United States Department of Agriculture

Corn Transportation Profile

AMS Transportation and Marketing Programs

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Executive Summary

America's farmers depend on transportation as the critical link between the fields of growers and the tables of consumers, both here and abroad. Transportation is a derived demand because the production and consumption of an agricultural commodity create the demand for transportation services. As such, it is an essential part of marketing; any change in supply or demand of the underlying commodity or commodities that compete for transportation services can affect the transport system's efficiency by bringing about either shortages or surpluses in transportation capacity. This report examines transportation implications of the recent trends and outlook for U.S. corn.

Key highlights:

- Since the mid-1990's, U.S. corn production has increased by 88 percent, but acreage devoted to growing corn has increased by only 34 percent. As demand for corn increased dramatically between 2006 and 2013, especially for ethanol production, U.S. farms responded by boosting production and acreage.
- The United States remains the world's largest exporter of corn. The U.S. market share of world corn exports, however, has been declining as the world corn trade has been increasing.
- Corn prices, transportation costs, and the price of feed substitutes (such as distillers' dried grains and feed-quality wheat) influence foreign demand for U.S. corn. Unexpected changes in export demand pose logistical challenges for U.S. grain shippers and carriers.
- If the projected long-term growth in corn exports materializes over the next 10 years, demand for barge and rail services will increase because corn exporters rely on these two modes of transportation to move the crops from the primary production regions of the United States to the ports on the West Coast, the Gulf of Mexico, the Atlantic Ocean, and the Great Lakes.
- The projected increase in feed use could also result in additional demand for truck and rail service.
- Lower total transportation costs are a major variable in keeping U.S. agriculture competitive in overseas markets.
- The majority of corn exports are shipped through the Mississippi Gulf Coast (65 percent of 2013 corn exports), but ocean shipping cost spreads between the Mississippi Gulf Coast (MGC) and the Pacific Northwest (PNW) exceeding $30 generally lead to a greater proportion of Asia-bound corn being shipped by rail to ports in the PNW.

Introduction

Transportation is an essential part of agricultural marketing. America's farmers depend on an adequate and efficient transportation system to move their crops to market and to bring them inputs, both of which are usually transported great distances.

Transportation demand is a derived demand because the production and consumption of an agricultural commodity create the demand for transportation services. As such, it is an essential part of marketing; any change in supply or demand of the underlying commodity can affect the transport system's efficiency by bringing about either shortages or surpluses in transportation capacity. Short-term agricultural transportation demand is influenced by weather-related transportation disruptions, variation in annual crop size and location, the timing of planting and harvesting, global trade patterns, crop quality concerns, competition in production by other countries, and commodity price fluctuations. These and other factors can translate into unexpected shifts in transportation patterns and costs, adding to the commodity price risk that must be managed by agricultural producers, processors, and shippers.

The United States is the world's largest producer and exporter of corn, accounting for 50 percent of the world corn trade each year during the past 10 years. Corn is the primary feed grain in the United States, making up 96 percent of feed grain production. Historically, the majority of corn grown in the United States has been used for animal feed. However, because of the rapid expansion of the ethanol and byproduct sector that began in 2005, the food, seed, and industrial uses category surpassed the feed use and residual category in the USDA's corn supply and demand balance sheet in 2010.[1] From 2007 to 2011, an average of 15 percent of corn production was exported annually, but U.S. corn exports vary from year to year because of global supply and demand and price volatility.[2] For example, during 2012/13, only 7 percent of corn production was exported due to the severe 2012 drought; according to the most recent USDA forecast, that share is expected to rebound to about 14 percent in 2013/14.

Most U.S. corn is produced in just seven States and is shipped by rail, barge, and truck to feedlots, feed mills, ethanol refineries, and ports for export.[3] Corn exporters depend mostly on rail and barge services to move the crop to ports; domestic corn movements are primarily handled by trucks. Volatility in the corn export market creates an element of uncertainty in anticipating the demand for transportation services.

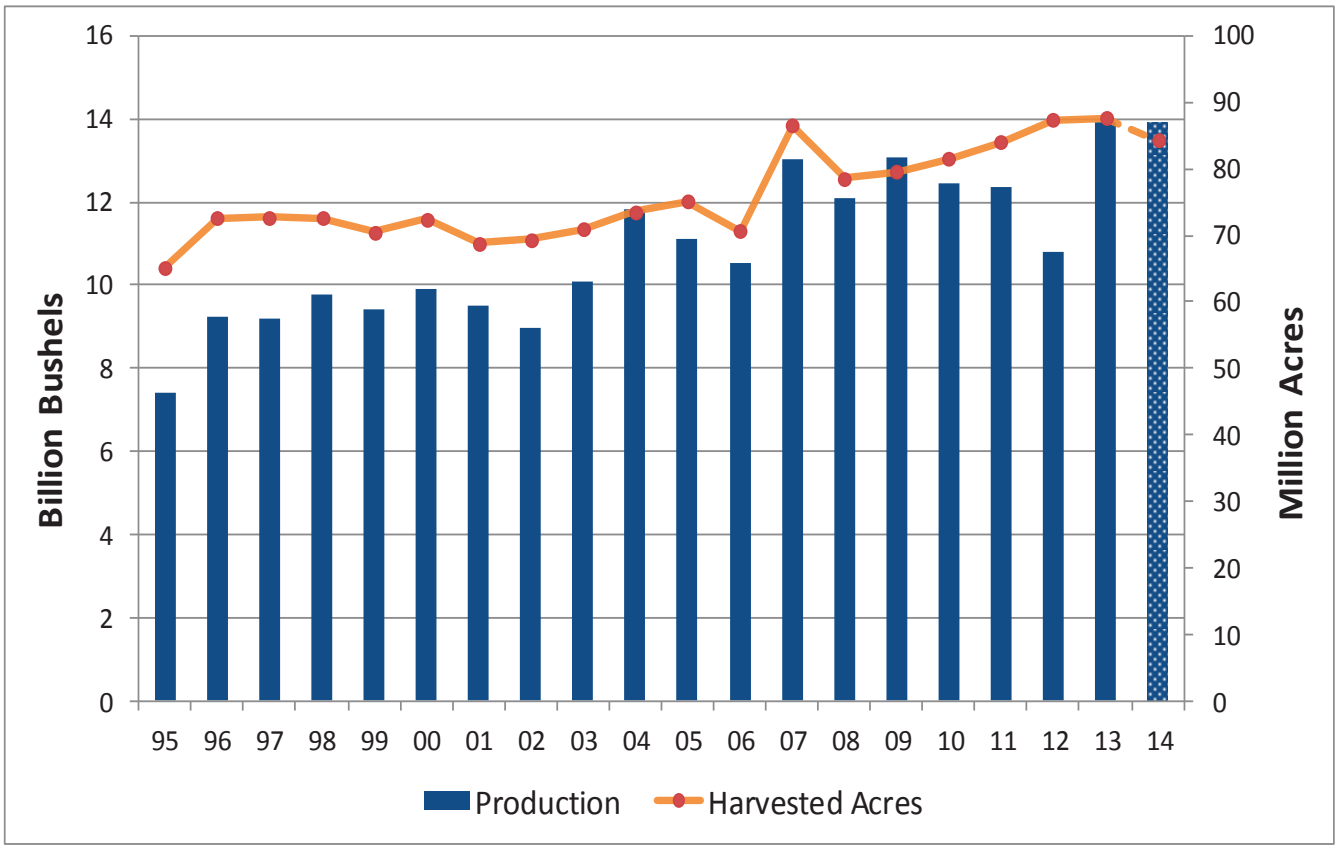
This report analyzes transportation issues facing U.S. corn growers and shippers by reviewing supply and demand trends, the long-term outlook, modal shares, and transportation costs.

