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Transportation of U.S. Grains A Modal Share Analysis, 1978-2004

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Abstract

This analysis of grain movements by transport mode updates three previous reports. The initial report was completed in 1992, the second was released in 1998, and the third in 2004. The purpose of these series of reports is to provide information about changes in the competitiveness and relative efficiencies among the modes. The goal of this analysis was to estimate the tonnages of grain railed, barged, and trucked, using secondary data sources. The report analyzes the movements of corn, wheat, soybeans, sorghum, and barley to either the domestic market or to U.S. ports for export.

Key words: Grain transportation, grain movements, modal shares

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Summary

The analysis of grain movements by rail, barge, and truck provides information about changes in the competitiveness and relative efficiencies among transportation modes. It also provides a framework to assess public policies that affect the development and success of the Nation's transportation infrastructure. This analysis, which covers the years 1978-2004, updates three previous reports.

From 1978 to 2004, the total amount of grain moved in the United States increased significantly. Grain tonnages rose from 242 million tons in 1978 to 394 million tons on 2004, a 63-percent increase in 26 years. Trucked grain increased 157 percent, while barged grain increased 31 percent and grain that was railed increased 16 percent. In 2004, most of the grain moved was corn, representing nearly 61 percent of all grain movements. Soybeans were the second most moved grain, with 18 percent of all movements. Wheat was a close third with 16 percent. Together, corn, soybeans, and wheat represented a combined 96 percent of all grain movements for 2004. Sorghum and barley are also included in this report.

Significant changes in modal share occurred during 1978 to 2004, particularly for the truck mode. All modes showed an increase in absolute tons moved. However, rail and barge shares decreased, while truck share increased, making truck the predominant mode of grain transport in the United States.

This report is the fourth update of the initial July 1992 study, which covered the years 1978-1989. The second report was completed in March 1998, and added 1990 through 1995. In October 2004, the third report, covering 1978 through 2000, was released.

Introduction

Grains produced in the United States move to domestic and foreign markets through a well-developed transportation system. Barge, rail, and truck transportation facilitate a highly competitive market that bridges the gap between U.S. grain producers and domestic and foreign consumers.

Barges, railroads, and trucks often compete head-to-head to supply transportation for grains. Despite a high degree of competition in some markets, these modes also complement each other. Before a bushel of grain reaches the market, it has often been transported by two or more modes. This balance between competition and integration provides grain shippers with a highly efficient, low-cost system of transportation. The competitiveness of U.S. grains in the world market and the financial well-being of U.S. grain producers depends on this competitive balance. A highly competitive and efficient transportation system results in lower shipping costs, smaller marketing margins, and more competitive export prices. Such efficiencies also result in lower food costs for U.S. consumers and higher market prices for U.S. producers.

An analysis of the transportation of the final movement of grain, by mode, provides information about changes in competitiveness and relative efficiencies among the modes. Over several years, such work helps identify critical trends affecting the transportation of grain. It also provides a framework to assess public policies that influence the development and success of the Nation's transportation infrastructure. Public policies that promote an efficient grain transportation system also promote strong U.S. agricultural and rural economies.

Methodology

Any effort to measure tonnages of grain moved by mode of transport is met with the absence of truck data. Accurate data exist on barge and rail freight tonnages and commodities, but not for trucks. Other analyses of grain movements have relied extensively on survey data to overcome this obstacle. This analysis estimates tonnages of grain barged, railed, and trucked, based on secondary data sources. Estimating these modal grain volumes and modal shares on an annual basis provides a data series that tracks changes in grain transportation over time.

In this analysis, the term “modal share” describes that portion of the total tonnages of grain moved by each mode of transport—barge, rail, or truck. These shares, expressed as percentages, were determined by mode for particular types of grains and movements. Grains identified for this analysis were corn, wheat, soybeans, sorghum, and barley. The 1992 and 1998 version of this study also included rye and oats. Rye and oats were taken out of the calculations for this report because of unreliability due to small volumes, which total less than 1 percent of all grain movements. Transport modes are categorized according to its final movement going to domestic markets or ports for export.

The estimates of modal tonnages and shares are based on the amount of grain moved to commercial markets. Total movement and barge and rail tonnages are attained from secondary sources. Truck tonnages are estimated by subtracting barge and rail tonnages from total tonnages transported.

Estimated Modal Shares

Modal shares are calculated for all grains and each grain type, based on the estimated modal tonnages. These modal shares are determined for total, export, and domestic movements (figure 1).

***Total Tonnages*.** The approach used to estimate modal tonnages and shares requires that total tonnages of grain transported to market be determined. It is also necessary to determine the portions of total tonnages transported to domestic and export markets. Total tonnages are defined as total disappearance minus grain that was grown and used on-farm. Total disappearance for this study is calculated using the United States Department of Agriculture's (USDA) Economic Research Service (ERS) *Wheat Outlook, Feed Outlook,* and *Oil Crop Outlook* reports. These reports include marketing year supply and disappearance tables that list domestic use and exports. The *Oil Crop Outlook* lists these numbers by marketing year. The other two reports break the numbers down on a quarterly basis. To get disappearance numbers for calendar years 1995 through 2004, monthly totals are calculated from the marketing year data and added together into respective calendar year totals.

***Total Export*.** Total exports are calculated using export numbers reported in the ERS *Outlook* reports.

***Total Domestic*.** Total domestic tonnages are estimated by subtracting total export tonnages from total disappearance.

***Grown and Used-on-Farm Totals*.** Grown and used-on-farm data are provided by ERS. These data are reported in percentages by year and commodity. Production numbers for each commodity are multiplied by the grown and used-on-farm percentages. Those numbers are then subtracted from total disappearance to get total transported grain tonnages. Grain grown and used on-farm must be deducted from total disappearance because it generates no commercial transportation demand.

***Rail Total*.** Rail movements for 1996 to 2004 came from the Surface Transportation Board's (STB) Master Carload Waybill Sample. The STB's Waybill Sample is a stratified sample of carload waybills for terminated shipments by railroad carriers. The STB collects operating statistics on U.S. railroads, which can be used to estimate rail traffic volumes and railroad characteristics. Total tonnages are calculated using the billed weight in tons from the Waybill Sample and multiplying it by an expansion factor to estimate the tonnages for all grain movements by all railroads. Movements that

originated and terminated in the same five-digit, Federal Information Processing Standards (FIPS) region are assumed to be short hauls, which would be double-counted and, thus, deleted. Some grain is moved by a combination of rail and barge. Since this represents a relatively small amount of grain, these movements are not included in the rail calculations. Instead, they are counted in the barge movements as that is the final mode used to transport the grain. There are other instances in which grain shipments are rebilled from one railroad to another at terminal markets. Such a movement would be considered a double-count of grain movements. An attempt is made to minimize the rebilled movements. Again, as with the rail-to-barge movements, these types of shipments represent a small portion of total rail shipments.

***Rail Export*.** Export regions are defined by five-digit FIPS codes and are listed in appendix B. The regions chosen are based on methodology from the 1998 modal share report as those regions with ports in the Pacific Northwest, Atlantic Coast, and Gulf of Mexico. Rail exports to the Great Lakes are determined from grain delivery information at Duluth-Superior, MN, and Toledo, OH. Total tonnages exported are then calculated using the designated export regions. Those movements that originated and terminated in the same five-digit FIPS region are assumed to be short hauls, which would be double-counted and, thus, deleted.

***Rail Domestic*.** Domestic rail tonnages are estimated by subtracting export grain tonnages moved by rail from total grain tonnages moved by rail.

***Barge Total*.** Barge movement data for 1996-2004, which are collected and compiled by the U.S. Army Corps of Engineers (Corps), are obtained from *Waterborne Commerce of the United States.* The categories used to calculate modal shares for barge are river shipping range (origin) and river receiving range (destination). Total movements are determined by summing the total of all receiving ranges. As explained under the "Rail" section above, when barge and rail are used in combination to ship grain, with barge being the final mode in the transportation route, only the barge movement is included.

