculture in these states is far greater than the role of agriculture in the nation's overall economy at 1.8% (Bureau of Economic Analysis 2015).

While the economies of these states have become more diversified over recent decades, the increasing magnitude of agricultural products as a transport-demand component and economic generator is evident in grain production trends. For example, U.S. Department of Agriculture figures show that in 1940 North Dakota produced approximately 9.5 million tons of grain. This grain was transported about 10 miles to local elevator facilities based on the legacy grain gathering system in the Midwest where elevators were spaced about 8 miles apart along the rail line (Ming and Wilson 1983). These early grain movements generated about 95 million farm truck ton-miles in freight demand (National Agricultural Statistics Service 2014). This compares to 800 million bushels, or 30 million tons, of grain moving approximately 30 miles to subterminal elevator facilities and local agricultural processors in 2010 (Tolliver et al. 2005) – 900 million farm truck ton-miles (Figure 1.1). This trend is related to changes in marketing patterns, farm management, agricultural technology and agronomic practices.

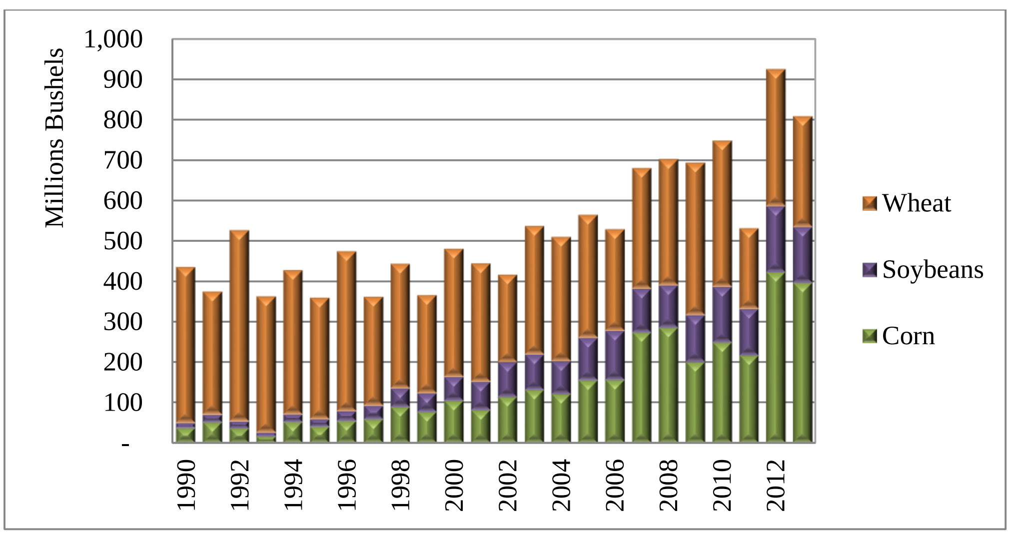

Figure 1.1 ND Grain Production Trend

Crop production is widely distributed across the states, with farms accounting for about 70% of the land use in the Northern Plains (U.S. Department of Agriculture 2014b). Farm-generated truck movement is defined as the initial movement of grain from field to market delivery point in the distribution chain. This market delivery point may be an elevator, feedlot, or processor and the move may include an interim movement to an on-farm storage facility. The grain distribution chain is complex with delivery timing and points influenced by factors such as market pricing signals, storage alternatives, global markets, and farm manager market expectations. It is especially important to understand the transportation patterns and trends for these farm truck shipments in making investment and policy decisions related to rural and agriculture-centric economies. National commodity transport data sources, such as the Commodity Flow Survey and Freight Analysis Framework, do not account for this farm-generated grain traffic (BTS 2010, Donnelly 2010).

The objective of this study is to partially fill the information gap for the farm truck inventory and grain marketing patterns in the Northern Plains. Collecting truck and trip information directly from farm operators is optimal for understanding patterns and trends in farm-generated grain traffic. This traffic is not otherwise inventoried in national data sources, so it is the responsibility of individual states or other entities to collect and/or estimate farm-generated grain traffic. As state and local decision makers consider infrastructure investments, policy changes, and traffic operations it is especially important to better understand the farm-generated grain traffic patterns and trends for this key local and widely dispersed freight generator. The information collected in this study should be unique and complementary to other farm-to-market studies (Baumel 1996, Tolliver et. al, 2005, Tun-Hsiang and Hart 2009) and national commodity flow publications. Results will prove useful to a wide array of groups. Farmers may use the results for their own investment and productivity assessments. Local and regional planners can utilize the information in calibrating travel demand and freight flow models for investment and asset management choices. In addition, policy makers will be able to consider this information when making infrastructure and industry related decisions.

The next section describes the method and data used in the study. Descriptive and statistical analyses are presented in the survey results section. Detail regarding farm truck fleet, road use, and marketing patterns are developed within this discussion. Section four is a summary of the findings.

2. METHOD AND DATA

The survey method was used to collect the data needed for the study. Based on a successful collaboration for the Tolliver et al. study (2005), the Upper Great Plains Transportation Institute (UGPTI) at North Dakota State University worked with the North Dakota Office of the Agricultural Statistics Service (NDASS) and the National Agricultural Statistics Service (NASS) of the U.S. Department of Agriculture to complete a survey of farmers in the region. The UGPTI was the lead agency in drafting the survey instrument and compiling survey results. The UGPTI worked with NDASS to finalize the survey instrument. Its six sections covered: (1) crop production and marketing, (2) farm grain truck fleet, (3-5) farm-generated transportation of hard red spring wheat,[1] corn, and soybean, and (6) select farm operation characteristics.

2.1 Mail and Phone Surveys

The survey process was a two-phase system. An initial mail survey was distributed to a sample of farmers in the NASS contact database. A follow-up phone survey of non-respondent farmers within that initial survey sample was completed to supplement the mail response to meet the sample size requirement. NASS completed and printed the final survey. In addition, NASS developed and conducted training for the telephone survey. A stratified non-probability quota sample was used to select the farmers from the population for the survey. The number of surveys collected, overall and from within each of the state strata, was deemed sufficiently large to approximate random selection so generalizations could be made about the larger population within the budget and time constraints. In addition, expertise of the NASS personnel with agricultural survey issues and the data quality control contribute to a strong likelihood that the sample is representative of the larger population. Although random influences cannot be ruled out within this sample technique, confidence intervals are shown since the large regional sample is assumed to have normal probability distributions.

The survey and mail sample were designed to collect data for a representative sample of corn, wheat, and soybean farms in North Dakota and the adjacent crop reporting districts (CRDs) from Montana, South Dakota, and Minnesota (Figure 2.1). The farms surveyed may produce one or all three commodities. The sample for the survey was derived from the larger population of farms that reportedly grew at least one of the major wheat, corn, and soybean crops based on the 2013 County Agricultural Production Survey (CAPS). This group is defined as the eligible farm population that was made up of the potential survey candidates. CAPS is a federally required submission used for federal farm program management at all jurisdictions. A random sample of 6,000 farms was drawn from the eligible population.

[1]HRS wheat is referred to as wheat for the discussion of survey results.

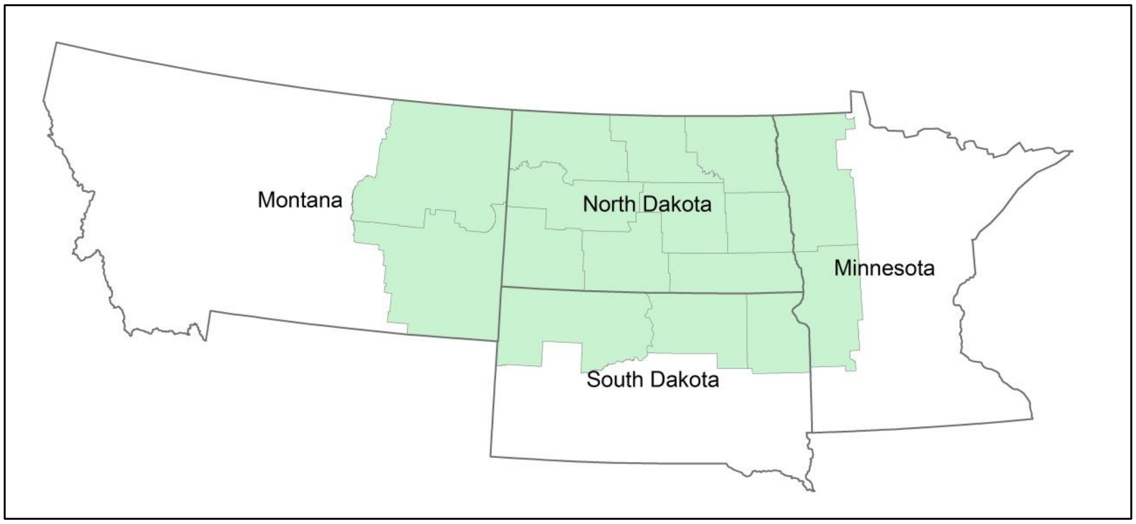

Figure 2.1 Farm Truck Survey Geography

2.2 Survey Responses

The survey was mailed to these 6,000 farmers in the survey region in June 2014. The agency received 623 responses from the mailed surveys. A month after the mailing, a phone survey of non-respondent farmers, randomly selected from stratum in the original sample, was conducted to complete the survey via phone. All survey collection efforts resulted in 3,006 responses for a response rate of 50%. One survey response from New York was omitted from the dataset for the study. The largest number of responses was from North Dakota with 932 survey returns. Responses from Minnesota, Montana and South Dakota totaled 832, 407, and 834, respectively. The responses were compiled by NASS and submitted to the UGPTI for analysis.

Results were developed based on the valid respondent population of 3,005. Stratification of respondent figures by state and commodity show that a sufficient number were received to develop statistically robust results for the farm truck fleet and its farm-generated grain traffic. The main descriptive statistics calculated to describe the farm grain fleet and farm-generated grain traffic are related to frequency, central tendency and dispersion. In addition, some means tests are presented to investigate potential differences in grain farm truck fleet and marketing characteristics among the state CRD groups and different size farms.

2.3 Statistical Metrics

This section provides a highlight of some statistics used in the report. This overview provides a cursory understanding of the measures.

The frequency distribution is simply a summary of frequency for the individual values (or value ranges) for a variable. With large samples, the frequency distribution tends to be a normal for independently and randomly distributed observations. This type of distribution presents itself in a bell-shaped observation frequency plot.

The sample mean is the simple average of all values in the responses. The mean is the most common measure of central tendency. Its calculation for a sample data set is:

$$\overline{x} = \sum_i x_i / n$$

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

$$\overline{x_w} = \sum_i w_i x_i \Big/ \sum_i w_i$$

Where w_i is the weight associated with variable w for observation in the set of responses. Dispersion of the data is important in projecting this sample data as reflective of the larger population. Dispersion is the spread of values around the mean. The standard deviation is a measure of dispersion. The measure corrects for outliers that may be a problem with simpler indicators of dispersion such as range. Standard deviation is an indicator of how widely dispersed individual responses are relative to the mean. If the standard deviation is larger than expected, it may indicate the sample is not sufficient for statistically sound results. The standard deviation in the sample is calculated as:

$$s = \sqrt{\sum (x - \bar{x})^2 / n - 1}$$

Where x represents each value in the responses, $\bar{x}$ is the mean value of the responses and n is the number of values in the sample of responses.

The sample variance is closely related to the standard deviation, also providing an indicator for robustness based on variability in the response data based on expectations for normal distribution associated with central tendency. The variance, as with the standard deviation, is a measure of dispersion for the responses. The variance is the average squared deviation. In general, higher variation indicates potential bias and lower quality data that may be associated with a sample or survey design error.

The final statistical measure calculated in the study is the standard error. The standard error of the mean provides information about the reliability of the sample based on the likelihood that mean values will vary when computed from different samples drawn from the working population. If the sample is sufficiently large, the sample averages will form a normal distribution that reflects what is expected in the population mean. The standard error decreases as the size of the sample increases. The sample here is sufficiently large relatively to the population so small standard errors are expected. The estimated standard error is found by taking the square root of the variance, so

$$SE(\hat{p}_s) = \sqrt{V(\hat{p}_s)}$$

Where:

$SE(\hat{p}_s) =$ the estimated standard error
$V(\hat{p}_s)$ = the estimated variance
$\hat{p}_s$ = the estimated response

From this, we can build a 95% confidence interval. For example, the 95% confidence interval formula is $\hat{p}_s \pm 1.96 * SE(\hat{p}_s)$, where each of the terms has the meaning above and the value 1.96 is the tabled value from the standard normal distribution for a 95% confidence interval. The 95% confidence interval means that statistically there is only a 5% chance that the actual value falls outside the range.

The sample design, survey administration and data collection have been completed to minimize any potential bias or error. The expertise of NASS in survey techniques and in working with the farmer population ensures this quality objective. In addition, the survey response data was assessed for validity. Non-response error was minimized with the follow-up phone survey because it is not reasonable to expect a 100% survey response. While non-response to specific questions did occur in some instances, most are associated with information that was not relevant for the respondent or that the respondent did not have readily available.

3. SURVEY RESULTS

The 3,005 survey responses were queried to create a profile of the farm truck fleet in the Northern Plains, a region covering North Dakota and the surrounding states' adjacent CRDs. In addition, information about grain marketing patterns and truck use characteristics associated with the farm-generated traffic were generated so farmers, policy makers and resource planners can better understand and manage demand associated with this transportation user group. The farm-generated demand is that trip segment from field to first delivery point. It does potentially include an interim move to on-farm storage that would impact the temporal aspects of the farm grain traffic cycle. This farm grain traffic is especially important in the management and allocation of rural and local road resources.

3.1 Respondent Profile

As mentioned previously, this region is heavily involved in production agriculture with three of the states dedicating 60% of their land use to crop production. The highest shares were in North Dakota and South Dakota where 87% and 88% of the land is in crop production, respectively. Montana has about 63% its land area in crop production. Minnesota has the lowest share of its land in crop production, at 47%.

The sample respondent group included a good representation of crops across the region. As expected with production patterns, Montana has limited reporting for corn and soybean transportation. Responses across commodities and other states are acceptable within the crop-geographic production sectors. The limited responses for corn and soybean production in Montana will be included in the aggregate figures for the region but the crop-state detail will be limited because of the small sample size.