Supply and Demand

Since the mid-1990's, U.S. corn production has increased by 88 percent, but acreage devoted to growing corn has increased by only 34 percent (see figure 1). Most of the increase in corn production occurred between 2005 and 2013, caused mainly by the rapid expansion of the ethanol sector. During that period, U.S. farms responded to the increase in demand, with corn production and acreage increasing by 32 and 24 percent, respectively.[4]

1 The food, seed, and industrial uses category includes all corn processed in ethanol plants. Some of the byproducts of these plants are used as animal feeds, such as distillers' grains, corn gluten feed, corn gluten meal, and corn oil, and are included in this category.
2 USDA/Economic Research Service (ERS) <http://www.ers.usda.gov/Briefing/Corn/background.htm>.
3 USDA/National Agricultural Statistics Service (NASS) Quickstats: Corn Production by State.
4 USDA/ERS, Feedgrains database Yearbook Tables, 2013.

Figure 1: U.S. corn production and harvested acreage, 1995–2014*



**2014: the marketing year from Sep 1, 2013, to Aug 31, 2014. 2014 production and acreage are USDA initial projections, May 2014.*

Source: Analysis of Official USDA supply and demand data. <http://www.usda.gov/oce/commodity/wasde/index.htm> <http://www.ers.usda.gov/data-products/feed-grains-database/feed-grains-yearbook-tables.aspx>.

From 1995 to 2013, total demand for corn increased by 57 percent as food, seed and industrial use increased 293 percent, surpassing feed use as the largest source of domestic consumption and reflecting the growing importance of biofuels.[5] In fact, during the 2011/12 growing season the use of corn for ethanol and byproducts (including distillers' grains, corn gluten feed and meal, and corn oil) accounted for 40 percent of total corn production.[6] Demand for corn for feed rose by 13 percent, from 4.69 billion bushels (bbu) in 1995/96 to 5.3 bbu projected for 2013/14, well below its peak of 6.14 bbu in 2004/05 (see Table 1).

5 USDA/ERS Corn Yearbook Tables, 2013.

6 USDA/World Agricultural Outlook Board (WAOB). WASDE-508, July 11, 2012.

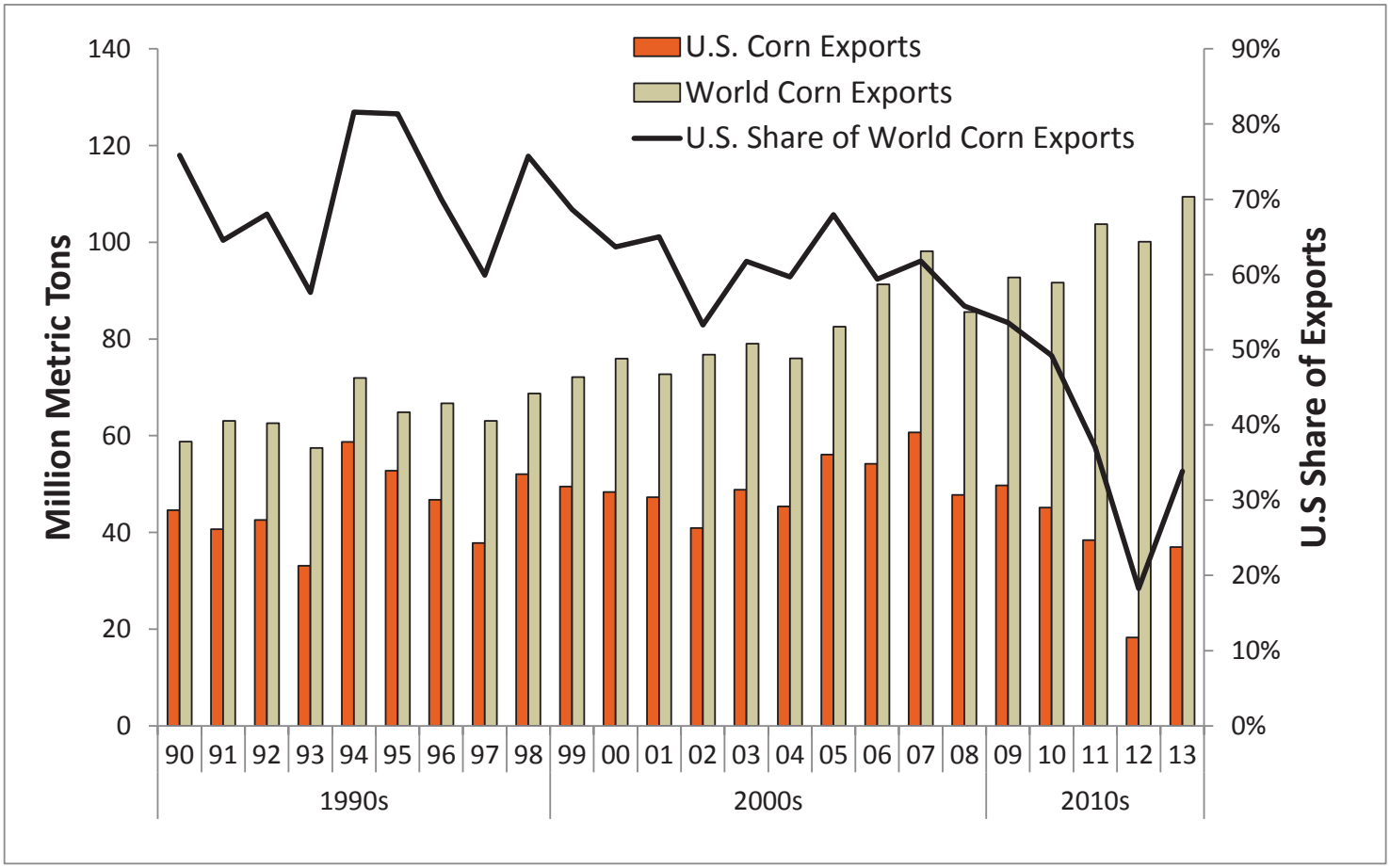
Table 1: U.S. corn supply, demand, and stocks/use, 1995-2013*, in million bushels