***Barge Export*.** The following river receiving ranges are used to find barge export movements: Atlantic, Pacific, Central Gulf, East Gulf, and West Gulf. Any movement that is received into a port in the defined regions is determined to be an export movement. The receiving ranges are based on the 1998 report's methodology. For that report, export barge modal shares were calculated using barge export tonnages based on internal grain and oilseed receipts reported on the inland waterways. Movements were defined as those to: 1) Kalama and Vancouver, WA, and Portland, OR, on the Columbia-Snake River system; 2) Baton Rouge through New Orleans, LA, to the mouth of the passes on the Mississippi River system; 3) Lake Charles, LA, on the Calcasieu River; 4) Mobile, AL, on the Tennessee-Tombigbee River system; 5) Pascagoula, MS, on the Gulf Intracoastal Waterway; 6) Beaumont and Port Arthur, TX; 7) Galveston Bay (including Houston), TX; 8) Corpus Christi, TX, and the Gulf Intracoastal Waterway ports between Corpus Christi and the Mexican border; and 9) Hampton Roads and Norfolk, VA, on the Chesapeake Bay.

***Barge Domestic*.** Domestic barge movements are calculated by subtracting export barge movements from total barge movements.

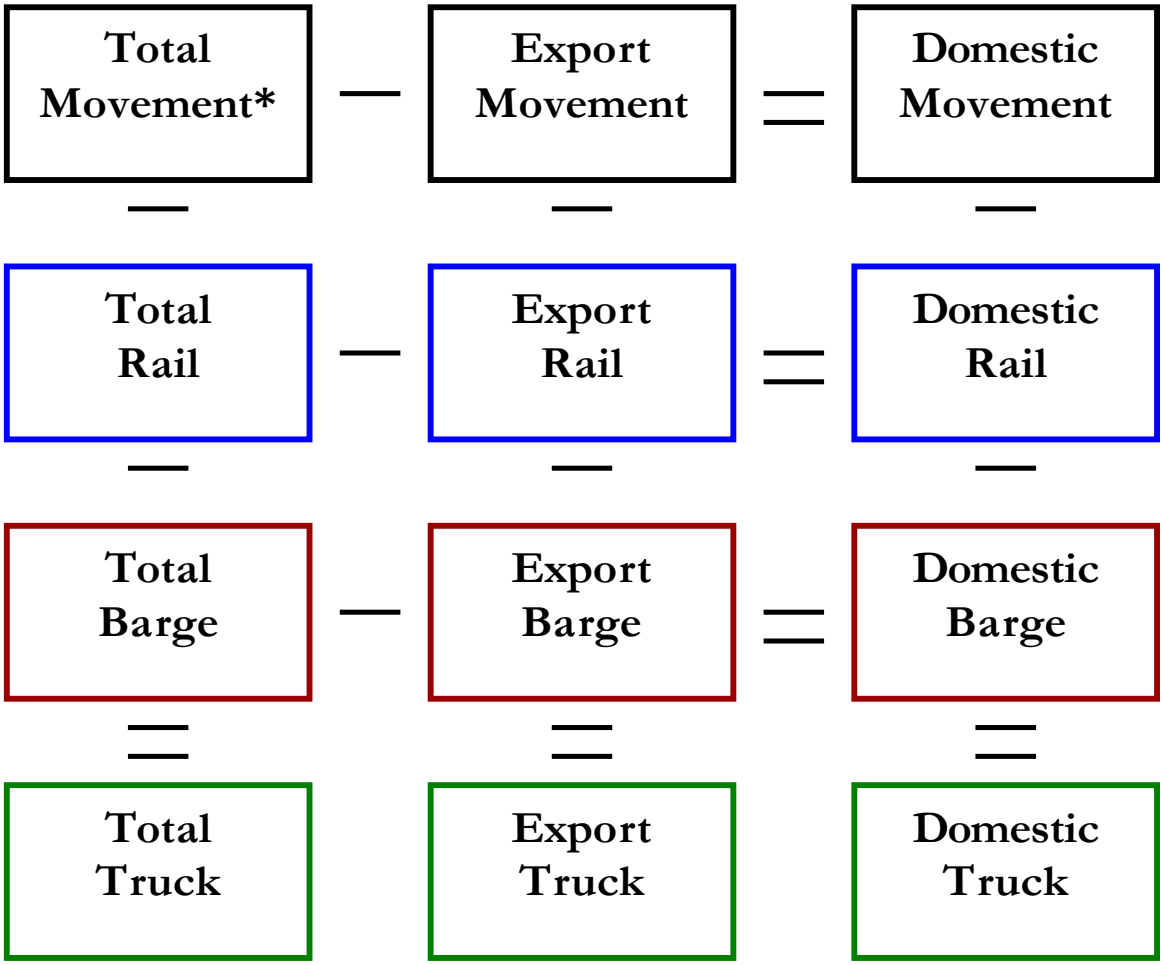
***Truck Total*.** Total truck tonnages are estimated by subtracting total rail and total barge from total disappearance. The method for estimating truck grain tonnages and modal shares assumes that all barge and rail tonnages represent "long-haul" movements. "Short-haul" movements (farm-to-elevator) that originate on the farm are almost exclusively done by truck. Such farm-to-elevator movements are considered gathering movements. Unlike barge or rail movements that typically end at the point of domestic consumption or export, these truck movements represent only the first and shortest segment of the entire shipping channel for grain.

***Truck Export*.** Truck export tonnages are estimated by subtracting rail export and barge export tonnages from total export tonnages.

***Truck Domestic*.** Domestic truck tonnages are estimated by subtracting domestic rail and domestic barge tonnages from total domestic tonnages.

***Data Used in 1998 Report*.** The methodology used for the 1998 version of this report is described in appendix A.

Figure 1: Model for estimating modal tonnages and share



*Total movement equals total disappearance less the amount of grain grown and used on farm.

Trends in Modal Shares and Tonnage

The purpose of the analysis is to examine trends in type of transportation used to move unprocessed field crops grown for the food and feed industry. Grain includes corn, soybeans, wheat, sorghum, and barley. Table 1 shows total tonnages, by export and domestic market, for grain movements from 1991 to 2004.

Future grain movements will be influenced by developing trends and events. Biosecurity of food and feed shipments is a considerable concern for agricultural shippers, especially in the post-September 11 world. When the initial shipment of grain from the farm is received at the elevator, grain is commingled with other grain deliveries and can no longer be traced back to its field of origin. If some form of contamination of

grain is detected, whether caused by nature or man, the initial source of the grain will need to be determined. The need to have accountability of grain sources to identify the exact source of a contamination will certainly increase the complexity of the grain transportation system.

Also, the need for the preservation of grain identity during transit and storage will add additional requirements to the transportation system. For identity-preserved grain to meet buyers' standards, the grain must be segregated during handling and shipping and may incur additional transportation requirements.

Grain movements are divided into two distinct categories—domestic and export. Domestic grain markets are the driving force for continued increases in grain movements. Figure 2 illustrates the general trend for annual increases in grain movements. Figure 3 shows the annual movements by commodity.

From 2000 to 2004, nearly 70 percent of all grain movements were for the domestic market. Emerging markets for grain are creating new transportation patterns. One of the most noticeable growth markets is the ethanol industry. The U.S. ethanol industry produced a record 3.9 billion gallons in 2005, averaging nearly 255,000 barrels of ethanol production daily.[1] The 2005 record represents the seventh consecutive year of record ethanol production.