Table 3.1 Respondents Reporting Crop Production, by State and Commodity

State	Wheat	Corn	Soybean
Minnesota	38%	71%	57%
Montana	80%	13%	<1%
North Dakota	70%	55%	27%
South Dakota	26%	80%	47%
Overall	51%	61%	37%

n=3,005

Representation across the Northern Plains is good considering the share of harvested acres represented by the respondent group. North Dakota accounted for 39% of the survey respondents' total harvested acres of 2.9 million acres of corn, soybeans and wheat. This is approximately 10% of the 29 million total harvested acres in the region for the three crops for 2013 (USDA 2014a).[2]

[2]All references to harvested acres or bushels for survey responses refer to only corn, soybean and HRS wheat for the survey discussion.

The survey sample should be a reasonable reflection of the population based on the large sample size. The stratified response distributions by state and commodity show that 1 in 10 harvested acres are represented for North Dakota corn and wheat production, while soybeans is half that value (Table 3.2). Soybean production is more geographically concentrated, so transportation characteristics likely have less variation relative to wheat and corn which are more widely distributed across the states. Production figures for 2013 show that 88% of soybeans were produced in the four largest production CRDs, this compares to 77% and 62% of corn and wheat, respectively. Among the adjacent states, Montana and South Dakota acres are well-represented in the sample. Minnesota is also acceptable, but does have a slightly smaller share so care should be given when considering using sample statistics to represent the larger population of adjacent CRD acres.

Table 3.2 Share of Harvested Acres Represented in the Sample Response

Crop Reporting Districts	HRS Wheat	Corn	Soybean
Western Minnesota	12%	7%	6%
Eastern Montana	21%	n.a.	n.a.
All North Dakota	11%	9%	5%
Northern South Dakota	15%	19%	11%

n=3,005; n.a. CRD Harvested Acres not available with USDA query

The respondent farm size averaged 750 harvested acres of corn, soybean and wheat in 2013. The harvested acres for the three commodities ranged from 2 to 28,000 acres. A distribution of responses across quadrants shows about 22% to 28% of response farms in each of the farm size groups; defined as (1) less than 300 harvested acres, (2) 301 to 750 harvested acres, (3) 751 to 1,500 harvested acres, and (4) 1,501 or more harvested acres (Table 3.3). The distribution across the farm group strata shows good representation of each group.

Table 3.3 Farm Group Characteristics

Farm Group	Count	Percent	Average Harvested Acres
300 acres or fewer	706	26%	156
301 to 750 acres	594	22%	479
751 to 1,500 acres	772	28%	1,057
1,501 acres or more	672	24%	3,079

not reported=261

Economies of size in the farm industry have been a key component in the continued evolution of this mature industry, especially for the commodity grains that are at the core of this study. Average farm size continues to increase (NASS 2014b). The ability of farms to spread costs, such as equipment and labor, over more acres is increasingly important with technology-enhanced farming and more expensive equipment needed to adopt it. The farm size has also been shown to relate positively to truck size, based on the economics of farm truck fleet decisions and with what has been observed in the market (Berwick et al. 2003).

3.2 Marketing Patterns

Farm markets vary substantially across respondents because transportation for these major grains can simply be a short haul to on-farm storage or a longer haul to an elevator, feedlot, or processor facilities. The transportation resources consumed do show some patterns for individual commodities. In addition, responses to on-farm storage questions provide some insight into the timing of grain deliveries. Overall regional marketing patterns are useful. In addition, insight is provided in the market patterns among state and farm group strata. Statistical tests confirm that the marketing patterns do vary significantly for all commodities across farm group strata when considering the share of production transported directly to market when harvested for wheat [$F(1,566)=5.13$, $\rho=<.002$], corn [$F(1,912)=12.99$, $\rho=<.001$], and soybean [$F(1,796)=6.77$, $\rho=<.002$] are significant at the 99th percentile based on generalized linear model results. Significant variance is also found among states for the wheat [$F(1,591)=22.28$, $\rho=<.001$] and soybean [$F(1,827)=4.97$, $\rho=<.002$] marketing patterns, considering the share delivered directly from field to market.[3]

3.2.1 On-Farm Storage

On-farm storage for corn, soybean, or wheat was confirmed by 83% of the respondent farms. The availability of on-farm storage was not answered in 10% of the surveys and was left blank in the remaining 7%. Among states, South Dakota had lowest share of farms with on-farm storage for corn, soybean, or wheat at 84%. In North Dakota and Montana, 94% of the respondents confirmed on-farm storage availability. Minnesota had on-farm storage reported in 84% of responses. Average on-farm storage capacity for the three commodities was reported at 86,375 bushels when weighted by harvested acres.

Table 3.4 Corn, Soybean and Wheat Storage Capacity, by State

Crop Reporting Districts	n	Storage Ratio, Bushels per Harvested Acre*	Average On-Farm Storage, Bushels*
Western Minnesota	769	77	156,276
Eastern Montana	360	70	103,904
All North Dakota	864	63	222,607
Northern South Dakota	751	69	374,173

*Weighted by Harvested Acres

The median on-farm storage capacity was 50,000 bushels with 25% reporting fewer than 20,000 bushels. A scatterplot illustrates the distribution for the responses with storage of 500,000 bushels or less (Figure 3.1). The survey had 28 responses from farms with more than a half-million bushels of storage. Among the facilities, 11 were in North Dakota, 10 in the northern South Dakota CRDs, 6 in the western Minnesota region, and a single location in eastern Montana. The higher storage volumes were attributed to the large farms of over 1,500 acres in 26 of the 28 cases.

[3] Note that in this paper 'state' always refers to the group of CRDs surveyed from each respective state in the cases of Minnesota, Montana and South Dakota so caution should be used in extrapolating any statewide figures based on the survey results for these states.

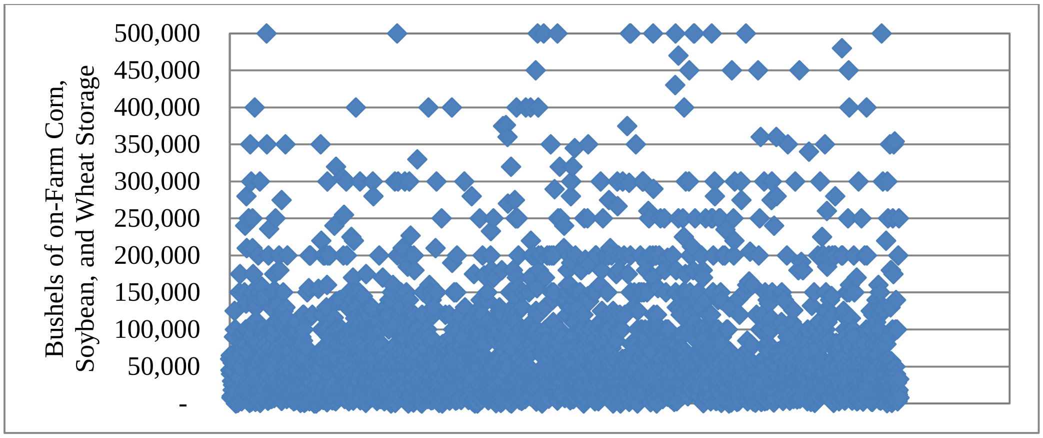

Figure 3.1 Scatterplot of Reported On-Farm Storage Capacity, Farms with 500,000 Bushels or Less

The storage capacity density, measured by farm as bushels produced per harvested acre (including corn, soybean, and wheat), was inversely related to the farm size (Table 3.5**Table**). The storage capacity volume, however, is substantially greater for the larger farms. Average on-farm storage was 329,097 bushels of corn, soybean, and wheat capacity for farms of 1,501 acres or more. The smallest farms averaged only 26,252 bushels of capacity for the three commodities.

Table 3.5 Corn, Soybean and Wheat Storage Capacity, by Farm Group

Farm Group	n	Share in Farm Groups	Average Storage Ratio, Bushels per Harvested Acre*	Average On-Farm Storage, Bushels*
300 acres or fewer	706	26%	151	26,252
301 to 750 acres	594	22%	82	40,003
751 to 1,500 acres	772	28%	73	80,718
1,501 acres or more	672	24%	62	329,097

*Weighted by Harvested Acres

On-farm storage is concentrated on the larger farms in terms of average capacity. In terms of flexibility, however, the smaller farms appear to be more able to adapt when increased on-farm storage is needed (Table 3.5). For the smallest farms, the ratio of storage capacity bushels per harvested acre was 151. The largest farms have an average of 62 bushels of on-farm storage for each harvested acre. The difference in the storage density may be related to expectations for yield among commodities. For instance, average corn yield in 2013 was 110 bushels per acre compared to 31 and 45 bushels per acre for soybean and wheat, respectively (NASS 2014a). Survey responses do support this premise for the larger farms reporting more harvested corn acres. Among farms larger than 1,501 acres reporting at least half of their harvested acres were corn, the ratio of storage bushels to harvested acres was 75 (n=198) 95% CI [50, 59] compared to 54 (n=436) 95% CI [69, 81] for farms attributing less than half their harvested acres to corn. Understanding farm-based storage capacity is important in discussing and predicting transportation scenarios for the industry.

The role of on-farm storage is important in understanding farm-generated crop traffic. On-farm storage provides an easily accessible option to delay grain delivery beyond the harvest season. In addition to the insight gained from the higher-yield corn stratification of the responses with regarding to the density of farm storage capacity, farmers were asked the share of the crop production delivered directly to market from the field at harvest time. Responses weighted by bushels produced, showed 36% of wheat (n=1,518) 95% CI [32%, 39%] and 32% of corn (n=1,835) 95% CI [30%, 36%] was delivered directly to an elevator, feedlot, or processor market. The average share of soybeans delivered directly to market from field is substantially higher at 66% (n=1,748) 95% CI [63%, 69%]. Among the state strata, the adjacent South Dakota farmers reported delivering the largest share of wheat directly to market at harvest at 50%, compared to 31%, 33%, and 36% for Minnesota, Montana, and North Dakota, respectively. On average, corn share delivered to market at harvest ranged from 32% in South Dakota to 39% in Montana. Minnesota farmers reported an average 34% and North Dakota farmers reported 33%. All averages are weighted based on respondents' reported production of the commodity.

A differentiation in the timing for crop delivery can also be recognized when considering the farm group strata. Table 3.6 shows that among the farm groups, the larger farms tend to deliver a smaller share of their production directly to market at harvest. A larger proportion of soybeans are delivered directly to market by farms of all sizes, but the smallest share is for the largest farms. With a continued trend toward larger farms, note the storage propensity for larger farms is a factor in the farm-generated crop traffic. Operational factors, such as seasonal load regulations, may require additional consideration as the industry's production and marketing practices continue to evolve.

Table 3.6 Crop Delivery from Field to Market, by Farm Group

Commodity	Farm Group	n	Average	Standard Error[4]	95% Confidence Limit	
Wheat	300 acres or fewer	303	45%	3%	39%	52%
	301 to 750 acres	316	43%	3%	37%	48%
	751 to 1,500 acres	455	39%	2%	35%	42%
	1,501 acres or more	441	33%	3%	28%	38%
Corn	300 acres or fewer	391	47%	3%	42%	52%
	301 to 750 acres	372	49%	2%	45%	54%
	751 to 1,500 acres	553	37%	2%	33%	40%
	1,501 acres or more	514	29%	2%	24%	33%
Soybeans	300 acres or fewer	313	71%	3%	65%	78%
	301 to 750 acres	375	74%	2%	69%	78%
	751 to 1,500 acres	548	70%	2%	66%	74%
	1,501 acres or more	508	62%	2%	58%	67%

Note: Averages Weighted by Bushels Produced

[4]Standard Error figures are standard error of the mean for all reported survey statistics.

3.2.2 Regional Markets

Farmers were asked to describe their corn, soybean and wheat marketing patterns in 2013. For wheat harvested, farmers reported that as of May 1, 2014, about 16% of bushels produced remained in on-farm storage with the largest share, 79%, transported to elevators (Table 3.7). A small 2% share was hauled to processors. Soybean marketing patterns were similar with regard to the share moved to elevators, but processors were a larger receiver, at 9%, of the 2013 crop sold at the time of the survey (Table 3.9). Farmers were less likely to use on-farm storage for soybeans than for wheat or corn. About half of the corn grown during 2013 was sold to an elevator (Table 3.8). Similar to wheat, 17% of the 2013 corn crop was held in on-farm storage on May 1, 2014. Feed use accounted for about 14%, with the largest share being used for feed on their own farms.

Table 3.7 Regional Markets for Wheat Produced in 2013

Market	Average	Standard Error	95% Confidence Limit	
Elevator	79%	1%	77%	81%
Processor	2%	1%	1%	4%
Feed Lot	0%	0%	0%	0%
Feed Own	0%	0%	0%	1%
Storage	16%	1%	14%	18%
Other	2%	0%	1%	3%

n=1,521; averages weighted by bushels produced

Table 3.8 Regional Markets for Corn Produced in 2013

Market	Average	Standard Error	95% Confidence Limit	
Elevator	54%	2%	51%	58%
Processor	11%	1%	8%	13%
Feed Lot	4%	1%	2%	5%
Feed Own	10%	1%	8%	13%
Storage	17%	1%	14%	20%
Other	4%	2%	0%	8%

n=1,821; averages weighted by bushels produced

Table 3.9 Regional Markets for Soybean Produced in 2013

Market	Average	Standard Error	95% Confidence Limit	
Elevator	79%	1%	77%	82%
Processor	9%	2%	6%	13%
Feed Lot	0%	0%	0%	1%
Feed Own	0%	0%	0%	1%
Storage	7%	1%	5%	10%
Other	4%	2%	0%	8%

n=1,115; averages weighted by bushels produced

Markets, State Strata. Minnesota farmers in the western CRDs report a smaller share of wheat and soybeans delivered to elevators compared to the regional market average (Table 3.10, Table 3.12). For wheat, a larger share of the 2013 crop was held on-farm at the time of the survey. A larger share of corn had been sold to elevators versus the regional average, with less used for feed on their own farms (Table 3.11).