	Supply				Use					
Year	Beginning Stocks	Production	Imports	Total Supply	Food, Seed and Alcohol	Feed	Exports	Total Use	Ending Stocks	Ending Stocks/Use
1995	1,558	7,400	16	8,974	1,628	4,692	2,228	8,548	426	5%
1996	426	9,233	13	9,672	1,714	5,277	1,797	8,789	883	10%
1997	883	9,207	9	10,099	1,836	5,450	1,504	8,791	1,308	15%
1998	1,308	9,759	19	11,085	1,862	5,452	1,984	9,298	1,787	19%
1999	1,787	9,431	15	11,232	1,935	5,643	1,937	9,515	1,718	18%
2000	1,718	9,915	7	11,639	1,977	5,822	1,941	9,740	1,899	19%
2001	1,899	9,503	10	11,412	2,062	5,849	1,905	9,815	1,596	16%
2002	1,596	8,967	14	10,578	2,355	5,548	1,588	9,491	1,087	11%
2003	1,087	10,087	14	11,188	2,549	5,781	1,900	10,230	958	9%
2004	958	11,806	11	12,775	2,707	6,135	1,818	10,661	2,114	20%
2005	2,114	11,112	9	13,235	3,019	6,115	2,134	11,268	1,967	17%
2006	1,967	10,531	12	12,510	3,541	5,540	2,125	11,207	1,304	12%
2007	1,304	13,038	20	14,362	4,442	5,858	2,437	12,737	1,624	13%
2008	1,624	12,092	14	13,729	5,025	5,182	1,849	12,056	1,673	14%
2009	1,673	13,092	8	14,774	5,961	5,125	1,980	13,066	1,708	13%
2010	1,708	12,447	28	14,182	6,426	4,798	1,834	13,055	1,128	9%
2011	1,128	12,360	29	13,517	6,428	4,557	1,543	12,528	989	8%
2012*	989	10,780	162	11,932	6,046	4,333	731	11,111	821	7%
2013*	821	13,925	35	14,781	6,400	5,300	1,750	13,450	1331	10%

**USDA Estimates and Projections as of January 2014; updated with World Agricultural Supply and Demand Estimates, April 2014*
**2013: the marketing year is from September 1, 2012, to August 31, 2013.*
Source: USDA Economic Research Service, Corn Yearbook Tables: Supply and Disappearance, 2013, Feed Outlook, January 2014, and World Agricultural Supply and Demand Estimates, April, 2014.

In addition to the large domestic corn demand, there is also substantial international demand for U.S. corn, demonstrating its global importance. The United States remains the world's largest exporter of corn, despite a decrease in exports since the mid-2000s caused by the global economic slowdown following the 2008 financial crisis and exacerbated by the 2012 drought.[7] The U.S. market share of world corn exports has been declining as world corn trade has been increasing (see figure 2). U.S. corn faces competition from other exporting countries, including the countries of the Black Sea region, Brazil, Argentina, and South Africa.[8] In some years, feed-quality wheat also competes with U.S. corn exports.