All Selected Grains

From 1978 to 2004, the most significant trend in a single mode of moving grain was the 157-percent increase in volume of grain moved by trucks. Figure 4 shows annual movements by mode, with the truck share becoming an increasingly larger portion of all movements. Truck use increased from 31 percent to 48 percent of all movements (figure 5). The volume of rail movements increased 16 percent while dropping from 48 percent to 35 percent of all movements. Barge volumes increased 31 percent, and the modal share of barged grain dropped slightly from 21 percent to 17 percent of all movements. As with tonnages, the modal share percentages are different for domestic versus export movements. The principal mode for the domestic market is truck, while the principal mode for the export market is barge. In 2004, truck movements represented two-thirds of the domestic grain market, while rail handled about one-third and barge represented a small percentage of all movements. In 2004, barge shipments represented 52 percent of export movements, with rail having 42 percent and truck with 6 percent. Table 2 shows tonnages and modal shares from 1991 to 2004.

From 1978 to 2004, there was a significant increase in the total amount of grain moved in the United States. Grain tonnages rose from 242 million tons in 1978 to 394 million tons in 2004, a 63-percent increase in 26 years. In 2004, as much corn was moved as the total of all grain moved in 1978. In 2004, most of the grain moved was corn, representing nearly 61 percent of all grain movements. Soybeans were second, with 18

[1] Renewable Fuels Association, Washington, DC. http://www.ethanolrfa.org/

percent of all movements. Wheat was a close third with 16 percent. Together, corn, soybeans, and wheat represented a combined 96 percent of all grain movements for 2004. Other grains included were sorghum and barley.

Generally, corn exports are almost one-quarter of all corn movements, soybean exports are over a third of all soybean movements, and wheat exports are more than half of all wheat movements. As U.S. grain production continues to exceed domestic requirements, agricultural export markets are important for sustaining prices and farm income. Export volumes are likely to fluctuate due, in part, to changes in competition from foreign grain producers, currency exchange rates, and shifts in global economic growth.

Table 1–Tonnages of U.S. grains transported by type of crop and type of movement, 1991-2004

Year	Corn	Wheat	Soybeans	Sorghum	Barley	All grains
			1,000 tons			
Total						
1991	172,122	72,283	57,038	15,734	10,272	327,449
1992	176,473	68,392	62,049	17,019	9,288	333,221
1993	190,562	71,875	62,454	17,727	8,791	351,409
1994	167,348	72,999	61,855	17,738	10,884	330,824
1995	217,515	64,583	70,492	15,118	9,394	377,102
1996	194,804	68,764	69,269	16,632	8,941	358,409
1997	207,856	64,099	73,549	19,031	8,241	372,775
1998	209,977	68,859	76,848	14,114	7,345	377,142
1999	223,875	69,227	77,501	15,112	7,021	392,736
2000	229,534	69,904	78,664	14,552	7,320	399,973
2001	237,851	64,481	85,347	12,448	6,714	406,841
2002	234,646	58,668	85,354	11,518	5,959	396,146
2003	236,406	64,804	84,950	11,018	5,624	402,802
2004	241,878	62,269	72,534	11,420	5,545	393,645
Export						
1991	48,683	34,072	19,324	6,530	1,671	110,280
1992	47,349	38,647	21,820	8,326	2,047	118,189
1993	44,288	44,395	21,410	6,645	1,663	118,401
1994	39,198	33,647	25,096	6,362	1,706	106,009
1995	65,200	35,515	24,760	6,103	1,368	132,946
1996	57,195	35,420	25,840	5,525	1,216	125,196
1997	45,995	28,960	26,340	5,768	1,768	108,831
1998	44,865	30,070	25,450	5,507	656	106,548
1999	57,820	33,130	25,509	6,309	704	123,472
2000	52,957	31,780	29,698	7,037	1,128	122,600
2001	53,032	29,410	31,663	6,720	944	121,769
2002	52,329	27,580	30,506	6,085	552	117,052
2003	47,607	29,410	34,147	5,546	684	117,394
2004	53,381	32,365	27,485	5,089	370	118,690
Domestic						
1991	123,439	38,211	37,714	9,204	8,601	217,169
1992	129,124	29,745	40,229	8,693	7,241	215,032
1993	146,274	27,480	41,043	11,082	7,128	233,007
1994	128,150	39,352	36,759	11,376	9,178	224,815
1995	152,315	29,068	45,732	9,015	8,026	244,156
1996	137,609	33,344	43,429	11,106	7,725	233,213
1997	161,861	35,139	47,209	13,263	6,473	263,945
1998	165,111	38,789	51,398	8,607	6,689	270,594
1999	166,055	36,097	51,992	8,803	6,317	269,264
2000	176,577	38,124	48,966	7,515	6,192	277,373
2001	184,819	35,071	53,685	5,728	5,770	285,073
2002	182,317	31,088	54,848	5,433	5,407	279,094
2003	188,799	35,394	50,802	5,472	4,940	285,408
2004	188,497	29,904	45,049	6,331	5,175	274,955