Table 3.10 Regional Markets for Wheat Produced in 2013, Minnesota

Market	Average	Standard Error	95% Confidence Limit	
Elevator	70%	3%	63%	76%
Processor	4%	2%	0%	8%
Feed Lot	1%	1%	0%	2%
Feed Own	0%	0%	0%	0%
Storage	23%	4%	16%	30%
Other	2%	1%	0%	3%

n=319; averages weighted by bushels produced

Table 3.11 Regional Markets for Corn Produced in 2013, Minnesota

Market	Average	Standard Error	95% Confidence Limit	
Elevator	61%	2%	56%	65%
Processor	10%	2%	5%	14%
Feed Lot	5%	1%	2%	8%
Feed Own	6%	1%	4%	9%
Storage	17%	2%	14%	21%
Other	1%	0%	0%	1%

n=595; averages weighted by bushels produced

Table 3.12 Regional Markets for Soybean Produced in 2013, Minnesota

Market	Average	Standard Error	95% Confidence Limit	
Elevator	76%	2%	73%	80%
Processor	9%	2%	6%	13%
Feed Lot	1%	1%	0%	2%
Feed Own	0%	0%	0%	0%
Storage	8%	1%	5%	10%
Other	6%	2%	1%	10%

n=678; averages weighted by bushels produced

Montana farmers in the eastern CRDs had sold a larger share of their 2013 crop to elevators by May 1, 2014, compared to the regional average (Table 3.13, Table 3.14). They held a smaller share in storage than other farmers in North Dakota and adjacent state CRDs. The limited response for corn production shows a much larger proportion of the corn grown in Montana is marketed to feedlots than in the remainder of the region. Montana farmers sold only about 1 in 5 bushels of corn to elevators compared to about 1 in 2 for the region on average.

Table 3.13 Regional Markets for Wheat Produced in 2013, Montana

Market	Average	Standard Error	95% Confidence Limit	
Elevator	83%	2%	79%	87%
Processor	3%	2%	0%	7%
Feed Lot	0%	0%	0%	0%
Feed Own	1%	0%	0%	1%
Storage	12%	2%	8%	16%
Other	1%	0%	0%	2%

n=327; averages weighted by bushels produced

Table 3.14 Regional Markets for Corn Produced in 2013, Montana

Market	Average	Standard Error	95% Confidence Limit	
Elevator	21%	2%	51%	58%
Processor	4%	1%	8%	13%
Feed Lot	54%	1%	2%	5%
Feed Own	16%	1%	8%	13%
Storage	4%	1%	14%	20%
Other	2%	2%	0%	8%

n=54; averages weighted by bushels produced

North Dakota mirrors the regional averages with regard to wheat, marketing 79% to elevators and storing 16% on-farm (Table 3.15). North Dakota farmers were more likely to sell corn to elevators and processors compared to the regional average, with a larger share remaining on-farm at the time of the survey (Table 3.16). With regard to soybeans, North Dakota sold a larger share to elevators compared to the regional average (Table 3.17). This soybean market pattern is expected given the longer distances for North Dakota farmers from soybean growing regions to processing plants in Minnesota and South Dakota.

Table 3.15 Regional Markets for Wheat Produced in 2013, North Dakota

Market	Average	Standard Error	95% Confidence Limit	
Elevator	79%	1%	77%	82%
Processor	2%	1%	0%	3%
Feed Lot	0%	0%	0%	0%
Feed Own	0%	0%	0%	1%
Storage	16%	1%	13%	19%
Other	3%	1%	1%	4%

n=655; averages weighted by bushels produced

Table 3.16 Regional Markets for Corn Produced in 2013, North Dakota

Market	Average	Standard Error	95% Confidence Limit	
Elevator	59%	2%	55%	64%
Processor	9%	2%	5%	13%
Feed Lot	2%	1%	0%	3%
Feed Own	3%	1%	2%	5%
Storage	23%	3%	18%	29%
Other	4%	2%	0%	7%

n=522; averages weighted by bushels produced

Table 3.17 Regional Markets for Soybean Produced in 2013, North Dakota

Market	Average	Standard Error	95% Confidence Limit	
Elevator	89%	1%	87%	91%
Processor	2%	1%	0%	3%
Feed Lot	1%	1%	0%	3%
Feed Own	0%	0%	0%	0%
Storage	6%	1%	3%	9%
Other	3%	1%	1%	5%

n=527; averages weighted by bushels produced

South Dakota's northern CRDs marketed a larger share of wheat and soybeans to elevators compared to the region on average with both crops at 82% (Table 3.18, Table 3.20). South Dakota farmers had the smallest share of each crop held on-farm compared to the region. The figures are, however, close to the regional averages. South Dakota farmers sold a relatively smaller share of their corn, 49%, to elevators, using a substantially larger share, 16%, for feed on their own farms (Table 3.19).

Table 3.18 Regional Markets for Wheat Produced in 2013, South Dakota

Market	Average	Standard Error	95% Confidence Limit	
Elevator	82%	2%	78%	86%
Processor	1%	1%	0%	2%
Feed Lot	0%	0%	0%	0%
Feed Own	0%	0%	0%	0%
Storage	15%	3%	10%	20%
Other	2%	1%	0%	4%

n=220; averages weighted by bushels produced

Table 3.19 Regional Markets for Corn Produced in 2013, South Dakota

Market	Average	Standard Error	95% Confidence Limit	
Elevator	49%	3%	43%	55%
Processor	12%	2%	8%	16%
Feed Lot	3%	1%	1%	5%
Feed Own	16%	2%	12%	21%
Storage	13%	2%	10%	17%
Other	6%	4%	0%	14%

n=669; averages weighted by bushels produced

Table 3.20 Regional Markets for Soybean Produced in 2013, South Dakota

Market	Average	Standard Error	95% Confidence Limit	
Elevator	82%	2%	78%	85%
Processor	10%	2%	6%	15%
Feed Lot	0%	0%	0%	0%
Feed Own	0%	0%	0%	1%
Storage	6%	1%	4%	9%
Other	2%	1%	0%	3%

n=541; averages weighted by bushels produced

Markets, Farm Group Strata. Farm Group 1, including farms with fewer than 300 acres, held a larger share of wheat, at 23%, in storage than the region average. These farm storage practices may be related to specialty or small scale milling operations that tend to have limited on-site inventory or to individual farmer decisions to hold inventory multiple years. Wheat that graded with higher milling quality characteristics has historically garnered a premium during years where weather or other factors lead to below average crop quality. The corn market is also somewhat different from the region for these farms using corn for feed, 19%, nearly double the share for the regional average. These smaller farms also report storing less of their corn and soybean crop relative to the regional averages.

Table 3.21 Regional Markets for Wheat Produced in 2013, Farm Group 1

Market	Average	Standard Error	95% Confidence Limit	
Elevator	72%	2%	68%	77%
Processor	1%	0%	0%	2%
Feed Lot	0%	0%	0%	1%
Feed Own	0%	0%	0%	1%
Storage	23%	3%	16%	29%
Other	3%	1%	0%	6%

n=303; averages weighted by bushels produced

Table 3.22 Regional Markets for Corn Produced in 2013, Farm Group 1

Market	Average	Standard Error	95% Confidence Limit	
Elevator	56%	2%	52%	60%
Processor	3%	1%	1%	6%
Feed Lot	9%	2%	6%	13%
Feed Own	19%	2%	15%	23%
Storage	11%	1%	8%	14%
Other	2%	1%	0%	3%

n=392; averages weighted by bushels produced

Table 3.23 Regional Markets for Soybean Produced in 2013, Farm Group 1

Market	Average	Standard Error	95% Confidence Limit	
Elevator	85%	2%	81%	90%
Processor	5%	2%	1%	9%
Feed Lot	0%	0%	0%	0%
Feed Own	0%	0%	0%	1%
Storage	7%	3%	1%	12%
Other	3%	1%	0%	5%

n=314; averages weighted by bushels produced

Farm Group 2, which includes farms sized 301 to 750 harvested acres, was close to the regional averages in its wheat marketing. This group did report selling a larger share of each commodity to elevators compared to the regional average. With 80% of wheat, 62% of corn and 88% of soybeans marketed at the elevator, the shares are 1 percentage point higher for wheat and 9 and 8 percentage points higher than the region average for corn and soybeans respectively (Table 3.24, Table 3.25, Table 3.26).

Table 3.24 Regional Markets for Wheat Produced in 2013, Farm Group 2

Market	Average	Standard Error	95% Confidence Limit	
Elevator	80%	2%	76%	83%
Processor	1%	1%	0%	3%
Feed Lot	0%	0%	0%	0%
Feed Own	0%	0%	0%	1%
Storage	16%	2%	12%	20%
Other	2%	1%	1%	4%

n=313; averages weighted by bushels produced

Table 3.25 Regional Markets for Corn Produced in 2013, Farm Group 2

Market	Average	Standard Error	95% Confidence Limit	
Elevator	62%	2%	57%	66%
Processor	6%	2%	2%	9%
Feed Lot	4%	2%	0%	8%
Feed Own	15%	2%	10%	19%
Storage	13%	2%	10%	17%
Other	1%	0%	0%	1%

n=372; averages weighted by bushels produced

Table 3.26 Regional Markets for Soybean Produced in 2013, Farm Group 2

Market	Average	Standard Error	95% Confidence Limit	
Elevator	88%	1%	85%	90%
Processor	5%	2%	1%	8%
Feed Lot	0%	0%	0%	0%
Feed Own	0%	0%	0%	1%
Storage	7%	1%	4%	10%
Other	0%	0%	0%	1%

n=375; averages weighted by bushels produced

Farms between 751 and 1,500 acres comprise the operations in Farm Group 3. This group is similar to the regional market average in the distribution of corn, soybeans and wheat. Elevators are the primary market for each commodity. Corn has the greatest diversification with regard to markets (Table 3.27, Table 3.28, Table 3.29).

Table 3.27 Regional Markets for Wheat Produced in 2013, Farm Group 3

Market	Average	Standard Error	95% Confidence Limit	
Elevator	76%	1%	73%	79%
Processor	3%	1%	1%	5%
Feed Lot	0%	0%	0%	1%
Feed Own	0%	0%	0%	1%
Storage	18%	2%	15%	21%
Other	2%	1%	1%	4%

n=457; averages weighted by bushels produced

Table 3.28 Regional Markets for Corn Produced in 2013, Farm Group 3

Market	Average	Standard Error	95% Confidence Limit	
Elevator	57%	2%	53%	60%
Processor	9%	1%	6%	11%
Feed Lot	3%	1%	2%	4%
Feed Own	10%	1%	7%	13%
Storage	19%	2%	16%	23%
Other	3%	1%	1%	4%

n=555; averages weighted by bushels produced

Table 3.29 Regional Markets for Soybean Produced in 2013, Farm Group 3

Market	Average	Standard Error	95% Confidence Limit	
Elevator	81%	1%	78%	83%
Processor	8%	2%	5%	12%
Feed Lot	1%	1%	0%	2%
Feed Own	0%	0%	0%	0%
Storage	7%	1%	5%	8%
Other	3%	1%	2%	5%

n=550; averages weighted by bushels produced

Farm Group 4 includes the largest operations among the respondent farms, at least 1,501 acres. These operations are similar to the regional market distributions. Farm Group 4 sells slightly more than the regional average share of its wheat and soybeans to elevators. The average corn share sold to elevators is slightly lower while the own feed use is slightly higher. Corn does show a greater variability with regard to market distribution, considering the standard errors. Figures for each commodity market sales share fall within the regional 95% confidence intervals.

Table 3.30 Regional Markets for Wheat Produced in 2013, Farm Group 4

Market	Average	Standard Error	95% Confidence Limit	
Elevator	80%	1%	77%	83%
Processor	2%	1%	1%	4%
Feed Lot	0%	0%	0%	1%
Feed Own	0%	0%	0%	1%
Storage	15%	2%	12%	18%
Other	2%	1%	1%	3%

n=441; averages weighted by bushels produced

Table 3.31 Regional Markets for Corn Produced in 2013, Farm Group 4

Market	Average	Standard Error	95% Confidence Limit	
Elevator	53%	2%	48%	58%
Processor	12%	2%	8%	15%
Feed Lot	4%	1%	2%	6%
Feed Own	9%	2%	6%	13%
Storage	17%	2%	14%	21%
Other	5%	3%	0%	11%

n=516; averages weighted by bushels produced

Table 3.32 Regional Markets for Soybean Produced in 2013, Farm Group 4

Market	Average	Standard Error	95% Confidence Limit	
Elevator	82%	1%	79%	84%
Processor	7%	1%	4%	10%
Feed Lot	1%	0%	0%	2%
Feed Own	0%	0%	0%	1%
Storage	7%	1%	4%	9%
Other	4%	1%	1%	6%

n=508; averages weighted by bushels produced

3.3 Grain Transportation Vehicle Inventory

Between 1963 and 2002, the U. S. Department of Transportation sampled private and commercial truck registrations in each state to compile a national public database. The database offered estimated truck characteristics in a five-year cycle. It was released as the Vehicle Inventory and Use Survey (VIUS) and had widespread use by government, academia and businesses in assessing policy and investment decisions. The database offered a source to profile a state's vehicle fleet using information such as vehicle registration numbers, model year (or fleet age), truck axle configuration, truck body type, and business activity (such as agriculture or manufacturing). The survey was discontinued in 2002 because of budget restrictions so the information provided here offers insight, missing since 2002, into the region's grain truck fleet.

The farm-owned grain truck fleet is comprised of five main truck types. The single-axle, tandem-axle, tridem-axle, 5-axle semi, and the 7-axle semi or Rocky Mountain Double (RMD). Many more types and combinations are used, but not in sufficient quantity for analysis.

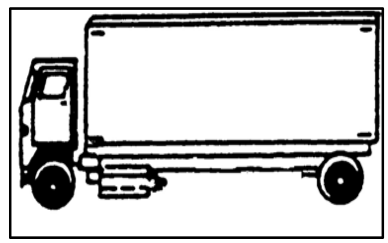

Figure 3.2 Single-Axle Truck

The single-axle truck was for decades the industry standard, used to deliver grain from farm to elevator. It provided sufficient utility for small farms in the Northern Plains. The single-axle truck (Figure 3.2) is agile and serves as a multiple use vehicle. However the single-axle truck is not efficient for moving grain long distances. A survey conducted by the Upper Great Plains Transportation Institute in 1984 estimated that the farm truck fleet was 80% single-axle trucks (Griffin 1984). That same survey found that the average trip to market was 12 miles. A study by the Upper Great Plains Transportation Institute in 2000 estimated that 52% of the farm fleet was single-axle trucks and 25% were tandems (Tolliver et al. 2005). Only 9% of the fleet was 5-axle or other types of semi-trucks. The problem with the single-axle truck is that the truck is small and the regulatory weight limit provides for a relatively small payload compared to other truck types. This severely limits any size economies for grain truck transport. The federal bridge formula[5] limits this truck because of its relatively short wheel base. Other factors that reduce the desirability of the single-axle farm truck is that it is expensive to buy if purchased new relative to its payload. It is also expensive to operate as the fuel economy per mile is equal to or less than some larger truck types.