Figure 2: Corn exports and U.S. share of world total, 1990-2013*

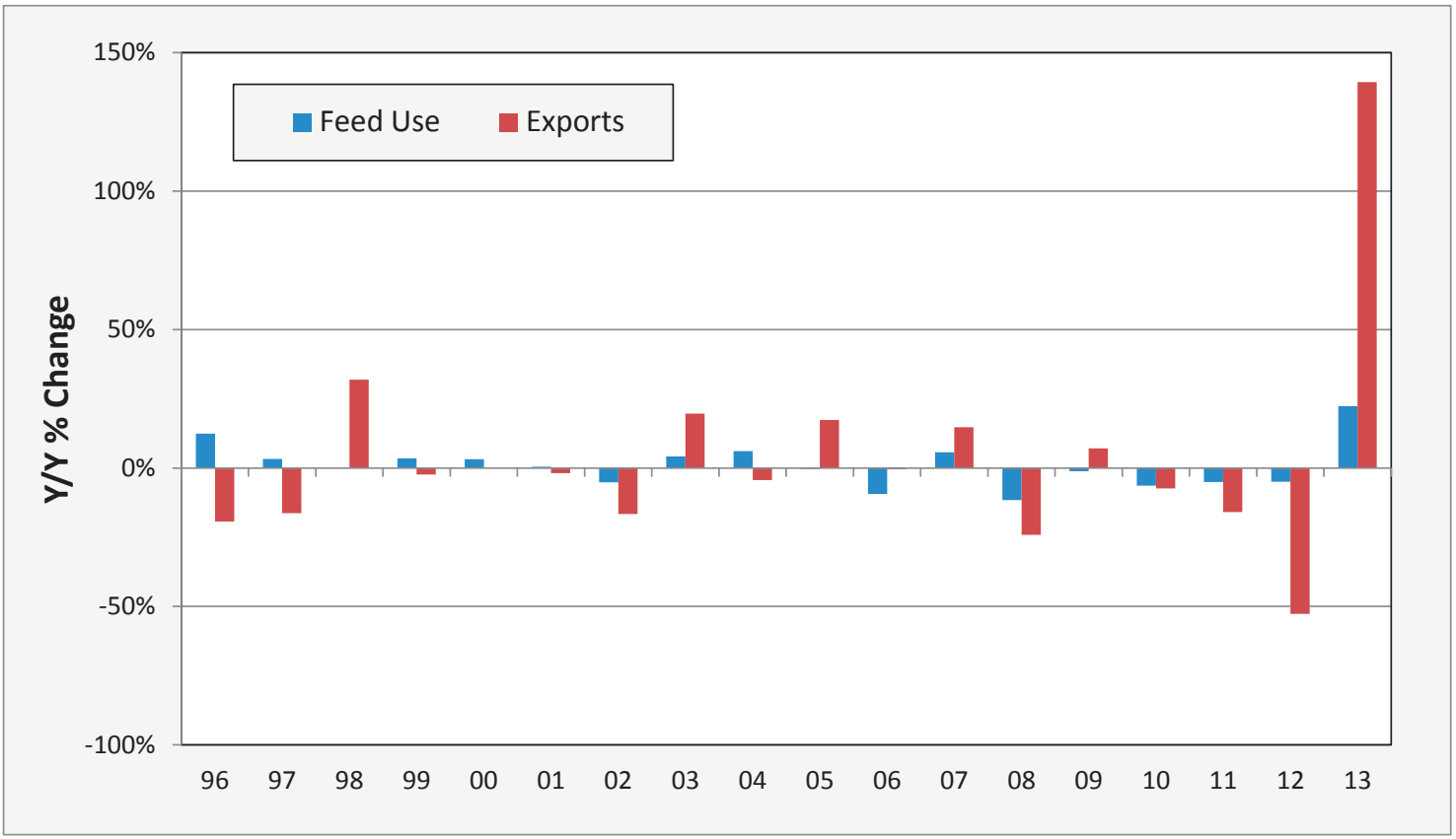


** World Agricultural Supply and Demand Estimates, January 2014*
Exports and U.S. share for 2012 and 2013 are estimates. (Marketing year 2013 is from September 1, 2012, to August 31, 2013.)
Source: Analysis of USDA's official production, supply, and distribution data <http://www.usda.gov/oce/commodity/wasde/index.htm>

7 http://www.ers.usda.gov/topics/crops/corn/background.aspx
8 Analysis of data in the World Agricultural Supply and Demand Estimates reports <www.usda.gov/oce>.

Demand for corn exports has been more volatile than demand for corn for domestic feed use (see figure 3).[9] From 2012 to 2013, for example, export demand dropped by more than 50 percent, followed by a projected increase of almost 100 percent the following year (2013–2014). Many factors influence the demand from importing countries, including corn prices, transportation costs, price of feed substitutes (such as distillers' dried grains and feed-quality wheat). Increases in export demand pose logistical challenges for grain shippers and carriers, especially during large harvests, as rail and barge carriers are called upon to deliver large amounts of grain to port in a relatively short period. On the other hand, a drought-induced reduction in U.S. corn production can result in a large drop in corn exports, as was the case during the 2012/13 marketing year. The significant reduction in crop size and exports resulted in a change in normal transportation patterns as areas that were short on feed grain sourced grain from regions further away by bidding up local prices.[10] In addition, the slack demand and the excess transportation capacity may have been used to transport other products.

Figure 3: Yearly percent changes in corn demand, feed and exports, 1997-2014*



** World Agricultural Supply and Demand Estimates, January 2014*
Demand for 2013 and 2014 are estimates.
Source: USDA Economic Research Service Corn Yearbook Table.

9 USDA Economic Research Service Corn Yearbook Tables, 2013.
10 http://beefmagazine.com/markets/some-year-end-thoughts-corn-basis-drought

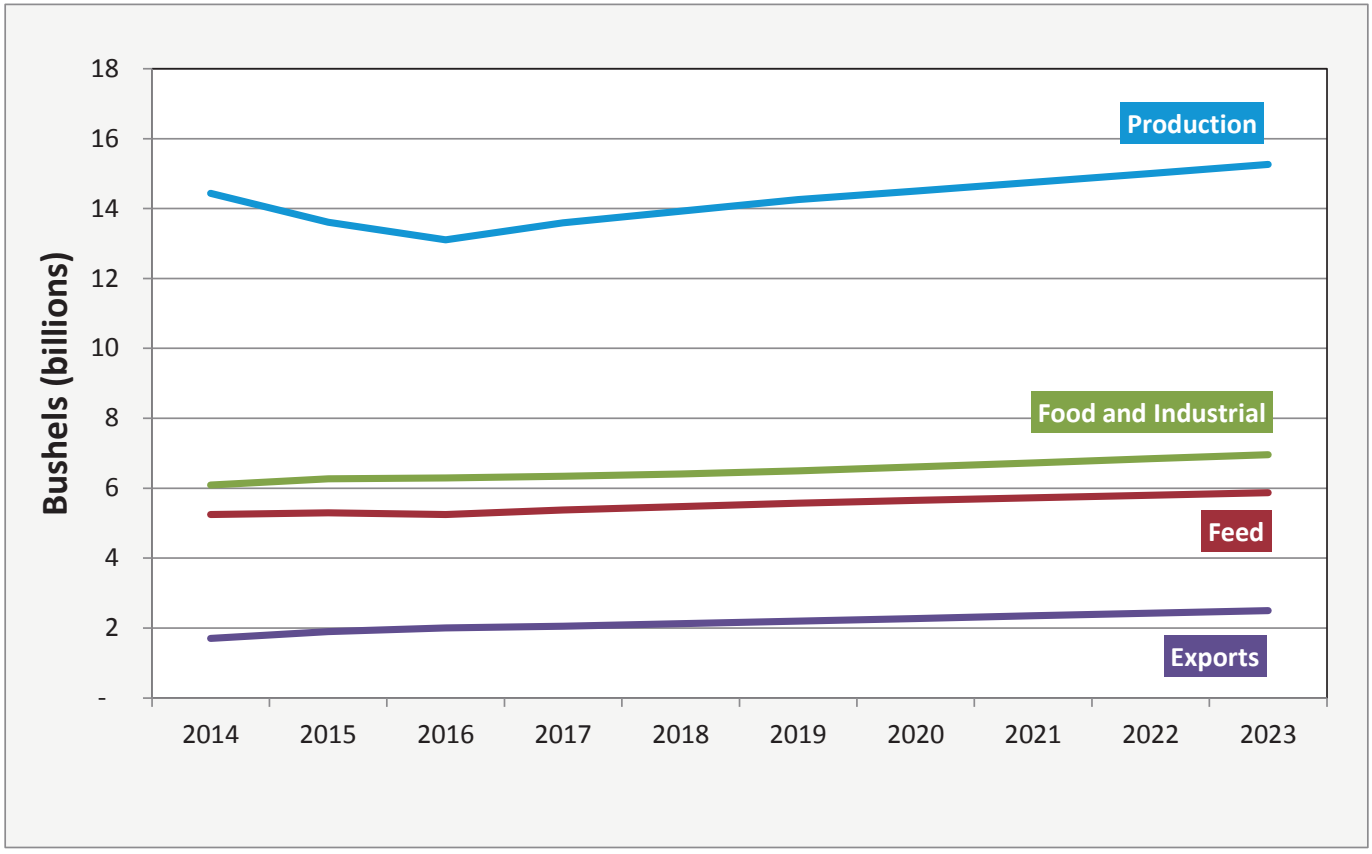
Long-Term Outlook

Every year, USDA publishes a 10-year long-term outlook report that estimates supply and demand for many commodities, including corn (see figure 4). Corn for feed and food and industrial uses is hauled predominantly by truck. Export corn is predominantly hauled by barge and rail.