Figure 2—Total grain movements to domestic and export markets, 1978-2004

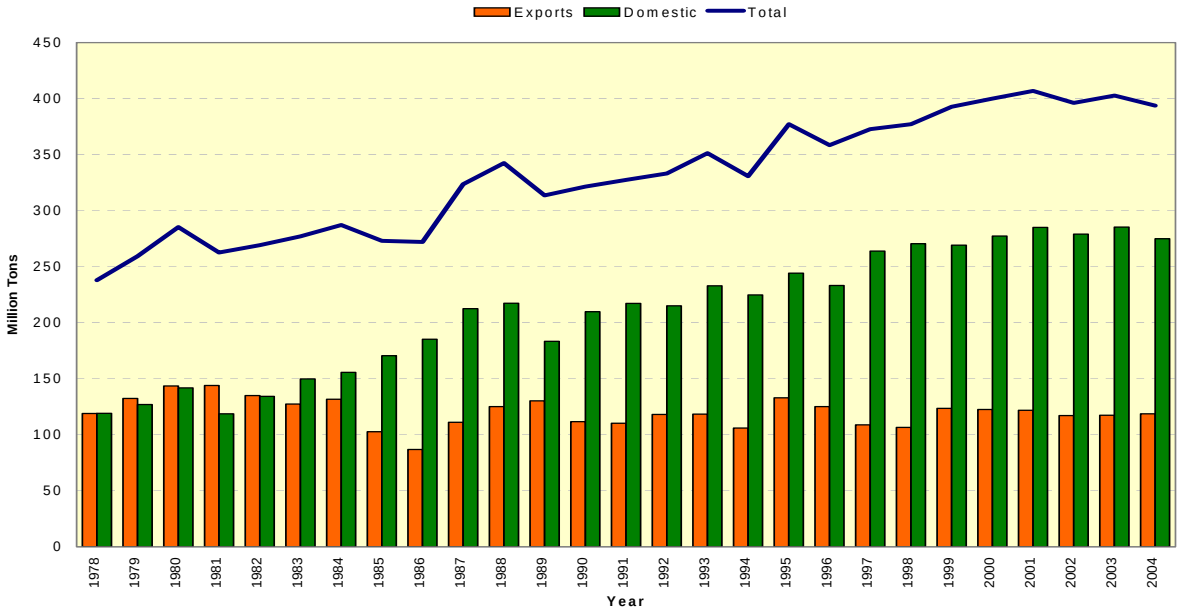


Figure 3–U.S. grain shipments by commodity, 1978-2004

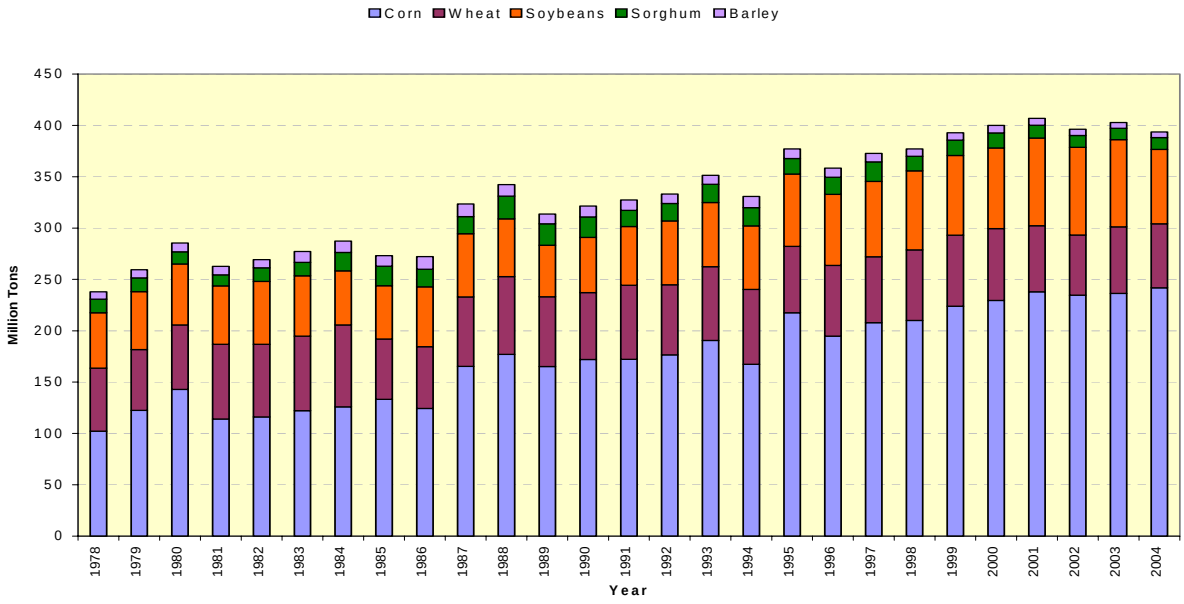


Table 2–Tonnages and modal shares for all U.S. grains, 1991-2004

Year & type of movement	Mode of transport					
	Rail		Barge		Truck	
	1,000 tons	Percent	1,000 tons	Percent	1,000 tons	Percent
Total						
1991	126,245	38	70,168	21	134,795	41
1992	135,681	40	76,162	23	124,494	37
1993	134,717	38	68,563	19	151,642	43
1994	124,489	37	64,968	19	144,751	43
1995	152,033	40	73,725	19	154,570	41
1996	131,344	36	73,504	20	156,040	43
1997	122,685	33	65,049	17	187,502	50
1998	125,021	33	64,199	17	190,727	50
1999	134,868	34	74,174	19	186,459	47
2000	129,498	32	72,197	18	200,750	50
2001	135,149	33	71,808	18	202,908	50
2002	131,390	33	74,264	19	192,883	48
2003	131,370	32	68,396	17	205,258	51
2004	136,362	35	67,274	17	190,010	48
Export						
1991	42,543	37	63,477	58	6,269	6
1992	40,827	35	68,424	58	9,017	8
1993	43,119	36	60,595	51	14,768	13
1994	27,722	26	57,966	55	20,336	19
1995	50,616	38	67,631	51	14,719	11
1996	46,836	37	66,921	53	11,486	9
1997	43,696	40	58,426	54	6,739	6
1998	41,700	39	57,509	54	7,369	7
1999	50,657	41	67,949	55	4,892	4
2000	46,040	38	67,556	55	9,020	7
2001	48,547	40	67,189	55	6,070	5
2002	45,935	39	68,505	59	2,660	2
2003	47,117	40	62,776	53	7,538	6
2004	50,176	42	61,729	52	6,785	6
Domestic						
1991	85,703	39	6,690	3	128,526	58
1992	94,854	44	7,738	4	115,477	53
1993	91,598	39	7,968	3	136,873	58
1994	96,767	42	7,002	3	124,416	55
1995	101,417	41	6,094	3	139,851	57
1996	84,509	36	6,583	3	144,555	61
1997	78,989	30	6,624	2	180,763	68
1998	83,322	30	6,690	2	183,357	67
1999	84,211	31	6,225	2	181,567	67
2000	83,458	30	4,641	2	191,729	69
2001	86,602	30	4,619	2	196,838	68
2002	85,454	30	5,759	2	190,223	68
2003	84,253	29	5,620	2	197,719	69
2004	86,186	31	5,544	2	183,225	67

Figure 4–Tonnages of all U.S. grains transported by mode, 1978-2004

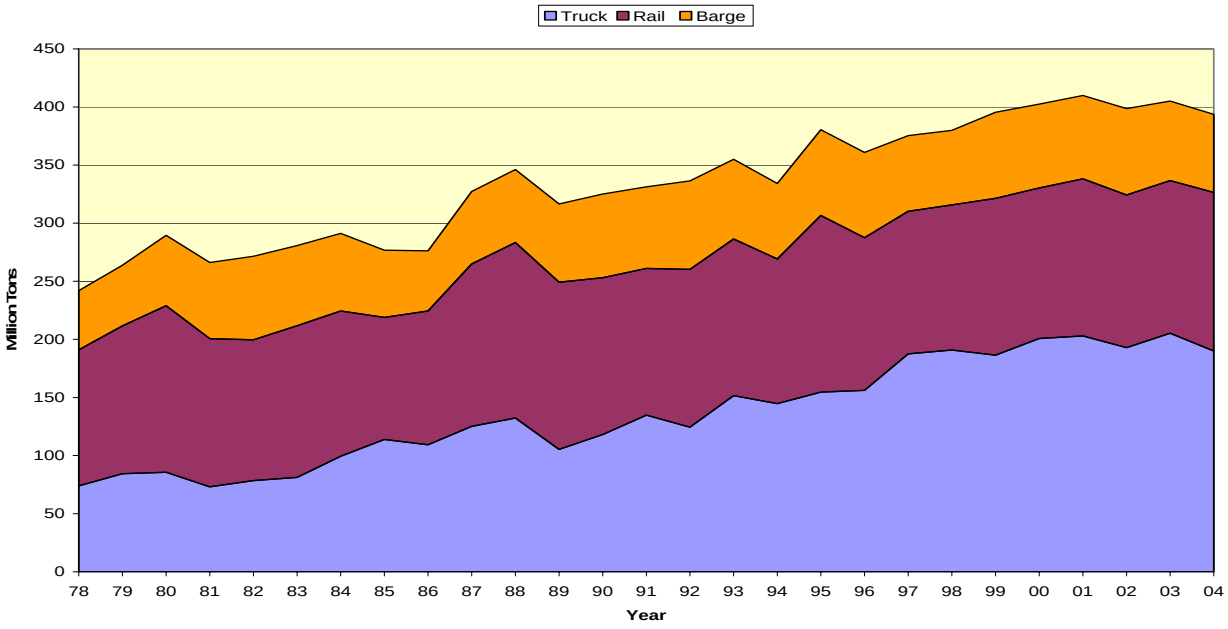
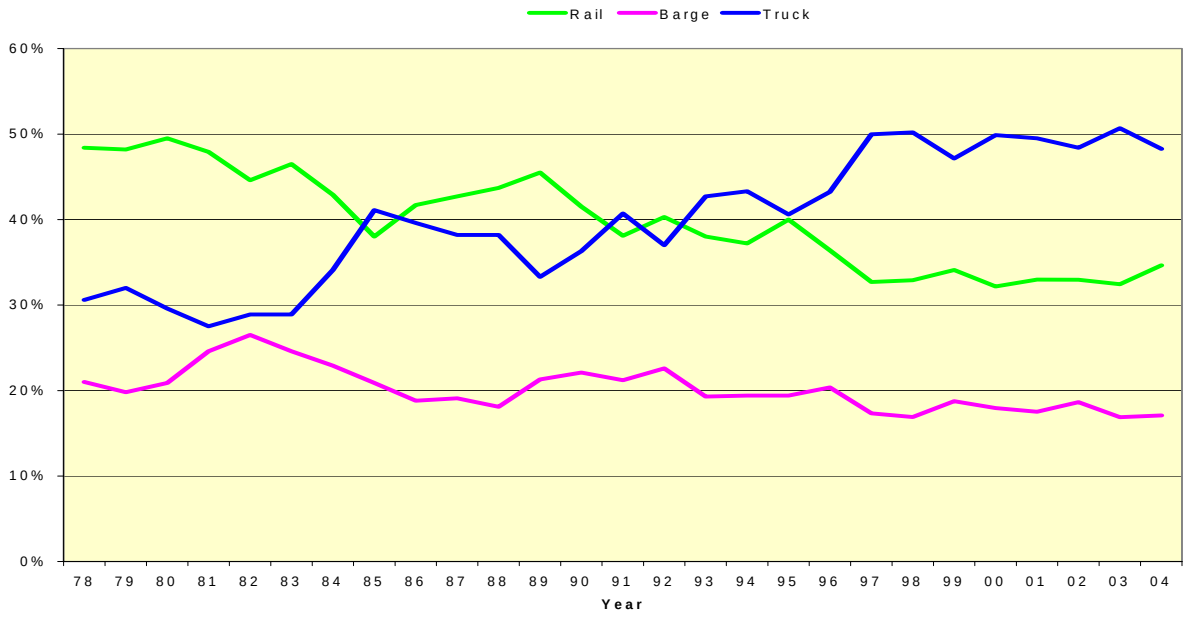