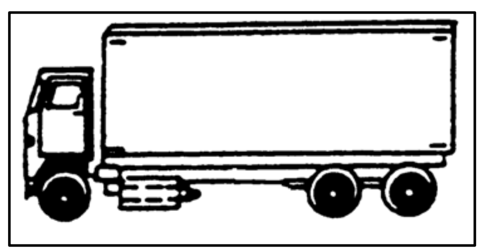

Figure 3.3 Tandem-axle Truck

The tandem-axle truck (Figure 3.3) increases payload weight by adding an axle. The Federal regulation for the interstate system and on most state highways limits the tandem-axle truck to 34,000 pounds on that tandem-axle. The gasoline powered tandem-axle truck served as a transition from the single-axle farm truck to the semi widely in use today. The GVW (gross vehicle weight) of

[5] W=500[(LN/N-1+12N+36)
W=The maximum weight in pounds that can be carried on a group of two or more axles to the nearest 500 pounds
L=The spacing in feet between the outer axles of any two or more consecutive axles
N=The number of axles being considered

the tandem-axle truck is 46,000 pounds, depending on the spread of the axles and the width of the front tires.

A third truck type represented in the survey is the tridem-axle single unit truck (Figure 3.4). This truck provides the agility of a single unit truck but adds an axle for increased payload. A tridem-axle with the front and rear axle centers set at a length of 8 feet can weigh 42,000 pounds compared to a tandem-axle at 34,000 pounds. This higher weight allows for larger payloads making this truck both agile and efficient. The federal bridge formula restricts the tridem to a GVW of 56,000 pounds on the interstate.

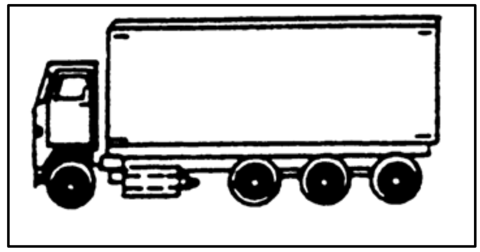

Figure 3.4 Tridem-axle Truck

Differences exist among tandems and even tridem trucks. Some have gasoline powered engines that lack power. Producers have found that a pre-owned over-the-road diesel powered semi-truck could be converted economically into a box and hoist truck for farm use. These converted trucks are adequately powered, agile and efficient for use as a farm truck. The cost of converting a pre-owned semi-tractor into a box and hoist truck is comparable to buying a new single-axle or tandem gas-powered truck.

The 5-axle semi is the most commonly used truck in the United States (Figure 3.5). The truck consists of two groups of tandem-axles and a steering axle. The grain trailer of a 5-axle semi can be made of either steel or aluminum or some combination. The trailer is usually a double hopper, which allows for gravity-flow unloading out the bottom, or is equipped with a hydraulic cylinder that lifts the trailer for gravity flow out the back. The truck is allowed to operate at a GVW of 80,000 pounds on the interstate system and most state highways if the distance between the extreme axles is at least 51 feet. Even though the empty weight of a 5-axle semi is greater than that of any previously mentioned straight truck the payload is considerably more. The payload of a 5-axle semi is usually more than 52,000 pounds; and depending on the type of tractor and trailer and can be higher. Many tractor and trailer types result in the 5-axle semi configuration – the payloads, however may vary. A semi with the condo sleeper or a steel trailer adds weight to the unit and reduces payload. A tractor called a day-cab or no sleeper semi-tractor, pulling an aluminum trailer is the lowest weight 5-axle semi providing for the biggest payload. These units may weigh as little as 22,000 pounds, allowing for up to a 58,000-pound payload.

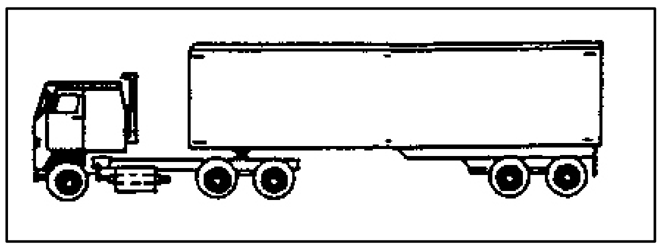

Figure 3.5 5-Axle Semi-truck

The 7-axle semi or Rocky Mountain Double (Figure 3.6) is allowed to operate in North Dakota, Montana and South Dakota at a GVW of 105,500 pounds if

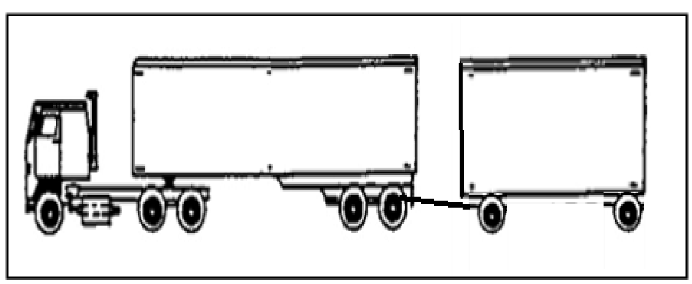

Figure 3.6 7-Axle Semi or RMD (Rocky Mountain Double).

from the front axle to the extreme back axle is at least 78 feet. This truck is not allowed on the Interstate System at more than 80,000 pounds. The RMD is not allowed to operate on Minnesota highways. The payload of the RMD depends on the unit. A day-cab tractor with aluminum trailers may allow for a 75,000-pound payload.

3.3.1 Farm Truck Ownership

The most commonly owned truck in the four-state Northern Plains region is the 5-axle semi. Responses show that the 5-axle semi comprises about 39% of all trucks reported followed by the tandem-axle truck with over 23% and then the single-axle with 18% (Table 3.33). The tridem and 7-axle semi-trucks were least owned among producers representing 8% and 3%, respectively.

Table 3.33 Regional Total Trucks Reported

Single-axle	1,226	18.3%
Tandem-axle	1,568	23.4%
Tridem-axle	542	8.1%
5-axle Semi	2,587	38.6%
7-axle Semi	209	3.1%
Other Truck Types	566	8.5%

n=3,005

Looking at the truck types by state there is some variation (Table 3.34). The 5-axle semi is similar at about 40% of the truck fleet in Minnesota, North Dakota, and South Dakota but only makes up about 24% of the fleet in Montana. In Minnesota, North Dakota, and South Dakota, the tandem truck is the second most popular representing about 23% of the fleet. According to respondents, the single-axle truck makes up 34% of the fleet in Montana and the tandem-axle is second at 27.6%. The 5-axle semi is third at 23.8%. In the other states, the single-axle is fourth-most reported with 12.1% in Minnesota, 18.7% in North Dakota, and 14.4% in South Dakota.

Table 3.34 Truck Type Owned, by State

	Minnesota	Montana	North Dakota	South Dakota
Single-axle	12.1%	**34.1%**	18.7%	14.4%
Tandem-axle	23.1%	27.6%	22.4%	23.0%
Tridem-axle	10.5%	2.6%	10.5%	4.3%
5-axle Semi	**40.4%**	23.8%	**40.6%**	**42.3%**
7-axle Semi	1.7%	3.6%	3.3%	4.2%
Other Truck Types	12.3%	8.2%	4.4%	11.8%

n=3,005

Examining fleet truck count data does not tell the whole story because traffic is ultimately a key factor. Truck miles or truck use by state is a better measure of farm truck activity. The 5-axle semi is the most heavily used truck in all states surveyed, based on truck miles reported. The 5-axle semi accounts for 63% of the miles in Minnesota followed by South Dakota, North Dakota, and Montana with 57.3%, 52.2%, and 42.4% respectively.

Table 3.35 Truck Annual Mileage Share in State, by Truck Type

	Minnesota	Montana	North Dakota	South Dakota
Single-axle	3.3%	9.6%	4.9%	4.1%
Tandem-axle*	9.9%	16.7%	11.2%	10.6%
Tridem-axle	9.9%	3.3%	10.2%	3.9%
5-axle Semi	63.0%	42.4%	52.2%	57.3%
7-axle Semi	8.5%	11.3%	10.1%	16.7%
Other Truck Types	5.3%	16.8%	11.4%	9.2%

n=3,005
*Tandem-axle is the only truck type with significant different mileage among states at the 99^{th} percentile.

The 5-axle semi is the truck of choice on larger farms (Table 3.36). The 5-axle semi makes up more than half of the fleet among farms with 1,501 acres or more and 37.7% of farms with 751 acres or more. The tandem-axle truck is second most owned among the larger farms while the single-axle truck is most owned among farms with 300 acres or fewer.

Table 3.36 Truck Fleet Owned, by Farm Size

	Farm Group			
	1	2	3	4
Truck Type	300 Acres or Fewer	301 Acres to 750	751 Acres to 1,500	1,501 or More Acres
Single-axle	37.4%	25.9%	16.8%	7.0%
Tandem-axle	23.6%	31.5%	27.5%	16.5%
Tridem-axle	3.9%	6.8%	10.5%	8.6%
5-axle Semi	19.6%	24.8%	37.8%	54.4%
7-axle Semi	1.8%	1.7%	2.3%	4.9%
Other Truck Types	13.8%	9.3%	5.1%	8.6%

n=2,744

Producers reported that the 5-axle semi is used most by all farm groups (Table 3.37). Although single-axle trucks are most often owned by farmers with 300 acres or less, the 5-axle semi is most heavily used for hauling grain to market. The tandem-axle is second in use among all farm groups except those farms with 1,501 acres or more. These largest farms reported using the tridem truck more frequently, in annual truck miles, than the tandem-axle truck. All farm sizes report that the 7-axle semi or the RMD is used more than the tridem.

Table 3.37 Annual Truck Miles, by Truck Type and Farm Group

	Farm Group			
Truck Type	1	2	3	4
Single-axle*	15%	8%	4%	2%
Tandem-axle	14%	18%	14%	7%
Tridem-axle	4%	5%	9%	8%
5-axle Semi	55%	40%	56%	58%
7-axle Semi*	12%	8%	11%	13%
Other Truck Types*	5%	20%	7%	11%

n=2,744
*Not significant at the 99th percentile for single-axle, 7-axle semi or other truck type.

The 7-axle truck is reported to have the most annual miles per unit at 16,920 miles (Table 3.38**Table**). This level of mileage, which is 2.4 times greater than the 5-axle average annual mileage, may explain this fleet investment decision as typified by heavier use in longer hauls of the producer's grain or in likely custom hauling activity. The 7-axle is also reportedly used more for custom hauling than any of the other truck types. Single-axle trucks reportedly have the least average annual miles at 1,186 miles. The order of truck types and use follows the order of efficiency among truck types. The truck type with the largest payload is most appropriate for hauling loads the longest distances. Therefore larger farms with large-payload trucks may have more flexibility to efficiently haul past the first option of delivery to maximize revenue.

Table 3.38 Regional Average Annual Miles by Truck Type

	n	Average Annual Miles	Standard Error	95% Confidence Interval	
Single-axle	731	1,186	95	999	1,374
Tandem-axle	918	2,172	102	1,972	2,372
Tridem-axle	342	3,768	268	3,241	4,294
5-axle Semi	1,353	6,954	324	6,318	7,590
7-axle Semi	119	16,920	2,662	11,650	22,191
Other Truck Types	265	6,680	883	4,942	8,419

3.3.2 Farm Truck Use

Producers reported the use of their trucks based on hauling their own grain, custom hauling for others, and other uses. Other uses included hauling crop inputs, feed for livestock, and other needs around the farm. The 5-axle semi was reported to be used 89.1% of the time for hauling the producers' own grain. The tridem, tandem and single-axle also were used for hauling owner grain at 83.6%, 81.7% and 65.3% respectively (Table 3.39).

Table 3.39 Regional Truck Average Annual Use for Hauling Own Grain, by Truck Type

	n	Haul Own Grain Share in Annual Use	Standard Error	95% Confidence Interval	
Single-axle	722	65.3%	1.7%	62.0%	68.5%
Tandem-axle	939	81.7%	1.1%	79.5%	84.0%
Tridem-axle	349	83.6%	1.6%	80.4%	86.8%
5-axle Semi	1,407	89.1%	0.7%	87.9%	90.5%
7-axle Semi	128	80.7%	3.0%	74.9%	86.6%
Other Truck Types	285	80.8%	1.9%	77.1%	84.5%

Producers reported the use of their trucks for custom hauling for others and, except for the 7-axle semi, this was a small percentage (Table 3.40). The 7-axle was reportedly used 9.2% of the time in custom hauling. Producers reported using their 5-axle semis for custom hauling 2.4% of the time.

Table 3.40 Regional Truck Average Annual Custom Use, by Truck Type

	n	Custom Haul Share in Annual Use	Standard Error	95% Confidence Interval	
Single-axle	722	0.8%	0.3%	0.2%	1.5%
Tandem-axle	939	1.6%	0.3%	0.9%	2.3%
Tridem-axle	349	1.6%	0.6%	0.5%	2.7%
5-axle Semi	1408	2.4%	0.3%	1.7%	3.0%
7-axle Semi	128	9.2%	2.3%	4.6%	13.8%
Other Truck Types	285	2.2%	0.7%	0.7%	3.6%

Respondents reported using their single-axle trucks 33.9% of the time for uses other than hauling their own grain or custom hauling. This truck is agile and handy for hauling small loads around the farm. The tandem and tridem were reported to be used for other uses 16.7% and 14.8% of the time respectively. The 5-axle and 7-axle reported 8.4% and 10.1% for other uses. Other uses include hauling agricultural inputs such as seed and fertilizer and for other uses around the farm (Table 3.41).