According to the February 2014 USDA long-term projections, U.S. corn exports are projected to rebound from the low during the 2012 drought of 19 million metric tons and trend upward to 57 million metric tons by 2024. However, the U.S. share of world corn exports only rises to 40 percent, well below the 65 percent average share during the two decades preceding 2011.[11]

If the projected growth in corn exports materializes over the next 10 years, demand for barge and rail services will probably increase because corn exporters rely on these two modes of transportation to move the crops from the heartland of the United States to the ports on the West Coast, the Gulf, the Atlantic, and the Great Lakes. The projected increase in domestic feed use could also result in additional demand for truck and rail service. At the same time, agricultural products are likely to face greater competition for transportation from other freight; total freight demand is projected to increase by 50 percent for all modes by 2040.[12]

Figure 4: USDA long-term projections for corn, 2013-2022



Source: USDA/Office of the Chief Economist, Agricultural Long-Term Projections to 2022/23, February 2014

11 USDA/ World Agricultural Outlook Board Agricultural Long-Term Projections to 2023, February 2014, page 21. <http://www.usda.gov/oce/commodity/projections/USDA_Agricultural_Projections_to_2023.pdf> (PDF)

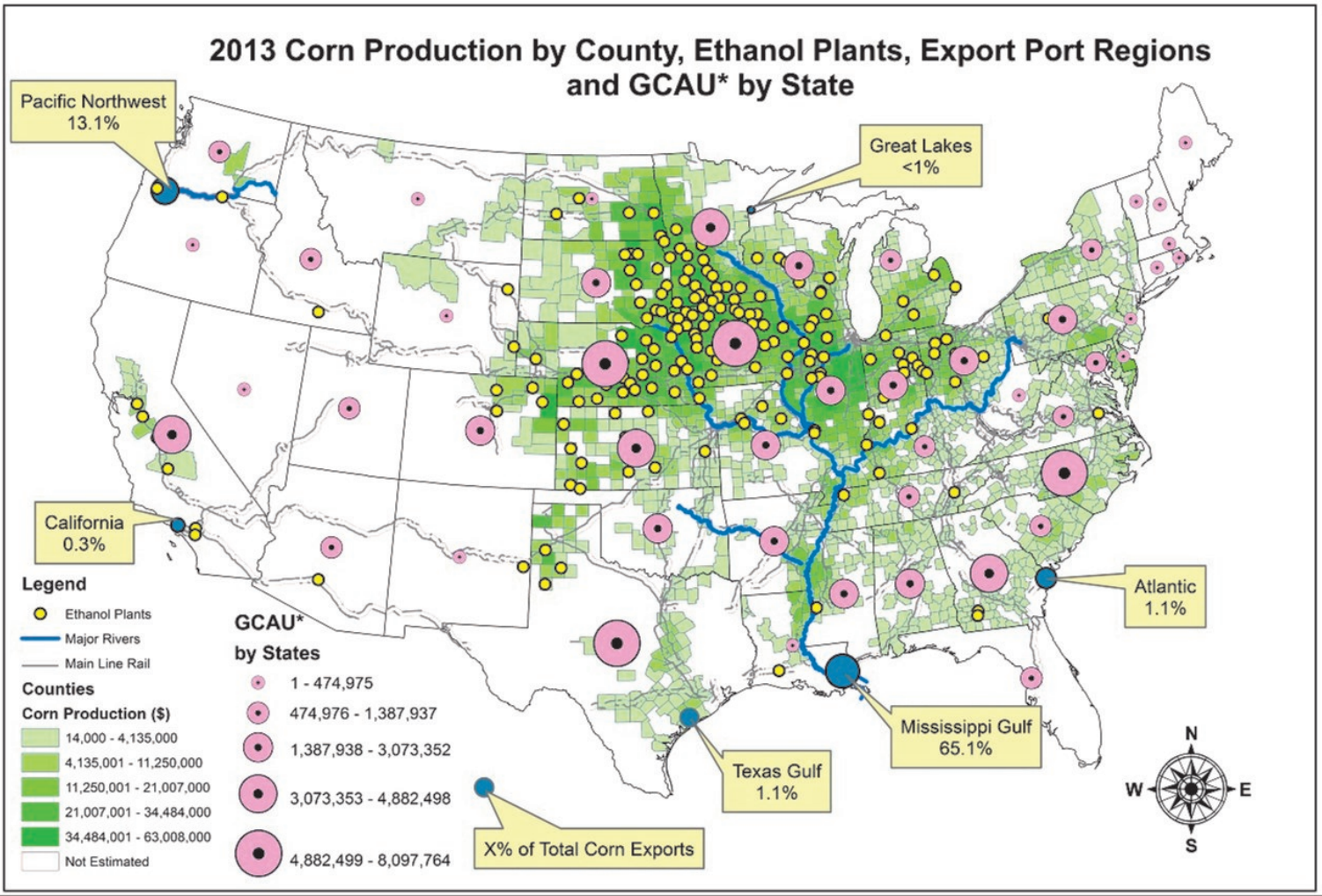
12 U.S. Department of Transportation, Federal Highway Administration, Freight Analysis Framework. <http://www.ops.fhwa.dot.gov/freight/freight_analysis/nat_freight_stats/docs/11factsfigures/index.htm>

Transportation Implications

Most U.S. corn is produced in the Midwest's Corn Belt. In 2013, just six States—Iowa, Illinois, Nebraska, Minnesota, Indiana, and South Dakota—accounted for more than 65 percent of U.S. corn production. with Iowa alone producing 2.16 bbu, or slightly more than 15 percent of the U.S. total.[13]

Corn is transported from the Midwest to ethanol refineries, feedlots, millers, and ports. The map in figure 5 illustrates how corn growers rely on rail and barge transportation to move corn from the farms in the Midwest to the port regions along the coasts, and on trucks for short-distance transportation to ethanol plants.