Figure 5–U.S. grain modal shares, 1978-2004



Corn

Corn is the principal feed source for the U.S. livestock industry. Nearly 74 million acres of corn were harvested for grain in 2004. Besides being a feed, corn is used in a variety of food and industrial products, including starches, sweeteners, corn oil, beverage and industrial alcohol, and fuel ethanol. The United States is a major supplier in the world corn market. Typically, the United States exports about 20 percent of its corn crop.[2]

Of all U.S. grains, corn has the highest transportation requirements due to volume. While the average annual harvested acreage of corn and soybeans is similar (about 71 million acres for corn, and 73 million acres for soybeans),[3] the total production of corn is about three and one-half times that of soybeans (10 billion bushels of corn versus 2.8 billion bushels of soybeans). Corn is predominately used as a feed ingredient in livestock rations, and in 2004, 14 percent of all corn production was used on the farms where it was grown. For off-farm use, with a much higher per-acre yield than soybeans (141 bushels per acre for corn versus 38 bushels per acre for soybeans), corn has 3.7 times greater transportation requirements per acre than soybeans. Table 3 shows tonnages and modal shares for corn from 1991 to 2004.

Tonnages Moved. From 2000 to 2004, corn movements increased 5 percent from 230 million tons to 242 million tons. While export movements fluctuated during this time, domestic corn movements reached record levels in 3 of the 5 years.

Modal Shares. Barge is the dominant transport mode for moving corn to export facilities, primarily because of the proximity of the Corn Belt to the Upper Mississippi River system. From 2000 to 2004, barge moved about 68 percent of total inland movements of corn to coastal export locations. Railroads handled about 30 percent of the export corn, and trucks moved the remaining 2 percent.

Domestic movements of corn are dominated by trucks, accounting for roughly 67 percent of the traffic from 2000 to 2004. Railroads move about 31 percent of corn within the United States. Barges handle only small amounts of domestic corn. Modal shares for domestic and export shipments of corn are shown in figures 6 and 7.

[2] Economic Research Service, USDA, Briefing Room, Corn. www.ers.usda.gov/briefing/corn,

[3] Figures are average of 2000-2004, Agricultural Statistics 2005, National Agricultural Statistics Service, USDA, http://www.usda.gov/nass/.

Table 3–Tonnages and modal shares for U.S. corn, 1991-2004

Year & type of movement	Mode of transport					
	Rail		Barge		Truck	
	1,000 tons	Percent	1,000 tons	Percent	1,000 tons	Percent
Total						
1991	58,542	34	36,398	21	77,181	45
1992	61,601	35	38,907	22	75,966	43
1993	60,997	32	35,346	19	94,219	49
1994	56,285	34	31,939	19	79,124	47
1995	79,333	37	40,778	19	97,407	45
1996	66,015	34	39,162	20	89,626	46
1997	61,582	30	31,343	15	114,931	55
1998	63,470	30	33,995	16	112,511	54
1999	71,807	32	40,620	18	111,447	50
2000	68,984	30	37,831	16	122,719	53
2001	73,633	31	38,864	16	125,355	53
2002	72,615	31	41,598	18	120,434	51
2003	71,443	30	36,488	15	128,475	54
2004	77,377	32	37,302	15	127,199	53
Export						
1991	13,366	28	33,505	69	1,812	4
1992	11,176	24	34,568	73	1,605	3
1993	10,403	24	30,907	70	2,977	7
1994	6,884	18	28,678	73	3,636	9
1995	21,665	33	38,098	58	5,438	8
1996	16,179	28	35,883	63	5,133	9
1997	15,061	33	27,747	60	3,186	7
1998	12,240	27	30,592	68	2,033	5
1999	18,307	32	37,533	65	1,980	3
2000	15,213	29	35,150	66	2,594	5
2001	15,822	30	35,904	68	1,306	2
2002	14,327	27	38,125	73	0	0
2003	14,371	30	32,872	69	364	1
2004	17,422	33	33,974	64	1,985	4
Domestic						
1991	45,176	37	2,893	2	75,369	61
1992	50,424	39	4,339	3	74,360	58
1993	50,594	35	4,439	3	91,242	62
1994	49,401	39	3,261	3	75,488	59
1995	57,668	38	2,680	2	91,969	60
1996	49,837	36	3,279	2	84,493	61
1997	46,521	29	3,596	2	111,744	69
1998	51,230	31	3,403	2	110,478	67
1999	53,501	32	3,087	2	109,467	66
2000	53,771	30	2,681	2	120,124	68
2001	57,811	31	2,960	2	124,048	67
2002	58,288	32	3,473	2	120,434	66
2003	57,072	30	3,616	2	128,112	68
2004	59,955	32	3,328	2	125,214	66