Table 3.41 Regional Truck Mileage Other Use

	n	Other Haul Share in Annual Use	Standard Error	95% Confidence Interval	
Single-axle	722	33.9%	1.7%	30.6%	37.1%
Tandem-axle	939	16.7%	1.1%	14.6%	18.8%
Tridem-axle	349	14.8%	1.6%	11.7%	17.9%
5-axle Semi	1,407	8.4%	0.6%	7.3%	9.6%
7-axle Semi	128	10.1%	2.2%	5.8%	14.4%
Other Truck Types	285	16.8%	1.8%	1.3%	20.3%

3.3.3 Farm Truck Fleet Current and Future Investments

The type and number of trucks owned in 2014, as reported by respondents, is listed in **Table**. For respondents reporting ownership of common truck types, an average 1.7 single-axle and 1.7 tandem-axle trucks were included in their fleet. The average farm ownership was highest among the 5-axle semi, at an average 1.9 per farm. A relatively small number of producers, 127, reported owning 7-axle RMDs. With average number per farm at 1.7, indicating that many of these producers own more than 1.

Table 3.42 Regional Number of Trucks Owned in 2014

	n	Number of Trucks Owned	Standard Error	95% Confidence Interval	
Single-axle	744	1.7	0.0	1.6	1.7
Tandem-axle	941	1.7	0.0	1.6	1.7
Tridem-axle	350	1.6	0.1	1.5	1.7
5-axle Semi	1,401	1.9	0.0	1.8	1.9
7-axle Semi	127	1.7	0.1	1.5	1.8
Other Truck Types	285	2.0	0.1	1.8	2.2

Farm operators estimate they will own fewer single-axle farm trucks in 2018 than they own in 2014 (Table 3.43). The trend also is true of the tandem-axle truck. They plan to increase the number of 5-axle semi-trucks by about 7%. The average number of tandem and tridem trucks will remain relatively stable.

Table 3.43 Regional Trucks to be Owned in 2018

	n	Average Number of Trucks to be Owned in 2018	Standard Error	95% Confidence Interval	
Single-axle	716	1.5	0.1	1.3	1.6
Tandem-axle	910	1.6	0.0	1.5	1.6
Tridem-axle	331	1.6	0.1	1.4	1.7
5-axle Semi	1,359	2.0	0.1	1.9	2.1
7-axle Semi	120	1.8	0.1	1.6	2.0
Other Truck Types	273	0.1	0.0	0.0	0.1

The number of trucks leased in the regional farm fleet is a small (Table 3.44). Farmers lease equipment for a couple reasons. The first is that leasing is an alternative to bank financing. Second, lease payments are tax deductible. The recent tax advantage of the Section 179 depreciation schedule allows producers to deduct the purchase price of equipment in a single year, with some limits. This provision gives ownership an advantage over leasing (Internal Revenue Service 2015). Producers have clearly chosen ownership over leasing.

Table 3.44 Regional Trucks Leased in 2014

	n	Average Number of Trucks Leased	Standard Error	95% Confidence Interval	
Single-axle	585	0.0	0.0	0.0	0.0
Tandem-axle	753	0.0	0.0	0.0	0.0
Tridem-axle	247	0.0	0.0	0.0	0.1
5-axle Semi	1,059	0.1	0.0	0.0	0.1
7-axle Semi	78	0.0	0.0	0.0	0.1
Other Truck Types	249	0.0	0.0	0.0	0.1

The number of trucks leased in 2014 is a very small percentage of the truck fleet and that is projected to continue into 2018 based on respondent truck fleet investment plans. The economic conditions and tax laws provide no advantage at the present time for leasing over owning. Leasing becomes more attractive when it is difficult to finance equipment and tax laws provide a tax savings for leasing.

Table 3.45 Regional Trucks to be Leased in 2018

	n	Average Number of Trucks to be Leased in 2018	Standard Error	95% Confidence Interval	
Single-axle	580	0.0	0.0	0.0	0.0
Tandem-axle	751	0.0	0.0	0.0	0.0
Tridem-axle	245	0.0	0.0	0.0	0.0
5-axle Semi	1,048	0.0	0.0	0.0	0.1
7-axle Semi	77	0.1	0.0	0.0	0.1
Other Truck Types	244	0.1	0.0	0.0	0.1

3.4 Farm to Market Trips

Maturation in agriculture has been typified by farm consolidation and elevator industry rationalization as firms seek to adopt new technologies and gain efficiencies while competing with a rather homogeneous product in a global grain market. It is reasonable to expect an increase in the average distance for farm-generated grain movements because farm size and distance between elevators industries have increased over recent decades. In addition, production pattern changes and policy incentives have created opportunities for local processing investments in industries such as ethanol and biofuels. On average, major crops were hauled 26.8 miles to the first choice delivery point and 41.7 miles to the second choice in the Great Plains region for marketing the 2013 crop (Table 3.46). About 1 in 5 miles was on unpaved roads for the first choice delivery point. Only about 2 miles of the average trip is on interstates. The largest share of the trip is on state roads, with 1 in 2 miles on state roads. Respondents reported that 41% of their average delivery miles to each the first and second choice delivery points is on local roads.

Table 3.46 Regional Market Road Type Miles for 2013 Grain Delivery				
Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	2.2	0.5	1.3	3.2
State 4-Lane Paved	1.0	0.2	0.7	1.3
State 2-Lane Paved	12.5	0.5	11.4	13.6
Local Paved	5.9	0.3	5.3	6.6
Local Unpaved	5.1	0.4	4.4	5.9
Total	26.8			
Second Choice Delivery Point				
Interstate	2.7	0.5	1.7	3.8
State 4-Lane Paved	2.6	0.7	0.0	4.0
State 2-Lane Paved	19.1	1.3	16.6	21.7
Local Paved	11.5	2.4	6.8	16.2
Local Unpaved	5.8	0.6	4.7	6.9
Total	41.7			

n=4,937; averages weighted by harvested acres

3.4.1 Road Use in Farm Grain Delivery

Figure 3.7 provides a summary of the road distances traveled to first choice delivery point for wheat, corn and soybean crops in the Northern Plains region for marketing the 2013 crop. These distances are weighted by the bushels produced for each respective crop. The second choice delivery points are 16 to 22 miles farther than the first choice delivery points. Respondents reported an average length of haul for wheat of 32.5 miles, of which 6.8 miles, or 21%, was on unpaved roads. These figures are weighted based on the wheat bushels reportedly produced. In 2000, the average delivery for wheat movements with a semi-truck was on 25.2 miles paved and 7.2 unpaved road miles, respectively (Tolliver et al. 2005). Comparatively, the average farm delivery in the early 1980's was about 12 miles, as noted in the truck fleet discussion.

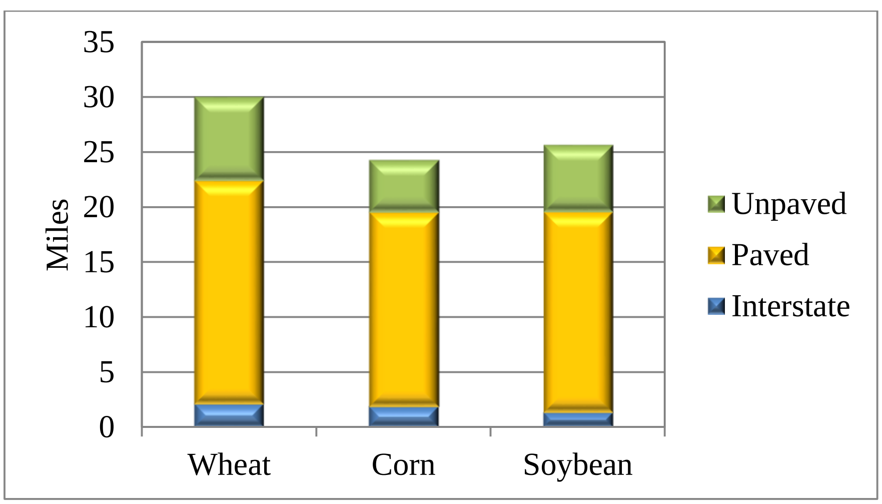

Figure 3.7 Regional Road Use for the First Choice Delivery Point

Wheat has the longest average trip to the first point delivery choice at 30.0 miles. About 25% of the distance is on unpaved roads (Table 3.47). The share of unpaved roads in the average corn trip of 24.3 miles is 20% and in the average soybean trip of 25.7 miles is 20% (Table 3.48, Table 3.49). Considering the road group, interstates are lightly used in the delivery of grains to their first choice delivery point, accounting for only 1 to 2 miles in a crop delivery trip. State 2-lane and 4-lane paved roads account for 50%, 50%, and 49% of the average trip distance for wheat, corn, and soybeans, respectively. Local roads make up the balance, comprising 43%, 43%, and 45% of the average trip distance for wheat, corn, and soybeans respectively. The distance to the second choice delivery point is farther for each commodity. Thus second choice deliveries tend to include a smaller share of travel on unpaved roads, with a similar allocation between state and local roads.

Table 3.47 Regional Market Road Type Miles for 2013 Wheat Delivery

Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	2.1	0.4	1.4	2.8
State 4-Lane Paved	0.8	0.3	0.3	1.4
State 2-Lane Paved	14.2	1.1	12.0	16.4
Local Paved	5.2	0.6	4.0	6.5
Local Unpaved	7.6	1.7	4.2	11.0
Total	30.0			
Second Choice Delivery Point				
Interstate	3.8	0.9	2.1	5.5
State 4-Lane Paved	6.7	3.9	0.0	14.4
State 2-Lane Paved	21.0	3.0	15.0	26.9
Local Paved	13.9	4.7	4.6	23.1
Local Unpaved	7.4	1.4	4.7	10.2
Total	52.8			

n=1,438; averages weighted by bushels produced

Table 3.48 Regional Market Road Type Miles for 2013 Corn Delivery				
Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	1.9	0.6	0.8	3.0
State 4-Lane Paved	1.0	0.2	0.7	1.4
State 2-Lane Paved	11.0	0.8	9.5	12.6
Local Paved	5.6	0.5	4.7	6.5
Local Unpaved	4.7	0.5	3.8	5.7
Total	24.3			
Second Choice Delivery Point				
Interstate	3.1	1.6	0.0	6.2
State 4-Lane Paved	1.4	0.5	0.0	2.4
State 2-Lane Paved	18.6	2.3	14.2	23.1
Local Paved	13.6	6.5	0.9	26.4
Local Unpaved	3.9	0.6	2.8	5.0
Total	40.7			

n=1,438; averages weighted by bushels produced

Table 3.49 Regional Market Road Type Miles for 2013 Soybean Delivery				
Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	1.3	0.2	0.9	1.8
State 4-Lane Paved	0.8	0.2	0.5	1.1
State 2-Lane Paved	11.0	0.8	9.4	12.5
Local Paved	6.5	0.8	4.9	8.1
Local Unpaved	4.2	0.3	3.6	4.8
Total	23.8			
Second Choice Delivery Point				
Interstate	1.9	0.7	0.5	3.3
State 4-Lane Paved	1.5	0.7	0.0	2.8
State 2-Lane Paved	17.2	2.4	12.5	21.9
Local Paved	14.1	6.2	1.9	26.3
Local Unpaved	6.1	1.1	3.8	8.3
Total	40.7			

n=1,438; averages weighted by bushels produced

3.4.2 Road Use in Farm Delivery, by State and Farm Group

Means tests using a generalized linear model show statistically significant differences among the state and farm group strata in the total miles to the 1st Choice Delivery Point. Among states, the difference is statistically significant for wheat [F(1,505)=6.94, ρ=<.001] and corn [F(1,771)=4.58, ρ=<.001]. The difference is statistically significant for soybeans [F(1,705)=5.23, ρ=<.01] among the farm groups.

Montana had the longest average wheat trip to the first choice delivery point at 47.7 miles, considerably farther than producers in the other surveyed states. The trip distance was similar among Minnesota, North Dakota and South Dakota respondents at 25.1, 24.5 and 27.8 miles, respectively (Figure 3.8). Montana had the highest share of unpaved roads in the trips reported for wheat with slightly more than 31% of miles on gravel. Minnesota reported the smallest share of unpaved miles at 13%. North Dakota farmers traveled unpaved roads for 1 in 4 miles and South Dakota farmers on 1 in 5 miles for wheat delivered to the first choice delivery point. With regard to state or local road use, South Dakota reported the heaviest local road use as a share of delivered miles. Local roads accounted for 45% of the wheat delivery trip miles in South Dakota. The shares in Minnesota, Montana and North Dakota were 27%, 35%, and 40%, respectively. Additional detail about the road type in wheat delivery is provided in Figure 3.8, Table 3.50, Table 3.51**Table**, Table 3.52, and Table 3.53.