Figure 5: Corn production, ethanol plants, export ports, and the transportation system



Source: USDA Agricultural Marketing Service analysis of data from USDA National Agricultural Statistics Service State and county level statistics 2013, and Federal Grain Inspection Service port inspection data, 2013.
**Grain Consuming Animal Units*

13 USDA/ NASS Quick-Stats, Corn Production by State.

Corn Modal Shares

For the 5 years between 2007 and 2011, corn accounted for 66 percent of total grain production (including corn, soybeans, wheat, sorghum, and barley) and 64 percent of all grains moved.[14] Trucks are the primary mode of transportation for corn used domestically. Between 2007 and 2011, trucks moved 78 percent of domestically used corn, gradually increasing over that period to a peak of 81 percent in 2010 (see table 2). Rail transportation accounted for an average of 21 percent of domestic corn movements, decreasing from 26 percent in 2007 to 19 percent in 2010. The barge share of domestic movements remained unchanged at 1 percent.[15] The increase in the amount of corn transported by truck can be traced to the increased demand for ethanol. Most ethanol plants are located within 50 miles of corn-producing areas, and trucks are highly cost-effective for short-distance transportation. They are usually more efficient than rail within about 250 miles between origin and destination.[16]

Corn being exported is mostly transported to major ports in the Gulf or Pacific Northwest by barge and/or rail. From 2007 to 2011, barges moved an average of 54 percent of export-bound corn, and rail moved 37 percent. Trucks accounted for only 9 percent, transporting less export corn because most growing areas are far from ports. Delivering corn long distances from the heartland to major ports in the Gulf or Pacific Northwest is more efficient by water or rail.

Table 2: Corn modal shares, 2006-2011

Year & Type of Movement	Rail		Barge		Truck	
	1,000 Tons	Percent	1,000 Tons	Percent	1,000 Tons	Percent
Total						
2007	78,650	27	37,407	13	174,937	60
2008	75,652	25	30,088	10	198,415	65
2009	69,803	23	32,147	11	201,853	66
2010	74,909	22	33,134	10	228,589	68
2011	72,059	22	29,434	9	226,736	69
5-year Average	***74,215***	***24***	***32,442***	***11***	***206,106***	***66***
Export						
2007	20,478	32	34,689	55	8,252	13
2008	24,615	42	27,457	47	6,803	12
2009	19,801	38	30,013	57	2,938	6
2010	22,070	40	31,174	57	1,692	3
2011	17,237	34	27,331	54	5,868	12
5-year Average	***20,840***	***37***	***30,133***	***54***	***5,111***	***9***
Domestic						
2007	58,171	26	2,718	1	166,684	73
2008	51,037	21	2,631	1	191,612	78
2009	50,002	20	2,135	1	198,915	79
2010	52,839	19	1,960	1	226,898	81
2011	54,822	20	2,102	1	220,868	80
5-year Average	***53,374***	***21***	***2,309***	***1***	***200,995***	***78***

Source: Transportation of U.S. Grains: A Modal Share Analysis 1978-2011. USDA Agricultural Marketing Service, May 2013

14 Analysis of official supply and demand data. <http://www.usda.gov/oce/commodity/wasde/index.htm>

15 USDA/Agricultural Marketing Service (AMS), *Transportation of U.S. Grains: A Modal Share Analysis 1977-2010*, March 2012.

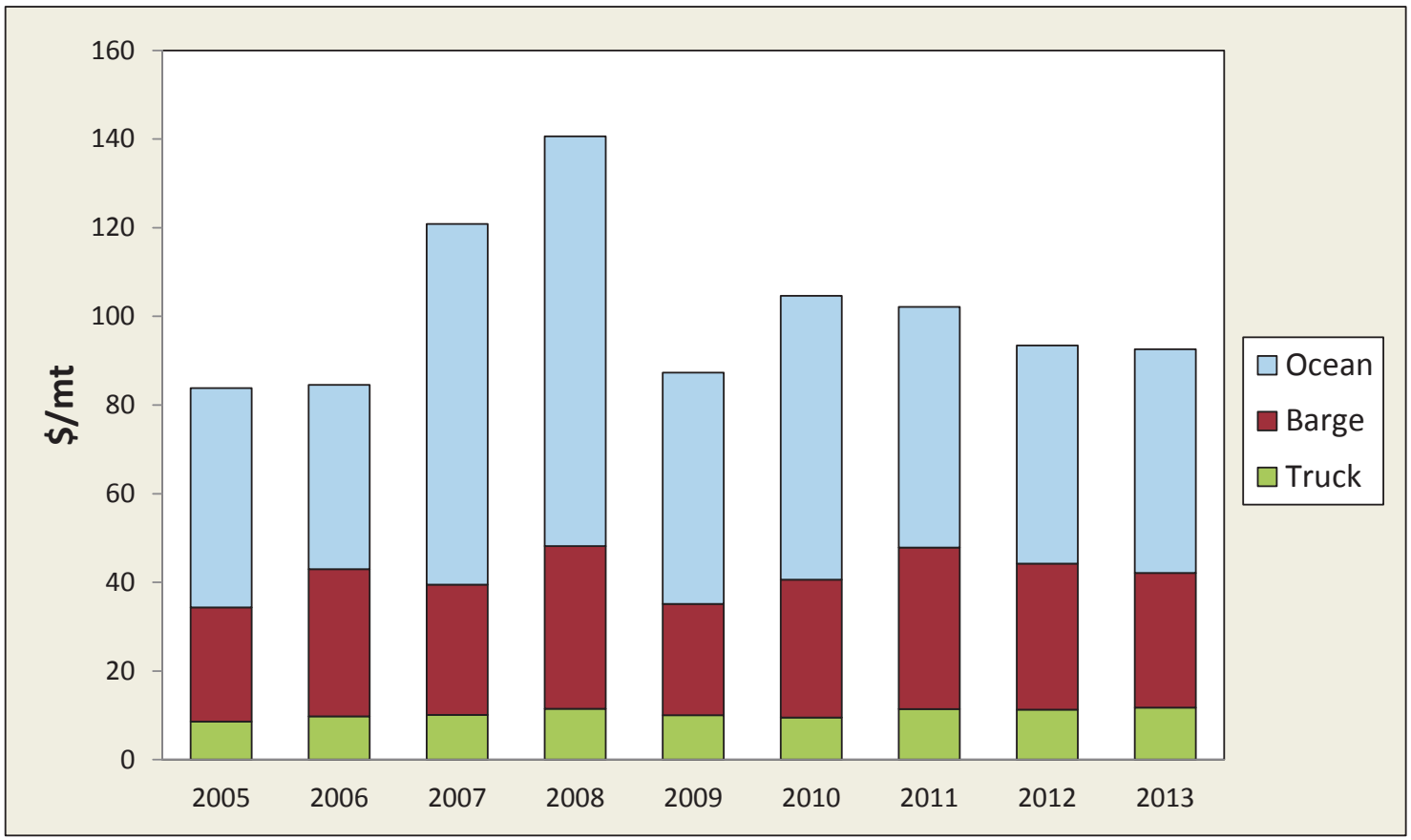
16 USDA/AMS. *Grain Transportation Report,* May 2012.