Figure 6–U.S. corn domestic shipments by mode, 1991-2004

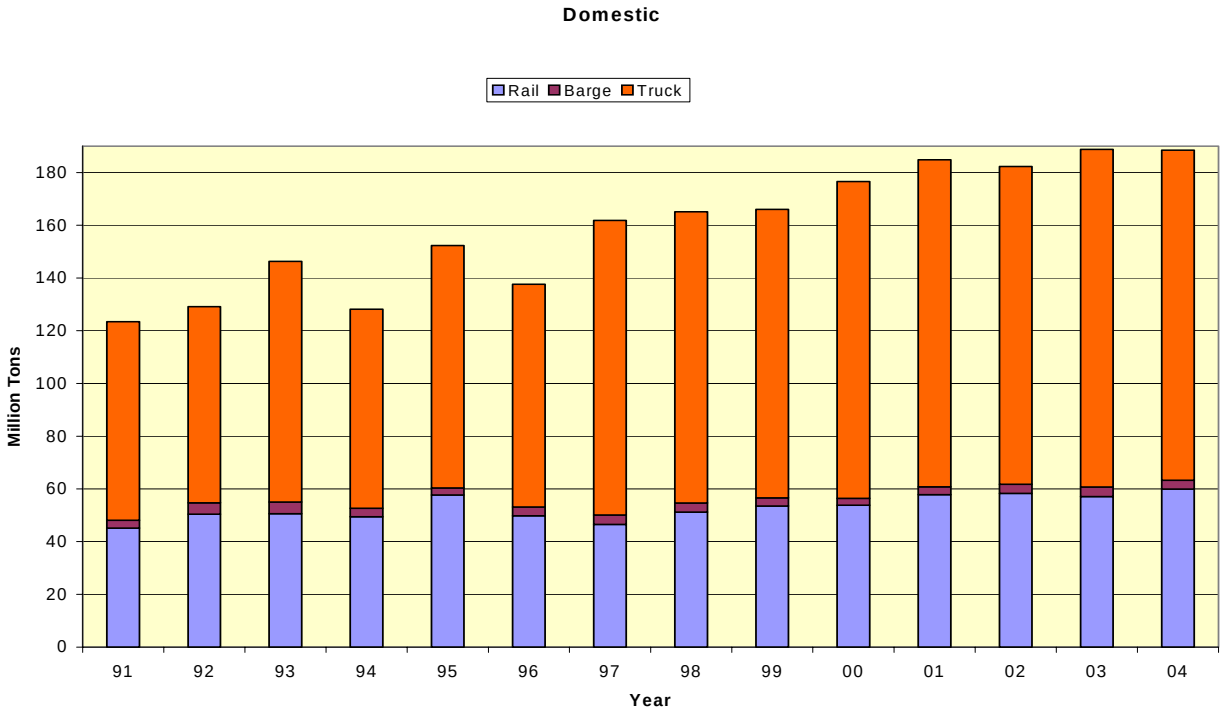
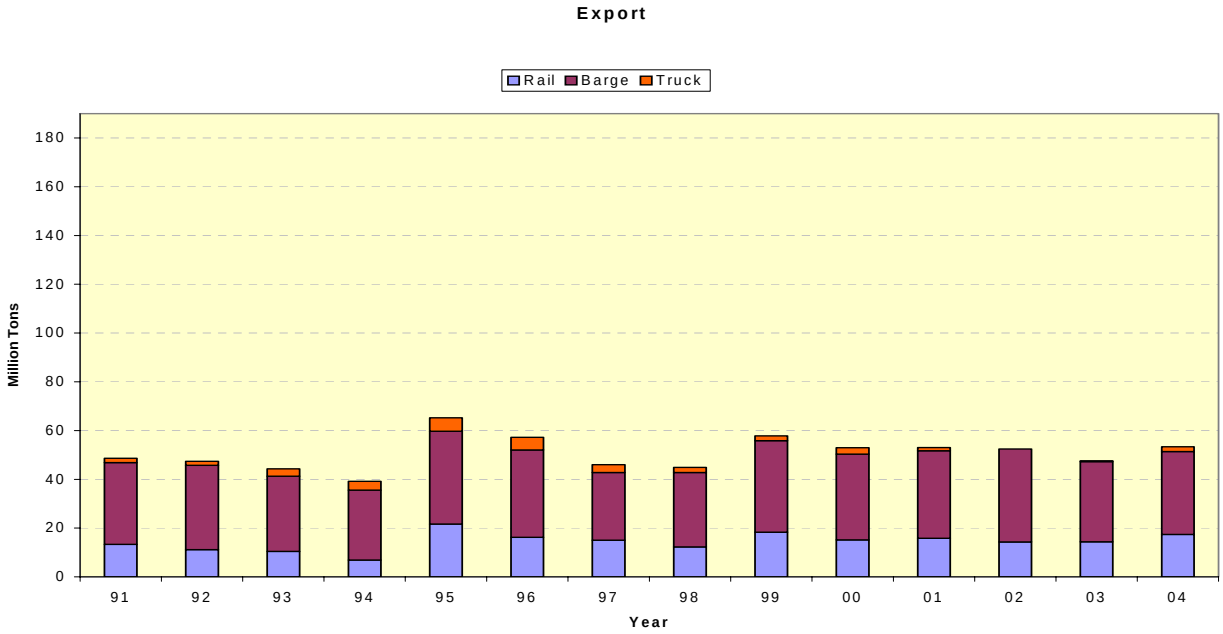


Figure 7–U.S. corn export shipments by mode, 1991-2004



Wheat

The United States is one of the top wheat producers in the world. China, India, the European Union, and the former Soviet Union countries are also significant wheat growers. In 2004, wheat, with 50 million harvested acres, ranked third among U.S. field crops, behind corn and soybeans. Since the 1980s, foreign competition has gradually reduced the U.S share of the world wheat market. Presently, almost half of the U.S. wheat crop is exported.[4] Wheat is generally used in the manufacture of food products, but is used as feed under some circumstances (for example, when feed-price ratios favor wheat over traditional feed grains). Table 4 shows tonnages and modal shares for wheat from 1991 to 2004.

Tonnages Moved. From 2000 to 2004, wheat movements decreased from 70 million tons to nearly 62 million tons, a decrease of 11 percent.

Modal Shares. Rail is the dominant transport mode for moving wheat to export facilities, primarily because the major wheat-producing States in the northern Plains have little or no access to waterways. From 2000 to 2004, rail moved about 60 percent of inland movements of wheat to coastal export locations. Barges handled about 36 percent of the export wheat, and trucks moved the remaining 4 percent.

Domestic movements of wheat are split 50 percent by truck and 49 percent by rail. The trends in domestic and export wheat shipments are depicted in figures 8 and 9.

[4] Economic Research Service, USDA, Briefing Room, Wheat www.ers.usda.gov/briefing/Wheat.

Table 4–Tonnages and modal shares for U.S. wheat, 1991-2004

Year & type of movement	Mode of transport					
	Rail		Barge		Truck	
	1,000 tons	Percent	1,000 tons	Percent	1,000 tons	Percent
Total						
1991	40,587	56	13,688	19	18,007	25
1992	44,165	65	14,964	22	9,263	14
1993	46,581	65	12,516	17	12,778	18
1994	40,336	55	12,620	17	20,043	28
1995	42,692	66	12,153	19	9,738	15
1996	37,662	55	12,239	18	18,863	27
1997	34,397	54	11,534	18	18,168	28
1998	37,119	54	10,756	16	20,984	30
1999	37,568	54	12,038	17	19,621	28
2000	35,380	51	12,391	18	22,132	32
2001	33,269	52	11,534	18	19,678	31
2002	32,702	56	9,876	17	16,091	27
2003	34,181	53	10,180	16	20,443	32
2004	37,302	60	11,937	19	13,031	21
Export:						
1991	19,088	56	12,234	36	2,750	8
1992	19,805	51	13,831	36	5,011	13
1993	24,639	56	11,589	26	8,167	18
1994	14,883	44	11,932	36	6,832	20
1995	20,470	58	11,221	32	3,824	11
1996	19,985	56	11,449	32	3,986	11
1997	16,796	58	10,884	38	1,281	4
1998	18,824	63	10,083	34	1,162	4
1999	19,556	59	11,558	35	2,016	6
2000	17,934	56	11,975	38	1,871	6
2001	16,549	56	11,099	38	1,762	6
2002	16,988	62	9,367	34	1,225	4
2003	17,983	61	9,726	33	1,701	6
2004	20,995	65	11,370	35	0	0
Domestic:						
1991	21,499	56	1,454	4	15,257	40
1992	24,359	82	1,133	4	4,252	14
1993	21,942	80	927	3	4,611	17
1994	25,453	65	688	2	13,211	34
1995	22,222	76	932	3	5,914	20
1996	17,677	53	790	2	14,878	45
1997	17,602	50	650	2	16,887	48
1998	18,295	47	672	2	19,822	51
1999	18,012	50	480	1	17,605	49
2000	17,446	46	416	1	20,262	53
2001	16,720	48	435	1	17,916	51
2002	15,714	51	509	2	14,866	48
2003	16,198	46	454	1	18,742	53
2004	16,307	55	566	2	13,031	44