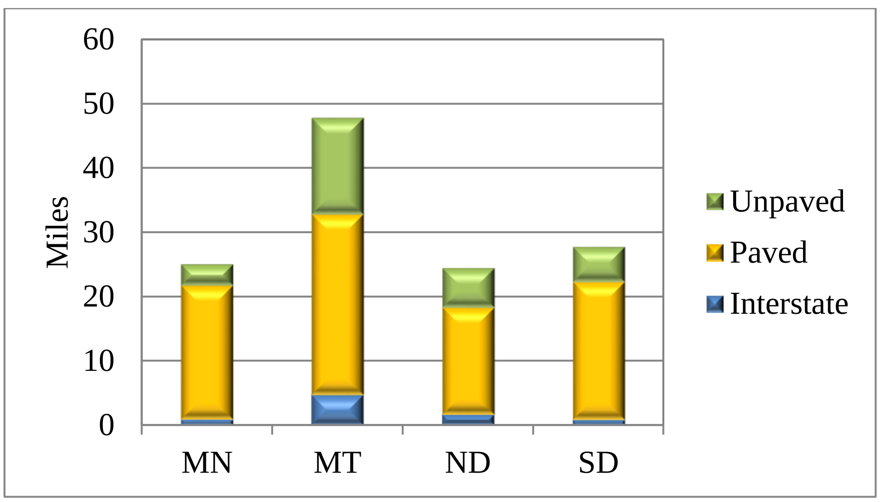

Figure 3.8 Road Type for Wheat Delivery, by State

Table 3.50 Wheat Market Road Type Miles for 2013 Grain Delivery, Minnesota

Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	0.9	0.6	0.0	2.1
State 4-Lane Paved	1.6	0.5	0.6	2.7
State 2-Lane Paved	12.2	2.9	6.6	17.9
Local Paved	7.0	1.0	4.9	9.0
Local Unpaved	3.4	0.9	1.6	5.1
Total	25.1			

n=306; averages weighted by bushels produced

Table 3.51 Wheat Market Road Type Miles for 2013 Grain Delivery, Montana

Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	4.7	1.3	2.0	7.3
State 4-Lane Paved	0.2	0.1	0.0	0.4
State 2-Lane Paved	24.1	2.9	18.3	29.9
Local Paved	3.9	1.1	1.8	6.0
Local Unpaved	15.0	7.4	0.4	29.5
Total	47.7			

n=306; averages weighted by bushels produced

Table 3.52 Wheat Market Road Type Miles for 2013 Grain Delivery, North Dakota

Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	1.6	0.3	1.0	2.3
State 4-Lane Paved	1.0	0.5	0.0	2.0
State 2-Lane Paved	11.2	1.4	8.5	13.8
Local Paved	4.5	0.8	2.9	6.1
Local Unpaved	6.2	0.8	4.5	7.8
Total	24.5			

n=628; averages weighted by bushels produced

Table 3.53 Wheat Market Road Type Miles for 2013 Grain Delivery, South Dakota				
Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	0.9	0.5	0.0	1.8
State 4-Lane Paved	0.4	0.2	0.0	0.7
State 2-Lane Paved	11.0	1.7	7.6	14.4
Local Paved	10.1	4.0	2.3	17.9
Local Unpaved	5.5	0.8	3.9	7.1
Total	27.8			

n=202; averages weighted by bushels produced

South Dakota had the longest average corn trip to the first choice delivery point at 26.7 miles. The trip distances for Minnesota, Montana, and North Dakota were 17.5, 18.9, and 22.9 miles, respectively. Montana had the highest share of unpaved roads in the trips reported for wheat with slightly more than 1 in 4 miles on gravel. With regard to state or local road use, Montana had the heaviest use of local roads, accounting for 52% of the average trip miles for corn delivery. North Dakota was second in dependence on local roads, with 47% of average wheat trip miles on the local road system. Minnesota and South Dakota reported 43% and 42%, respectively, of the trip miles for corn to the first choice delivery point were on the local system. Additional detail about the road type in corn delivery is provided in Figure 3.9, Table 3.54, Table 3.55, Table 3.56, and Table 3.57.

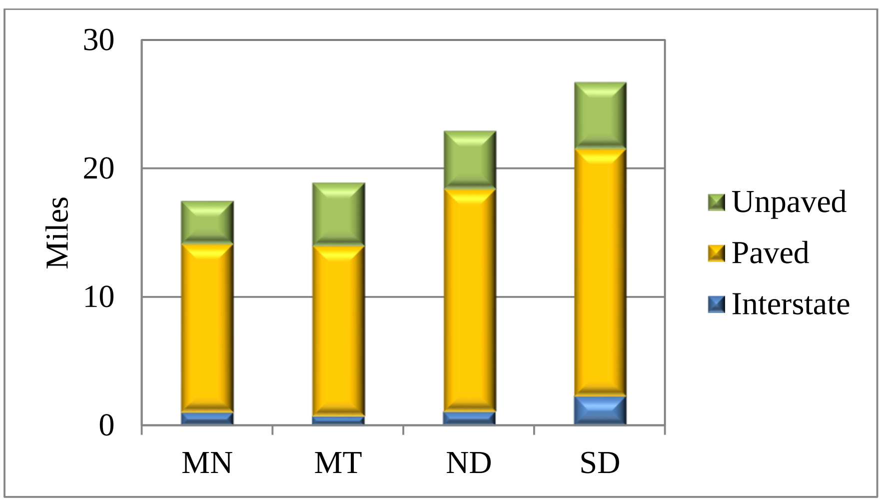

Figure 3.9 Road Type for Corn Delivery, by State

Table 3.54 Corn Market Road Type Miles for 2013 Grain Delivery, Minnesota				
Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	0.9	0.4	0.0	1.7
State 4-Lane Paved	0.7	0.2	0.3	1.2
State 2-Lane Paved	9.1	1.3	6.6	11.6
Local Paved	6.4	0.8	4.8	7.9
Local Unpaved	3.2	0.4	2.3	4.1
Total	20.3			

n=545; averages weighted by bushels produced

Table 3.55 Corn Market Road Type Miles for 2013 Grain Delivery, Montana				
Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	6.2	3.6	-1.1	13.5
State 4-Lane Paved	0.0	0.0	0.0	0.1
State 2-Lane Paved	20.5	11.5	-2.7	43.8
Local Paved	15.0	9.6	-4.4	34.4
Local Unpaved	15.3	8.3	-1.6	32.1
Total	57.0			

n=40; averages weighted by bushels produced

Table 3.56 Corn Market Road Type Miles for 2013 Grain Delivery, North Dakota				
Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	4.1	1.9	0.3	7.9
State 4-Lane Paved	1.6	0.4	0.8	2.4
State 2-Lane Paved	12.5	2.0	8.6	16.4
Local Paved	4.6	1.0	2.7	6.4
Local Unpaved	5.0	0.7	3.7	6.3
Total	27.8			

n=522; averages weighted by bushels produced

Table 3.57 Corn Market Road Type Miles for 2013 Grain Delivery, South Dakota				
Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	1.2	0.4	0.3	2.0
State 4-Lane Paved	0.9	0.3	0.3	1.4
State 2-Lane Paved	11.4	1.1	9.2	13.5
Local Paved	5.6	0.7	4.3	7.0
Local Unpaved	5.6	1.0	3.5	7.6
Total	24.6			

n=618; averages weighted by bushels produced

The average delivery distances for soybeans to the first choice delivery point are significantly different across the farm groups, ranging from 16.8 to 24.0 miles. The distances show a positive relationship with larger farms typified by longer average trips (Figure 3.10). Farm Group 3 reports the greatest share of local road use, with an average soybean trip at 55%. Farm Group 2 reports that 29% of its average 16.8 trip miles are on unpaved surfaces. Farm Groups 3 and 4 report the smallest unpaved mileage shares of 17%. Farm Group 1 reports that 4.4 of 17.8 miles, or 25%, of the average trip on unpaved roads. Farm Group 1 was similar in local road use, with about 49% of average delivery miles on local roads. Group 4 attributed the smallest share of miles to the first delivery point, 44%, to local roads. Additional farm group road use in soybean marketing is provided in Figure 3.10, Table 3.58, Table 3.59, Table 3.60, and Table 3.61.

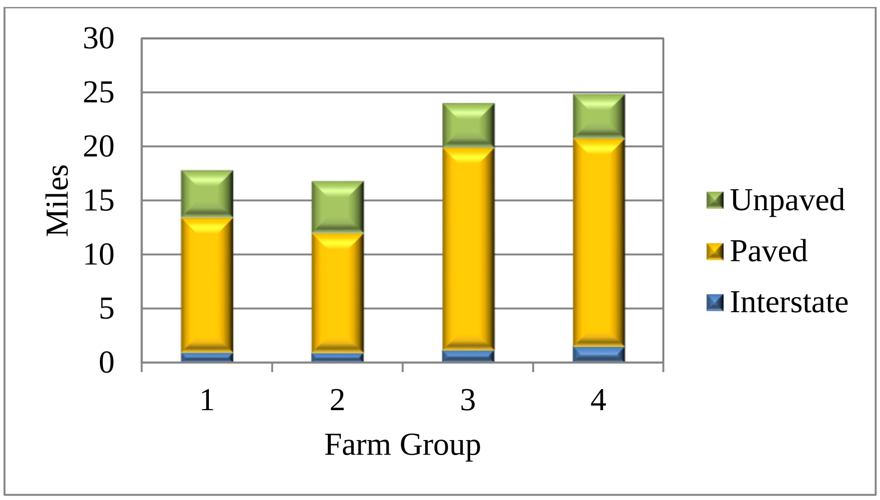

Figure 3.10 Road Type for Soybean Delivery, by Farm Group

Table 3.58 Soybean Market Road Type Miles for 2013 Grain Delivery, Farm Group 1

Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	0.9	0.4	0.1	1.7
State 4-Lane Paved	0.4	0.2	0.0	0.7
State 2-Lane Paved	8.2	2.7	2.9	13.5
Local Paved	4.0	0.4	3.2	4.7
Local Unpaved	4.4	1.8	0.9	7.8
Total	17.8			

n=285; averages weighted by bushels produced

Table 3.59 Soybean Market Road Type Miles for 2013 Grain Delivery, Farm Group 2

Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	0.9	0.3	0.2	1.5
State 4-Lane Paved	0.3	0.1	0.1	0.5
State 2-Lane Paved	6.6	1.1	4.5	8.6
Local Paved	4.2	0.4	3.5	4.9
Local Unpaved	4.8	1.7	1.4	8.2
Total	16.8			

n=356; averages weighted by bushels produced

Table 3.60 Soybean Market Road Type Miles for 2013 Grain Delivery, Farm Group 3

Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	1.1	0.3	0.5	1.7
State 4-Lane Paved	0.5	0.2	0.2	0.8
State 2-Lane Paved	9.1	1.2	6.8	11.4
Local Paved	9.1	2.6	4.0	14.2
Local Unpaved	4.1	0.5	3.2	5.0
Total	24.0			

n=525; averages weighted by bushels produced

Table 3.61 Soybean Market Road Type Miles for 2013 Grain Delivery, Farm Group 4

Road Type	Average Miles	Standard Error	95% Confidence Limit	
First Choice Delivery Point				
Interstate	1.4	0.4	0.7	2.2
State 4-Lane Paved	0.9	0.3	0.4	1.5
State 2-Lane Paved	12.5	1.1	10.3	14.6
Local Paved	5.8	0.8	4.3	7.4
Local Unpaved	4.1	0.4	3.4	4.9
Total	24.8			

n=495; averages weighted by bushels produced

The variation of trip distances to the second choice delivery points was substantially greater, considering the coefficient of variation. Therefore, the strata differences were not investigated since confidence in the findings would not be acceptable. The earlier regional summary of the second choice delivery points does provide some insight into the delivery point trip distances and road types for wheat, corn, and soybeans.

3.5 Truck Type Characteristics, Trips from Field to On-Farm Storage or Market

Farmers were asked to describe their farm truck fleet use specific to wheat, corn, and soybean movements. The high use of the 5-axle semi in farm-to-market trips in the region is first discussed in the farm truck fleet. Other commonly reported truck types were the single-axle and tandem trucks. Number of trucks in the fleet, as discussed earlier, does not provide a good metric for understanding the actual use of these trucks in grain marketing. For example, single-axle trucks represent 18% of the farm truck fleet but account for only 5% of the annual miles traveled for the fleet. Therefore, understanding the annual miles traveled as well as the typical truck type trip for farmers in the region is useful for planning and operational analysis. The specification here for the grain fleet is to define the individual truck types used for the three major crops during the 2013 harvest season. Key descriptors were defined as bushels per load, loaded weight, empty weight, and one-way distance to delivery point.

3.5.1 Regional Truck Type Characteristics

The average loaded weight shows the expected trend across commodities, larger trucks are associated with heavier loaded weights (Figure 3.11 and Table 3.63). The average loaded weight for a single-axle truck ranges from 28,340 pounds for wheat to 30,169 pounds for corn. The fleet average for the single-axle truck is 28,772 pounds (Table 3.62). The 5-axle semi, which is attributed with the over half of the annual farm truck miles, ranges from 79,142 pounds for soybeans to 80,320 pounds for wheat. Overall, the average loaded weight for a 5-axle semi is 79,747 pound. The average loaded weight for the tandem truck is 39% less at 49,744 pounds.

Table 3.62 Farm Truck Fleet Truck Trip Distance and Loaded Weights				
Truck Types	Average Distance	Standard Error	Average Loaded Weight	Standard Error
Single-axle	12.9	0.7	28,722	516
Tandem	16.9	1.0	49,744	548
Tridem	16.5	1.0	61,331	776
5-Axle Semi	23.7	0.9	79,747	145
7-Axle Semi	43.6	6.2	91,029	2,323

Averages weighted by harvested acres

The commodity-based differences in trip distance and loaded weight were not significant for the for the single, tridem or 7-axle trucks. Average loaded weight for the tandem [$F(1,142)=4.45$, $\rho=0.02$] and 5-axle semi-trucks [$F(2,602)=4.91$, $\rho=<.01$] did vary significantly among commodities. Commodity-based trip distance differences within the truck types were only significant for the tandem truck [$F(1,263)=10.95$, $\rho=<.001$].