Transportation Costs

An efficient U.S. transportation system facilitates the marketing of U.S. grain overseas because transportation costs—a major variable in total landed corn cost—are vital in keeping U.S. agriculture competitive.

Figure 6 shows the relative costs (in dollars per metric ton) by mode of transportation (truck, rail, barge, ocean) of shipping corn from Minnesota to Japan, the largest importer of U.S. corn, through the Mississippi Gulf from 2005 to 2013. Total transportation costs (ocean, barge, and truck) averaged $101.16 per metric ton (mt) over the period, spiking from 2007 to 2008. The rise in costs was due to increasing ocean shipping rates, which rose from $55.03 per mt in 2007 to a record high of $124.53 per mt in 2008, because of higher diesel fuel prices and increase in bulk shipping due to massive infrastructure development by China in preparation for the 2008 Summer Olympics. Since 2009, the Gulf-to-Japan ocean rates have been relatively stable and averaged around $54.96 per mt. Fuel costs, port congestion, and strong global demand for bulk ocean services can all contribute to higher ocean transportation costs.

Figure 6: Transportation costs for corn exports, Minnesota to Japan through the Mississippi Gulf, 2005 to 2013

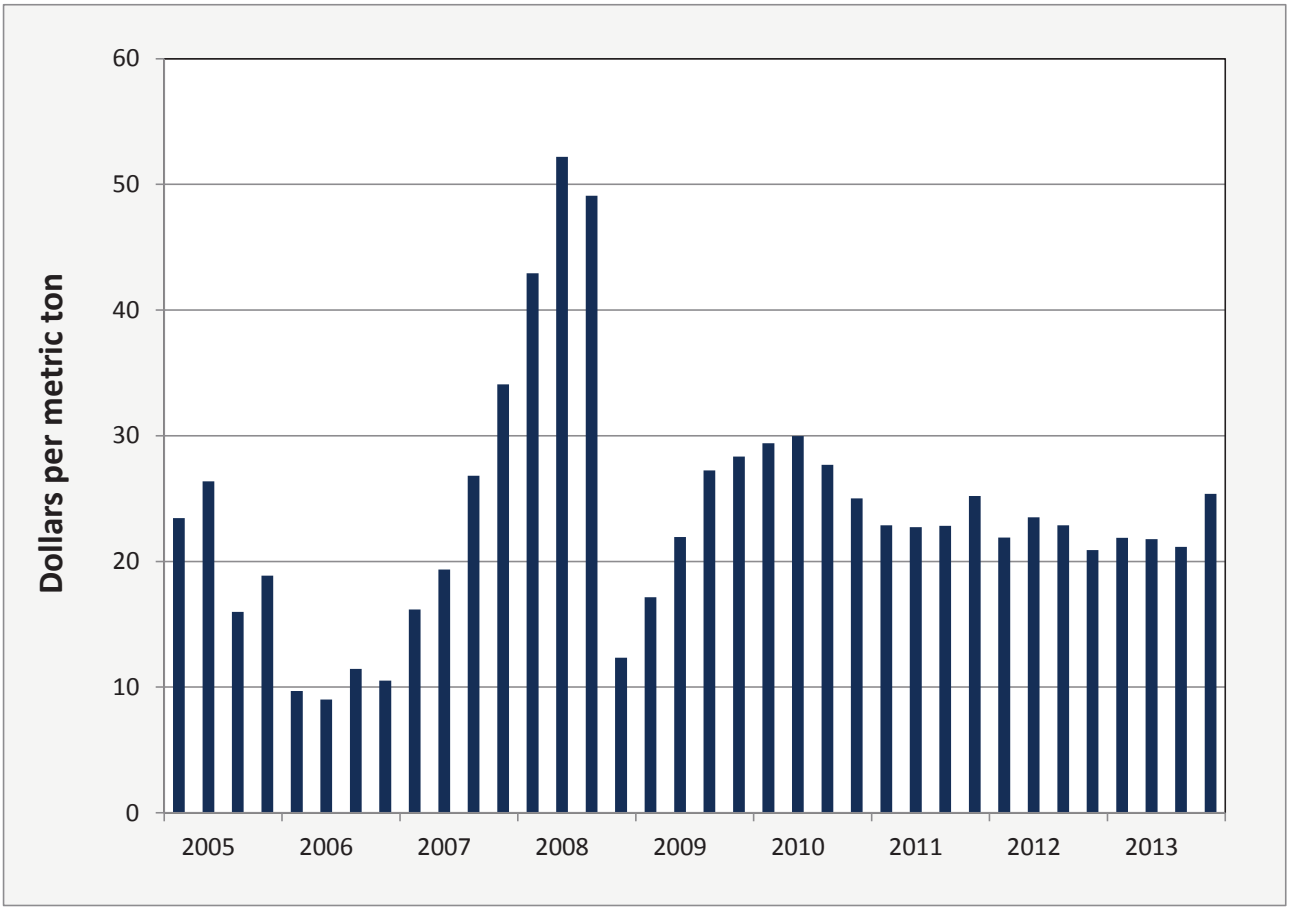


Source: USDA Agricultural Marketing Service, Transportation Services Division, Grain Cost Estimators, 2014 (No barge data for first quarter, 2008-13. Data points were extrapolated.)