Figure 8–U.S. wheat domestic shipments by mode, 1991-2004

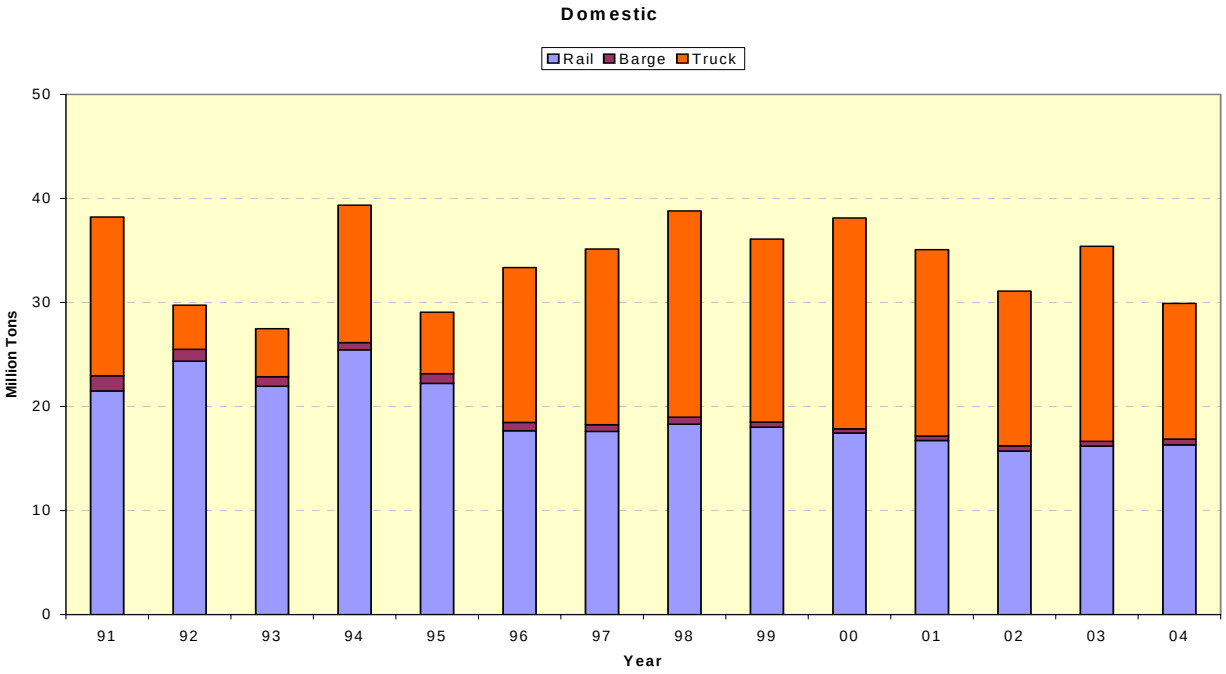
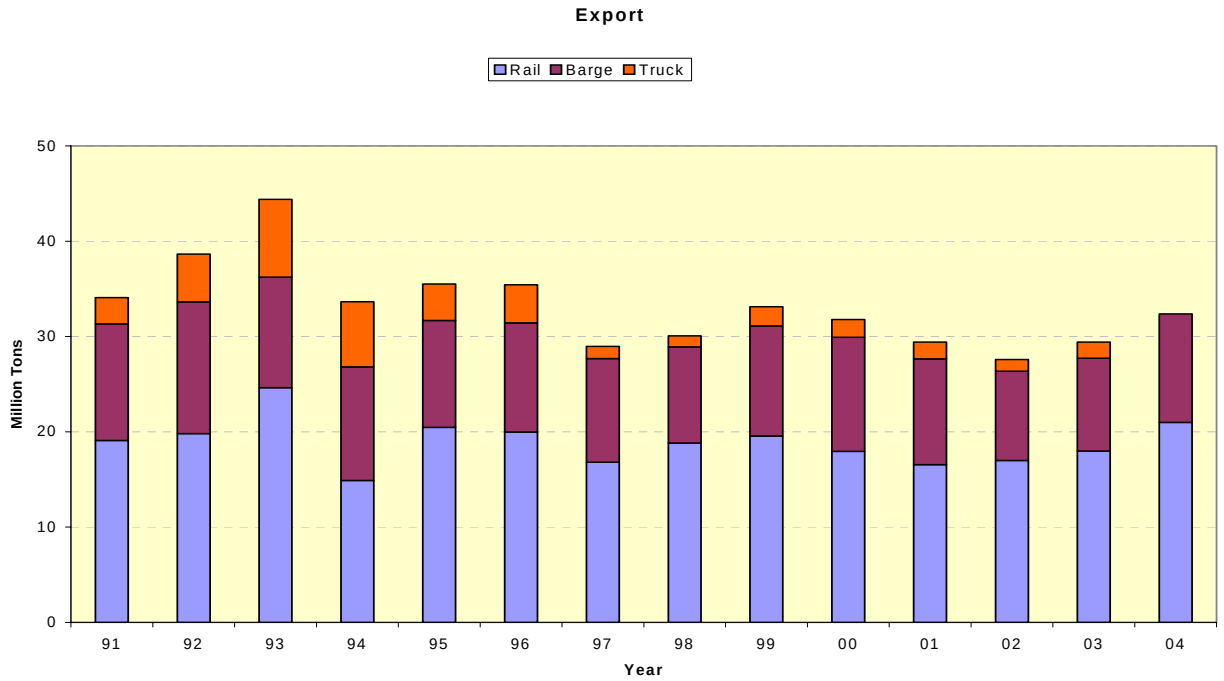


Figure 9–U.S. wheat export shipments by mode, 1991-2004



Soybeans

Soybeans are the dominant oilseed grown in the United States. The United States is a major exporter of whole soybeans, typically exporting about 35 percent of its soybeans. Most domestic soybeans are processed at crushing facilities where whole soybeans are separated into oil and meal components. Soybean oil is used in a variety of food products, as well as in several industrial applications such as plastics, coatings and inks, lubricants, adhesives, and solvents. Most soybean meal is used as the major source of protein in livestock feed, but is also used in small amounts for food products, such as bakery goods and meat substitutes.

Since 1998, the United States has harvested more than 70 million acres of soybeans. Increased planting flexibility, steadily rising yield improvements from narrow-rowed seeding practices, a greater number of 50-50 corn-soybean rotations, and relatively lower production costs (partly due to widespread adoption of herbicide-tolerant varieties) have favored expansion of soybean acreage since the early 1990s.[5] Table 5 shows tonnages and modal shares for soybeans from 1991 to 2004.

Tonnages Moved. From 2000 to 2004, soybean movements have decreased 8 percent, from 79 million tons to 73 million tons.

Modal Shares. Barge is the dominant transport mode for moving soybeans to export facilities for similar reasons as it is for corn. From 2000 to 2004, barges were responsible for 59 percent of total inland movements of soybeans to coastal export locations. Railroads handled 34 percent of exported soybeans, and trucks moved the remaining 7 percent.

Domestic movements of soybeans are dominated by truck, with about 81 percent of the traffic from 2000 to 2004. Rail moves about 16 percent of soybeans within the United States. Barge handles only about 3 percent of domestic soybeans. These modal share trends for domestic and export soybean movements are illustrated in figures 10 and 11.

[5] Economic Research Service, USDA, Briefing Room, Soybeans and Oil Crops http://www.ers.usda.gov/Briefing/SoybeansOilCrops/.