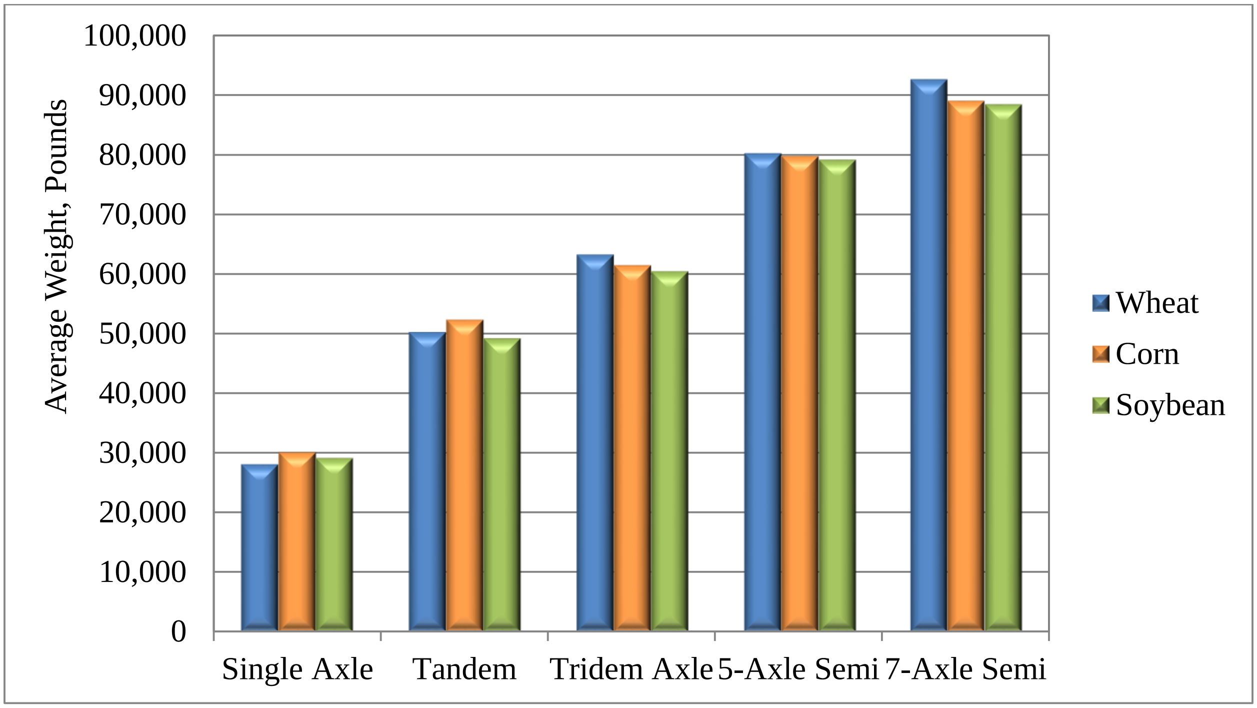

Figure 31.11 Truck Type Average Loaded Weight, By Commodity

Table 3.63 Average Loaded Weight, by Commodity									
	Wheat			Corn			Soybean		
Truck Type	n	Mean	Standard Error	n	Mean	Standard Error	n	Mean	Standard Error
Single-axle	217	28,340	881	141	30,169	1,762	159	29,340	1,076
Tandem	407	50,421	829	362	52,328	1,886	364	49,323	1,011
Tridem-axle	183	63,361	1,799	159	61,496	1,758	181	60,520	980
5-Axle Semi	741	80,320	213	929	79,750	269	871	79,142	305
7-Axle Semi	64	92,634	2,493	68	89,015	3,095	66	88,438	2,874
Other	125	85,920	1,985	139	93,783	7,769	137	87,591	5,917

Averages weighted by bushels produced

Part of this difference may be in the differences in the empty truck weight. An empty 5-axle semi weighs 25,984 to 26,994 pounds on average. In comparison, the empty tandem truck weighs an average of 18,500 to 18,949 pounds. Additional details for the empty weights are presented in Table 3.64.

Table 3.64 Average Empty Weight, by Commodity									
	Wheat			Corn			Soybean		
Truck Type	n	Mean	Standard Error	n	Mean	Standard Error	n	Mean	Standard Error
Single-axle	224	10,462	271	143	11,521	457	164	10,878	373
Tandem	416	18,659	303	357	18,949	403	356	18,500	326
Tridem-axle	185	24,024	591	160	22,576	624	181	23,024	326
5-Axle Semi	733	26,994	208	913	26,164	169	856	25,984	157
7-Axle Semi	62	31,553	608	68	28,900	1,374	67	29,529	1,142
Other	120	29,576	641	135	29,604	2,510	139	28,359	1,802

Averages weighted by bushels produced

The average bushels per load ranged from 324 bushels for a single-axle truck carrying wheat to 1,092 bushels for a 7-axle truck loaded with corn, considering the capacity for the common truck types (Table 3.65). Using the combination of the loaded weights, empty weights, and bushels per load, a reasonableness test was conducted by estimating the pounds per bushel across the commodities and truck types. All bushel weights fall in a range between 51 and 60 pounds which is acceptable since commonly used crop bushel weights are 60 pounds for wheat and soybeans and 56 pounds for corn.

Table 3.65 Truck Type Average Bushels per Load, by Commodity									
	Wheat			Corn			Soybean		
Truck Type	n	Mean	Standard Error	n	Mean	Standard Error	n	Mean	Standard Error
Single-axle	253	324	6	169	366	14	183	331	10
Tandem	451	547	10	404	581	26	397	532	10
Tridem-axle	193	674	21	171	661	20	192	635	9
5-Axle Semi	755	885	5	949	930	5	890	885	4
7-Axle Semi	67	1,101	34	71	1,092	23	65	1,036	24
Other	128	940	20	156	1,096	104	153	982	79

Averages weighted by bushels produced

The economies of the heavier loads are captured as trip distance increases. The positive relationship between the loaded truck weight and trip distance is illustrated in Figure 3.12. The longest average truck trip was reported for wheat hauled in a 7-axle semi-truck at 43.6 miles and the shortest was 12.5 miles for corn or soybeans moved in single-axle trucks. Wheat has the longest average trip within each of the truck types. The relatively large standard error for the 7-axle semi across all commodities does show less certainty with regard to the typical trip distance associated with the truck (Table 3.66).

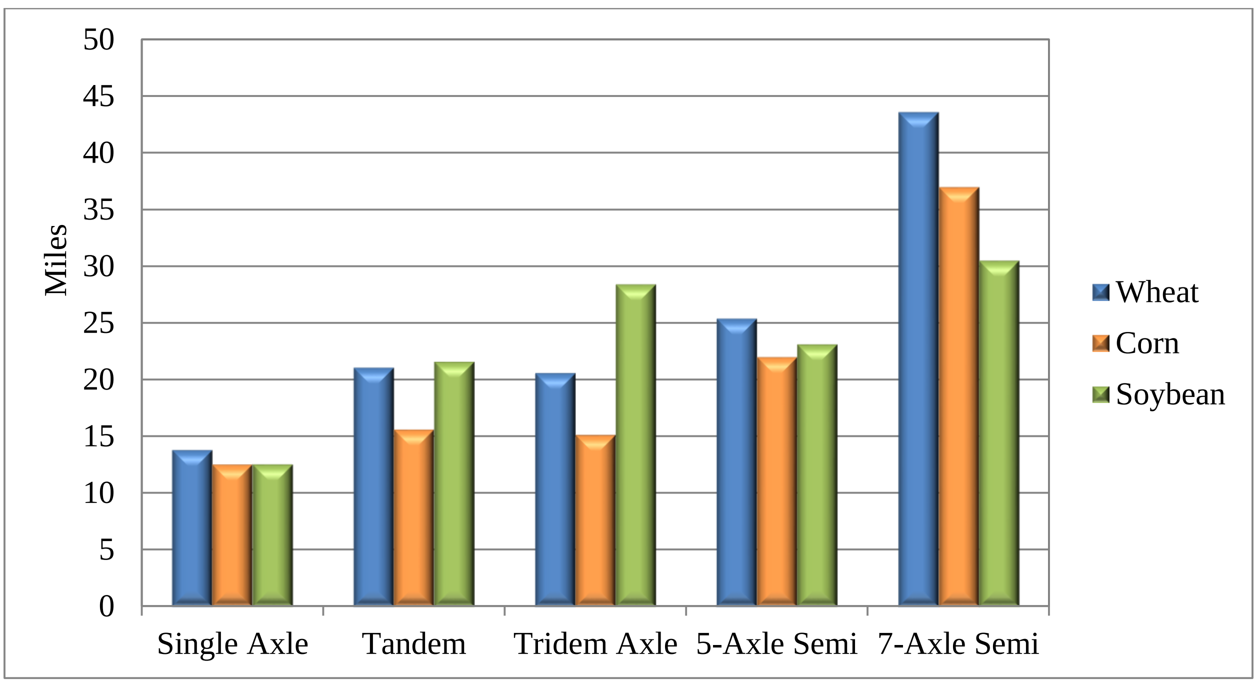

Figure 3.12 Truck Type Trip Distance, by Commodity

Table 3.66 Truck Type Average Trip Distance, by Commodity									
	Wheat			Corn			Soybean		
Truck Type	n	Mean	Standard Error	n	Mean	Standard Error	n	Mean	Standard Error
Single-axle	253	13.8	1.2	169	12.5	1.3	190	12.5	1.6
Tandem	448	21.1	2.5	394	15.6	1.3	403	21.6	8.2
Tridem-axle	194	20.6	2.6	164	15.1	1.7	190	28.4	13.5
5-Axle Semi	761	25.4	1.4	946	22.0	1.0	893	23.1	2.5
7-Axle Semi	68	43.6	7.0	73	36.9	7.2	65	30.5	4.2
Other	132	30.7	4.2	156	30.0	3.9	158	23.3	2.8

Averages weighted by bushels produced

3.5.2 Truck Type Characteristics, by Farm and State Strata

It is important to consider the farm group and state strata for the truck trip descriptors to identify differences that should be considered as a way to calibrate application of the survey findings in case studies or other sub-region analysis. To simplify analysis and presentation of differences, only the 5-axle semi-truck farm trip load weights and trip distances were analyzed with regard to the size and geographic strata. In addition, due to limited observations for corn and soybean shipments, Montana farm truck trips are omitted in this analysis to minimize potential sample size bias in the means tests. Among the three major commodities in the survey, wheat shows the least uniformity across the region with significant differences in the loaded weight for farm group [$F(763)=4.21$, $\rho=0.01$] and state [$F(1,142)=4.45$, $\rho=0.02$], as well as trip distance for farm group [$F(786)=3.16$, $\rho=0.02$] and state [$F(798)=14.06$, $p<.001$]. Corn is characterized by significantly different loaded weights for farm group [$F(947)=3.66$, $\rho=0.01$] and state [$F(957)=4.51$, $\rho=0.01$], and by distance among the states [$F(979)=7.23$, $p<.001$]. Soybean farm truck trips do not vary significantly for either the farm group or state strata. Regarding the loaded weights, Montana allows 20% overload coming out of the field at harvest. North Dakota allows 10% overload out of the field at harvest with permit. South Dakota allows a 10% overload from field to farm and a 5% overload from farm to market for agricultural loads in the state, compared to the normal allowed weights for trucks.

Table 3.67 Wheat Trip 5-Axle Loaded Weight, by Farm Group					
Farm Group	N	Mean	Standard Error	95% Confidence Limit	
300 acres or fewer	65	78,141	1,254	75,637	80,646
301 to 750 acres	111	80,220	505	79,219	81,220
751 to 1,500 acres	251	79,361	387	78,599	80,122
1,501 acres or more	337	80,444	289	79,875	81,013

Table 3.68 Wheat Trip 5-Axle Average Distance, by Farm Group

Farm Group	N	Mean	Standard Error	95% Confidence Limit	
300 acres or fewer	67	36.6	4.4	27.8	45.5
301 to 750 acres	118	29.9	3.6	22.7	37.1
751 to 1,500 acres	255	24.6	2.0	20.7	28.4
1,501 acres or more	347	24.7	1.4	22.0	27.4

Table 3.69 Wheat Trip 5-Axle Loaded Weight, by State

State	N	Mean	Standard Error	95% Confidence Limit	
Minnesota	143	79,103	434	78,244	79,961
Montana	128	82,683	503	81,688	83,678
North Dakota	374	79,868	279	79,319	80,417
South Dakota	119	80,745	811	79,138	82,351

Table 3.70 Wheat Trip 5-Axle Average Distance, by State

State	N	Mean	Standard Error	95% Confidence Limit	
Minnesota	149	25.5	3.5	18.7	32.3
Montana	136	39.0	2.8	33.4	44.6
North Dakota	379	21.7	1.5	18.8	24.6
South Dakota	123	24.8	1.8	21.2	28.3

Table 3.71 Corn Trip 5-Axle Loaded Weight, by Farm Group

Farm Group	N	Mean	Standard Error	95% Confidence Limit	
300 acres or fewer	64	76,355	1,305	73,747	78,963
301 to 750 acres	135	79,255	808	77,656	80,853
751 to 1,500 acres	340	79,157	367	78,435	79,879
1,501 acres or more	397	80,042	284	79,484	80,599

Table 3.72 Corn Trip 5-Axle Loaded Weight, by State					
State	N	Mean	Standard Error	95% Confidence Limit	
Minnesota	304	79,426	236	78,962	79,890
North Dakota	332	80,424	301	79,832	81,015
South Dakota	300	79,177	625	77,948	80,406

Table 3.73 Corn Trip 5-Axle Average Distance, by State					
State	N	Mean	Standard Error	95% Confidence Limit	
Minnesota	311	20.7	2.1	16.5	24.8
North Dakota	338	25.5	1.9	21.8	29.2
South Dakota	307	23.7	1.7	20.3	27.1

3.6 Truck Fleet Inspection

A single question was included in the study to gauge truck fleet adherence to truck maintenance and safety. Farmers were asked if they had any grain trucks inspected by their Department of Transportation (DOT) in 2013. The inspections performed by the state patrols in each state would also fall within the DOT inspections. Overall, 34% of the 2,760 farm operators who responded to the question reported to have had at least one truck inspected. A significant difference in inspection activity was found at the 99th percentile among states (χ^2=165.49, p<.001, n=2,760) and farm groups (χ^2=170.01, p<.001, n=2,700).

Minnesota had the largest share reporting a farm truck inspection with 1 in 2 farms having a truck inspected (Figure 3.14). Montana had the lowest share with about 1 in 5 farms reporting an inspection. Among the farm groups, the largest farms were most likely to report a DOT inspection with about 1 in 2 having a truck inspected (Figure 3.13). The smallest farms were least likely to have a truck inspected with 17% reporting an inspection. The differences may be related to regulatory policies in the individual states as well as local practices with regard to safety and enforcement.

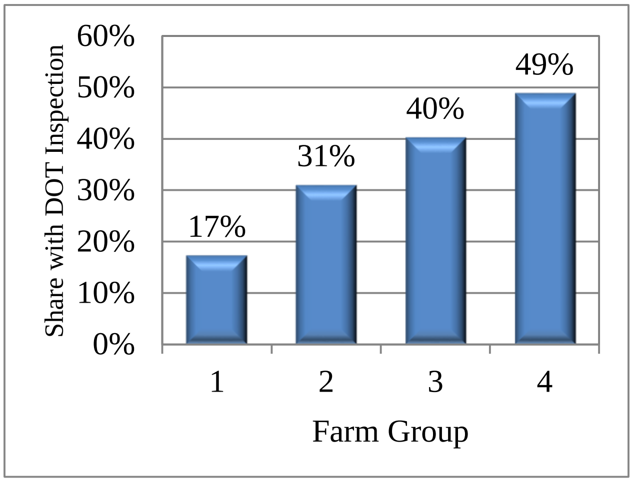

Figure 3.13 State Agency Truck Inspection, by Farm Group

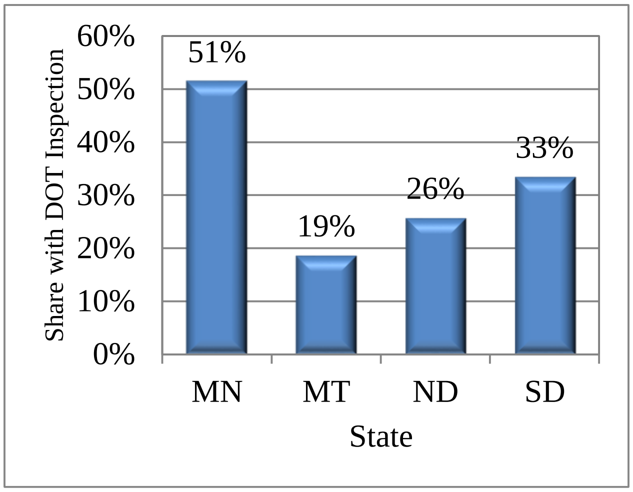

Figure 3.14 State Agency Truck Inspection, by State

The propensities for farm truck inspections by state and farm group are insinuated in farm truck inspections reported in the region (Table 3.74). Minnesota had the highest inspection levels across all farm groups with the likelihood increasing with farm size. Among the largest farms, Minnesota and South Dakota had the largest shares of farms with DOT inspections at 75% and 54%, respectively.