Figure 7 shows the spread (difference) between ocean shipping costs for corn through the Mississippi Gulf and the Pacific Northwest (PNW). The spread widens or contracts when the ocean rate from the Gulf changes faster than the PNW rate. Although the majority of corn exports are shipped through the Mississippi Gulf, exceptionally large ocean spreads generally lead to an increased proportion of Asia-bound corn being shipped by rail to ports in the Pacific Northwest. From 2005 through 2013, shipping through the Gulf was, on average, $24 per mt more expensive than shipping through the Pacific Northwest. Between Q1 2005 and Q1 2013, the largest spread was $52 per mt (Q2 2008) and the smallest spread was $9 (Q2 2006). [17] Several situations in 2008 contributed to the large Gulf-PNW ocean rate spreads, including flooding on the Mississippi River that caused the shutdown of barge shipping during spring and summer, extremely high ocean freight rates due to high fuel costs, and shipping demand that exceeded vessel supply.

For the near future, projected excess of ocean vessels relative to shipping demand is expected to keep the ocean spreads relatively flat.

Figure 7: Spread of ocean transportation costs between Gulf-to Japan and Pacific Northwest-to-Japan trade routes (Gulf total costs minus Pacific Northwest total costs), 2005 to 2013, by quarter



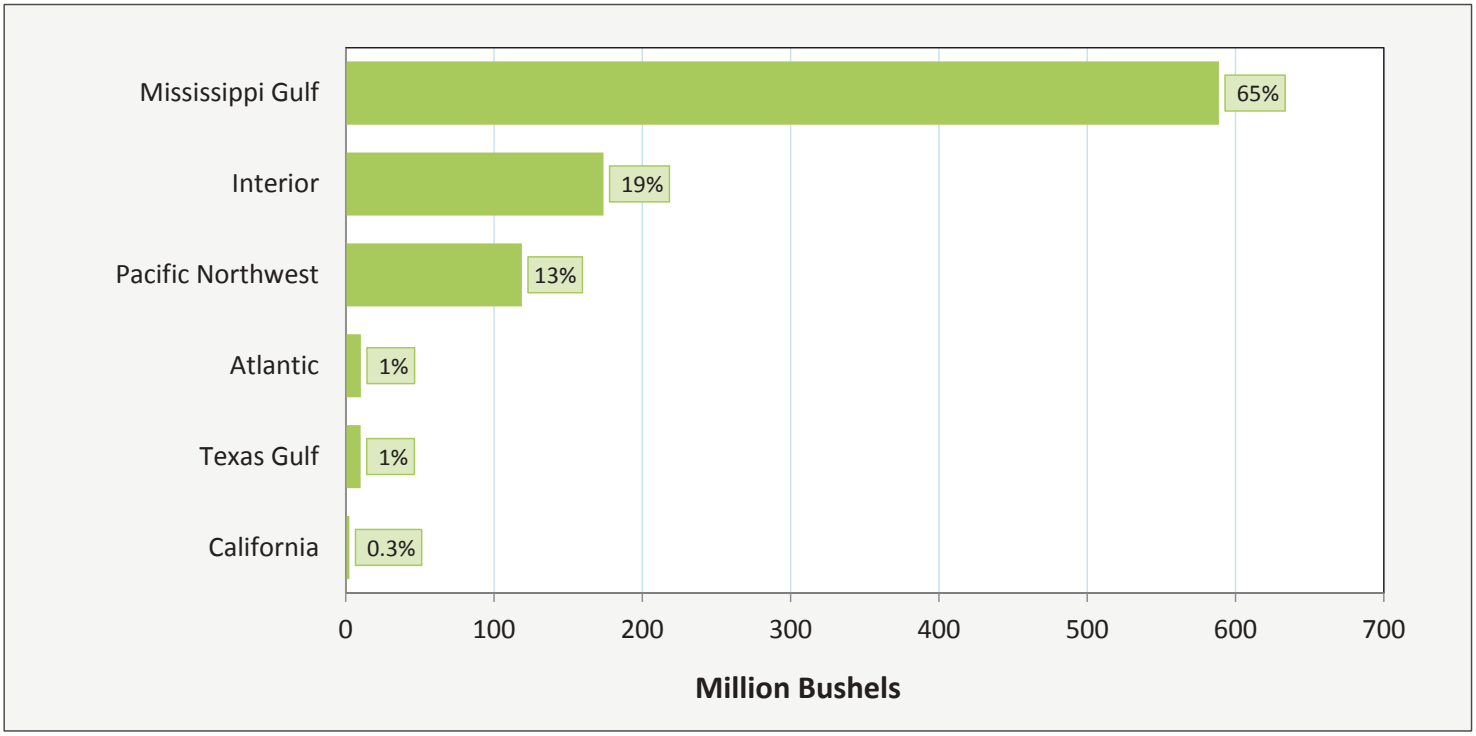
Source: USDA Agricultural Marketing Service, Transportation Services Division, Grain Transportation Cost Indicators, 2014

17 USDA/Agricultural Marketing Service, *Grain Transportation Cost Indicators*, 2013, based on data collected by Transportation Services Division.

Corn Exports by Port Region

In 2013, 65 percent of corn exports were shipped from the Mississippi River Gulf, 13 percent from the Pacific Northwest, and the rest from several other port locations (see figure 8). The five biggest markets for U.S. corn are Japan, Mexico, China, Venezuela, and Columbia, which together accounted for 85 percent of total exports in 2013.[18]

Figure 8: Corn export inspections* by port region, 2013



Source: USDA Federal Grain Inspection Service grains inspections, 2013

** All grain leaving the United States is inspected by the Federal Grain Inspection Service, so this figure is a good measure of the total grain being exported.*

Conclusion

Growth in demand for U.S. corn production over the past 10 years occurred mostly in the domestic markets because of the increased use of corn for the production of ethanol and its byproducts. Over the next 10 years, however, USDA projects that most of the growth in demand for corn will occur in the export and domestic feed categories. If this growth materializes, U.S. farmers and shippers will increasingly require reliable, efficient, and economical long-distance transportation by rail, barge, and ocean vessels to deliver corn and byproducts to the export markets. Volatility in the export markets is usually greater than in the domestic markets, making year-to-year estimates of corn exports an important indicator of shifts in transportation demand. Over the long term, as total freight demand growth materializes, grain shippers will benefit from improvements to the transportation capacity and efficiency of the rail, water (inland waterways and ports), and truck sectors.

18 Federal Grain Inspection Service, *Grain Inspections*, 2013.

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