Table 3.74 DOT Truck Inspection Reported, by State and Farm Group

	Minnesota	Montana	North Dakota	South Dakota
Farm Group	Share Reporting Inspection			
300 acres or fewer	28%	13%	13%	11%
301 to 750 acres	56%	11%	19%	28%
751 to 1,500 acres	59%	23%	25%	46%
1,501 acres or more	75%	35%	36%	54%

4. SUMMARY

Agriculture is a large part of the economy in the Northern Plains region of North Dakota, northern South Dakota, western Minnesota and eastern Montana. For North Dakota, agriculture generated 14.5% of its gross state product and an even higher proportion in South Dakota at 15.3%. Agriculture in Montana and Minnesota were about half of that rate at 7.4% and 5.0% respectively. Nationally, agriculture makes up 1.8% of the economy (U.S. Department of Agriculture 2014a). While the economies of these states have become more diversified, the increasing magnitude of agricultural products as a transport demand component and economic generator is evident. For example, U.S. Department of Agriculture figures show that in 1940 North Dakota produced approximately 9.5 million tons of grain which was transported about 10 miles to local elevator facilities (Ming and Wilson 1983). These early grain movements generated about 95 million farm truck ton-miles in freight demand (National Agricultural Statistics Service 2014). This compares to 800 million bushels, or 30 million tons, of grain moving approximately 30 miles to subterminal elevator facilities and local agricultural processors in 2010, resulting in an estimated 900 million farm truck ton-miles (Tolliver et al. 2005).

The objective of this study was to provide information about farm truck inventory and grain marketing patterns in the Northern Plains. There is no other source for this information and this study should be unique and complementary to other farm-to-market information and national commodity flow publications. Farmers may use this information for investment and productivity assessments. Local and regional planners and policy makers can use the information in calibrating travel demand and freight flow models for investment and asset management choices. The survey of farm operators in this Northern Plains region was conducted to gather information about transportation of crops, the inventory of the farmer owned truck fleet, and on-farm storage capacity. Survey design and implementation was a successful collaboration of the Upper Great Plains Transportation Institute (UGPTI) at North Dakota State University and the North Dakota Office of the Agricultural Statistics Service (NDASS) and the National Agricultural Statistics Service (NASS) of the U.S. Department of Agriculture.

The survey was mailed to a sample of farmers in the NASS contact database and followed-up with a phone survey of non-respondent farmers. A stratified non-probability quota sample was used to select the farmers from the population for the survey. The number of surveys collected was sufficiently large so generalizations could be made about the larger population from the survey sample. The survey collected data for a representative sample of corn, wheat, and soybean farms in North Dakota and the adjacent crop reporting districts (CRDs) from Montana, South Dakota, and Minnesota. The main descriptive statistics calculated to describe the farm grain fleet and farm-generated grain traffic are related to frequency, central tendency, and dispersion. In addition, some means tests are presented to investigate potential differences in grain farm truck fleet and marketing characteristics among the state CRD groups and different size farms.

Average on-farm storage capacity for the three commodities was 86,375 bushels when weighted by harvested acres. The median on-farm storage capacity was 50,000 bushels with 25% reporting fewer than 20,000 bushels. The storage capacity density, measured by farm as bushels produced per harvested acre (including corn, soybean and wheat), was inversely related to the farm size

Storage capacity volume, however, is substantially greater for the larger farms. Average on-farm storage was 329,097 bushels of corn, soybean and wheat capacity for farms of 1,501 acres or more. The smallest farms averaged only 26,252 bushels of capacity for the three commodities. The on-farm storage is concentrated on the larger farms in terms of average capacity. In terms of flexibility, however, the smaller farms appear to be more able to adapt when increased on-farm storage is needed. For the smallest farms, the ratio of storage capacity bushels per harvested acre was 151 where the largest farms have an average of 62 bushels of on-farm storage for each harvested acre. The difference in the storage density may be related to expectations for yield among commodities

On-farm storage provides an easily accessible option for delaying grain delivery beyond the harvest season. Farmers were also asked to identify the share of the crop delivered directly to market from the field at harvest time. Responses weighted by bushels produced showed 36% of wheat (n=1,518) 95% CI [32%, 39%] and 32% of corn (n=1,835) 95% CI [30%, 36%] was delivered directly to market. The average share of soybeans delivered directly to market from field is substantially higher at 66% (n=1,748) 95% CI [63%, 69%]. Among the state strata, the adjacent South Dakota farmers reported delivering the largest share of wheat directly to market at 50%, compared to 31%, 33% and 36% for Minnesota, Montana, and North Dakota, respectively. On average, corn share delivered to market at harvest ranged from 32% in South Dakota to 39% in Montana. Minnesota farmers reported an average 34% and North Dakota farmers reported 33%.

The most owned and operated truck in the four-state area reported by survey respondents is the 5-axle semi. The 5-axle semi accounted for more than 38% of all trucks reported followed by the tandem-axle truck with more than 23% and then the single-axle with 18%. The tridem and 7-axle semi were least owned among producers representing 8% and 3% respectively.

Comparing data from this survey with historical data shows a trend towards ownership and use of larger trucks by farmers. In a survey and report by the Upper Great Plains Transportation Institute in 1989, it was estimated that 80% of the farm truck fleet was single-axle trucks. That same survey found that the average trip to market was 12 miles. A study by the Upper Great Plains Transportation Institute in 2005 estimated that 52% of the farm fleet in the year 2000 was single-axle trucks and 25% were tandems. Only 9% of the fleet was 5-axle or other types of semis.

In the current survey, producers reported that the 5-axle semi is used most by all farm groups. Even though more single-axle trucks are owned by farmers with 300 acres or less, the 5-axle semi is used more for hauling to market. The tandem gets second most use by all farm groups except those farmers with 1,501 acres or more who report using the tridem more than the tandem.

The 5-axle semi was reported to be used 89.1% of the time by producers hauling their own grain, followed by the tridem, tandem and single-axle with 83.6%, 81.7%, and 65.3%, respectively. Farmers estimate that single-axle and tandem-axle truck ownership will decline in the future while 5-axle and 7-axle semi ownership will increase. Ownership of tridem-axle trucks is expected to remain constant.

In 2000, the average delivery for wheat movements with a semi-truck was on 25.2 miles paved and 7.2 unpaved road miles, respectively (Tolliver et al. 2005). Comparatively, the average farm delivery in the early 1980's was about 12 miles, as noted in the truck fleet discussion.

It is reasonable to expect an increase in the average distance for farm-generated grain movements because farm size and distance between elevators has increased over time. In addition, production pattern changes and policy incentives have created opportunities for local processing investments in industries such as ethanol and biofuels. On average, the major crops were hauled 26.8 miles to the first choice delivery point and 41.7 miles to the second choice in the Northern Plains region in marketing the 2013 crop. About 1 in 5 miles was on unpaved roads for the first choice point. Only about 2 miles of the average trip is attributed to interstates. The largest share of the trip is on state roads, with 1 in 2 miles on state roads. Respondents reported that 41% of their average delivery miles to each the first and second choice points is on local roads.
In comparing the trip distances to the Tolliver study, note that even though there has been rationalization in the elevator industry, the number of large shuttle elevators has more than doubled since 2005. This provides more options to farmers and perhaps shorter distance to the first or second delivery choice for some than was available in 2005 hauling to shuttle facilities. Montana had the longest average wheat trip to the first choice delivery point at 47.7 miles. The trip distance for Minnesota, North Dakota, and South Dakota farmers was considerably less compared to Montana, at 25.1, 24.5 and 27.8 miles respectively. Montana had the highest share of unpaved roads in the trips reported for wheat with slightly more than 31% of miles on gravel. Minnesota reported the smallest share of unpaved miles at 13%. North Dakota farmers traveled unpaved roads for 1 in 4 miles and South Dakota 1 in 5 miles for wheat delivered to the first choice point. With regard to state or local road use, South Dakota reported the heaviest local road use as a share of delivered miles. Local roads were attributed with 45% of the wheat delivery trip miles in South Dakota. The shares in Minnesota, Montana and North Dakota were 27%, 35%, and 40%, respectively.

South Dakota had the longest average corn trip to the first choice delivery point at 26.7 miles. The trip distances for Minnesota, Montana, and North Dakota were 17.5, 18.9, and 22.9 miles, respectively. Montana had the highest share of unpaved roads in the trips reported for wheat with slightly more than 1 in 4 miles on gravel. With regard to state or local road use, Montana had the heaviest use of local roads as they accounted for 52% of the average trip miles for corn delivery. North Dakota farmers were second in dependence on local roads, attributing 47% of average wheat trip miles to the local road system. Minnesota and South Dakota reported 43% and 42%, respectively, of the trip miles were on local roads for delivering corn to the first choice delivery point.

The average delivery distances for soybeans to the first choice delivery point are significantly different across the farm groups, ranging from 16.8 to 24.0 miles. The distances show a positive relationship with larger farms having longer average trips. Farm group 2 reports 29% of its average 16.8 trip miles are on unpaved surfaces. Farm groups 3 and 4 report the smallest unpaved mileage shares of 17%. Farm group 1 reports that 4.4 of 17.8 miles, or 25%, of the average trip is on unpaved roads. The use of local roads in soybean marketing was greatest for farm groups 2 and 3, at 54% and 50% of the delivery miles to the first choice point. Farm group 1 was similar in local road use, with about 49% of average delivery miles on local roads. Group 4 attributed the smallest share of miles to the first choice delivery point, 44%, to local roads.

The average loaded weight shows the expected trend across commodities; larger trucks are associated with heavier loaded weights. The average loaded weight for a single-axle truck ranges from 28,340 pounds for wheat to 30,169 pounds for corn. The fleet average for single-axle trucks is 28,772 pounds. The 5-axle semi, which is attributed with more than half of the annual farm truck miles, ranges in loaded weight from 79,142 pounds for soybeans to 80,320 pounds for wheat. Overall, the average loaded weight for a 5-axle semi is 79,747 pounds. The average loaded weight for the tandem truck is 39% less at 49,744 pounds.

Farmers were asked if they had any grain trucks inspected by their Department of Transportation (DOT) in 2013. Inspections performed by the state patrols in each state would also fall within the DOT inspections. Overall, 34% of the 2,760 farm operators who responded to the question reported to have had at least one truck inspected.

Minnesota had the largest share reporting a farm truck inspection with 1 in 2 farms having a truck inspected. Montana had the lowest share with about 1 in 5 farms reporting an inspection. Among the farm groups, the largest farms were most likely to report a DOT inspection with about 1 in 2 having a truck inspected. The smallest farms were least likely to have a truck inspected with 17% reporting an inspection. The differences may be related to regulatory policies in the individual states as well as local practices with regard to safety. Minnesota had the highest inspection levels across all farm groups with the likelihood increasing with farm size. Among the largest farms, Minnesota and South Dakota had the largest shares of farms with DOT inspections at 75% and 54%, respectively.

REFERENCES

Qasmi, Bashir A., Yonas Hamda, and Scott W. Fausti, 2009, Impacts of Dramatic Increase in Corn Based Ethanol Production on Grain Production and Marketing Patterns in South Dakota, South Dakota State University, Brookings.

Baumel, C. Phillip, Jean-Philppe Gervias, H. Hommes, and C. O'Riley, 1996, The Iowa Grain Flow Survey: Where and How Iowa Grain Producers and Country Elevators Ship Corn and Soybeans, Iowa State University.

Berwick, Mark and Mohammad Farooq, 2003, Truck Costing Model for Transportation Managers, North Dakota State University, Upper Great Plains Transportation Institute, Fargo, MPC03-152.

Donnelly, Rick, 2010, Best Practices for Incorporating Commodity Flow Survey and Related Data into MPO and Statewide Planning Processes, prepared by Parsons Brinckerhoff, Inc., Albuquerque, New Mexico as requested by American Association of State Highway and Transportation Officials, Standing Committee on Planning. NCHRP-08-36-65.

Griffin, Gene C., William W. Wilson, and Kenneth Casavant, 1984, Characteristics and Costs of Operation of North Dakota's Farm Trucks, Upper Great Plains Transportation Institute, North Dakota State University, DP-51.

Internal Revenue Service, 2015, accessed online at www.irs.gov/publications/p225/ch07.html

Ming, Dennis and William W. Wilson, 1983, The Evolving Country Grain Marketing System in North Dakota, Upper Great Plains Transportation Institute, Fargo, Report No. 49.

U.S. Department of Commerce, 2015, Regional Data, Bureau of Economic Analysis, Accessed online at http://www.bea.gov/.

Tolliver, Denver, Mark Berwick, and Kimberly Vachal, 2005, Farm-to-Market Transportation Patterns and Truck Use in the Northern Plains, North Dakota State University, Upper Great Plains Transportation Institute, Fargo, DP-167.

U.S. Department of Transportation, 2010, Bureau of Transportation Statistics, Commodity Flow Survey, Accessed online at www.bts.gov/help/commodity_flow_survey.html.

U.S. Department of Agriculture, 2014a, National Agricultural Statistics Service, Research and Development Division, Quick Stats, accessed online at http://www.nass.usda.gov/Quick_Stats/.

U.S. Department of Agriculture, 2014b, National Agricultural Statistics Service, Census of Agriculture, accessed online at http://agcensus.usda.gov/Publications/2012/.