Table 5–Tonnages and modal shares for U.S. soybeans, 1991-2004

Year & type of movement	Mode of transport					
	Rail		Barge		Truck	
	1,000 tons	Percent	1,000 tons	Percent	1,000 tons	Percent
Total						
1991	14,605	26	16,717	29	25,716	45
1992	16,118	26	18,265	29	27,665	45
1993	14,237	23	17,731	28	30,486	49
1994	14,754	24	17,049	28	30,052	49
1995	17,067	24	18,399	26	35,026	50
1996	18,863	27	20,337	29	30,068	43
1997	16,976	23	20,374	28	36,198	49
1998	16,476	21	18,000	23	42,372	55
1999	16,685	22	19,875	26	40,941	53
2000	17,257	22	20,174	26	41,232	52
2001	20,662	24	19,872	23	44,813	53
2002	19,120	22	21,399	25	44,835	53
2003	20,216	24	20,167	24	44,567	52
2004	16,346	23	17,053	24	39,136	54
Export:						
1991	3,962	21	14,966	77	396	2
1992	5,005	23	16,547	76	268	1
1993	4,657	22	15,476	72	1,277	6
1994	3,452	14	14,773	59	6,870	27
1995	5,572	23	16,308	66	2,880	12
1996	7,895	31	17,922	69	23	0
1997	7,912	30	18,091	69	337	1
1998	7,299	29	15,410	61	2,741	11
1999	8,189	32	17,240	68	80	0
2000	8,591	29	18,665	63	2,442	8
2001	11,711	37	18,689	59	1,262	4
2002	10,602	35	19,642	64	263	1
2003	12,479	37	18,632	55	3,036	9
2004	9,322	34	15,412	56	2,752	10
Domestic:						
1991	10,643	28	1,751	5	25,320	67
1992	11,113	28	1,718	4	27,397	68
1993	9,580	23	2,255	6	29,208	71
1994	11,302	31	2,276	6	23,182	63
1995	11,495	25	2,091	5	32,145	70
1996	10,968	25	2,416	6	30,045	69
1997	9,064	19	2,283	5	35,861	76
1998	9,177	18	2,590	5	39,631	77
1999	8,496	16	2,636	5	40,861	79
2000	8,666	18	1,510	3	38,790	79
2001	8,950	17	1,183	2	43,552	81
2002	8,518	16	1,758	3	44,572	81
2003	7,737	15	1,535	3	41,531	82
2004	7,024	16	1,641	4	36,384	81

Figure 10–U.S. soybean domestic shipments by mode, 1991-2004

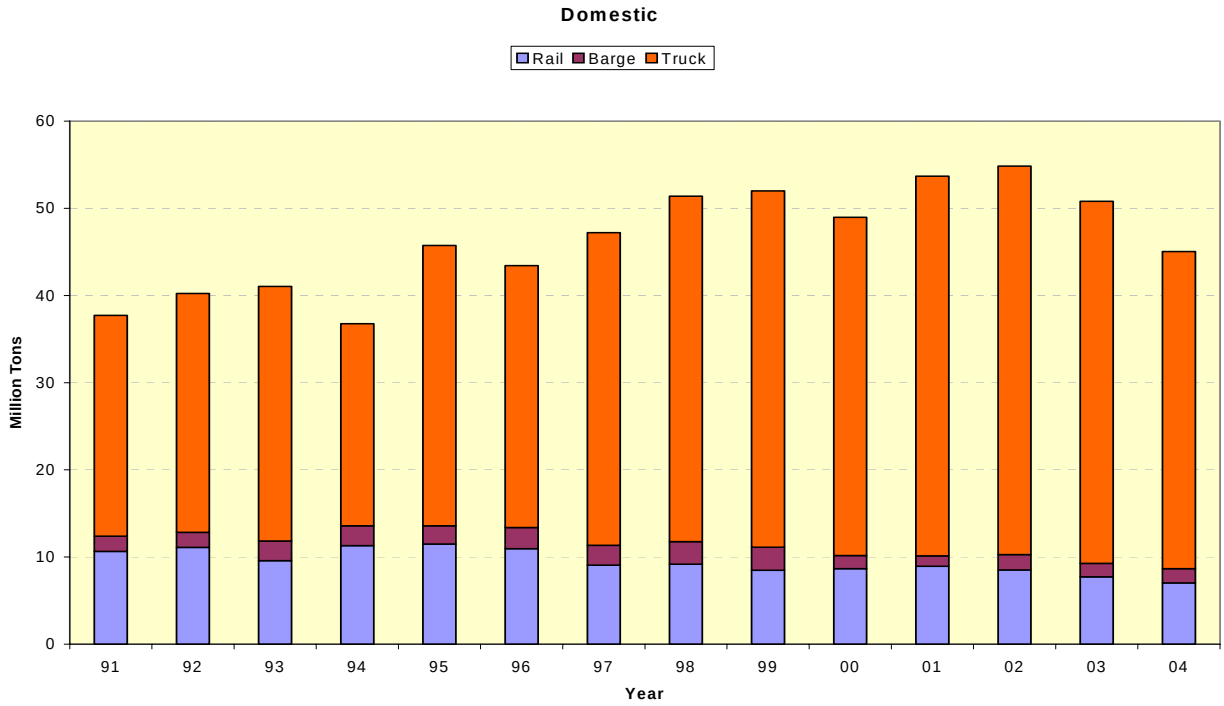
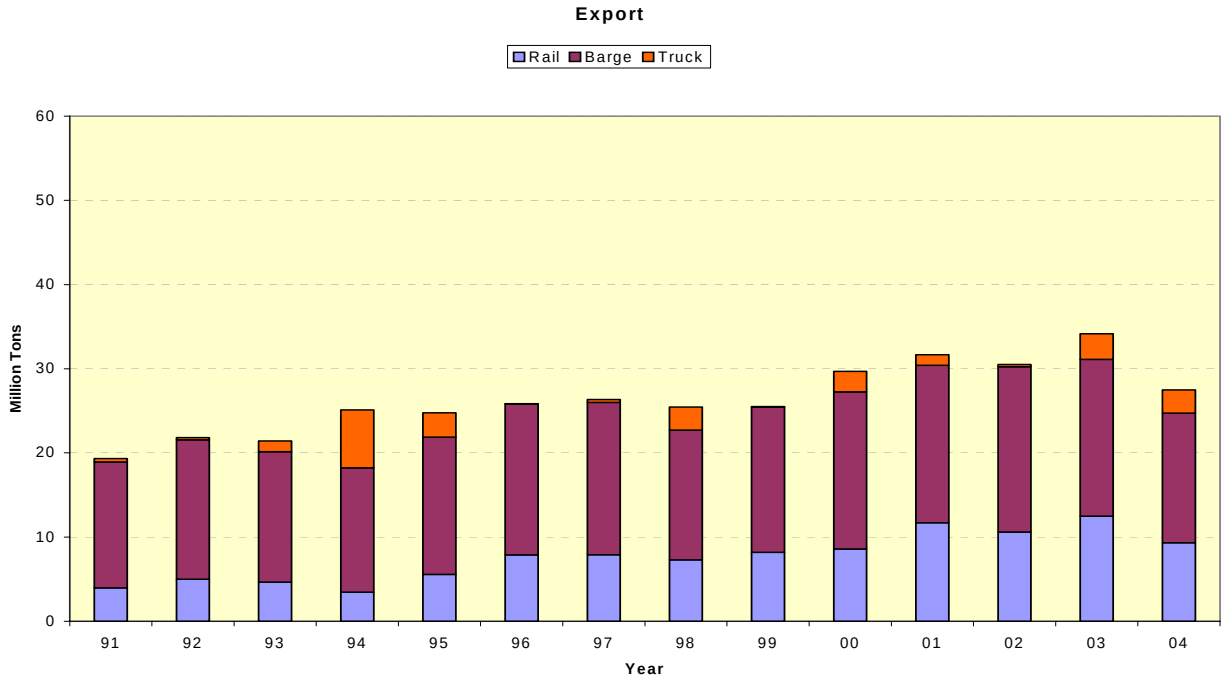


Figure 11–U.S. soybean export shipments by mode, 1991-2004



Sorghum

In 2004, 6.5 million acres of sorghum were harvested in the United States.[6] Sorghum makes up about 5 percent of feed grain production in the United States.[7]

On average from 2000 to 2004, the United States exported 42 percent of its sorghum crop.[8] Table 6 shows tonnages and modal shares for sorghum from 1991 to 2004.

Tonnages Moved. From 2000 to 2004, sorghum movements have decreased 22 percent, from 14.6 million tons to 11.4 million tons.

Modal Shares. Most sorghum is transported to export facilities by rail. From 2000 to 2004, rail was responsible for an average of 48 percent of total inland movements of sorghum to coastal export locations. Trucks handled about 32 percent of exported sorghum, and barge moved the remaining 20 percent.

Domestic movements of sorghum are dominated by truck, with about 90 percent of the traffic from 2000 to 2004. Rail moved an average 10 percent of sorghum within the United States from 2000 to 2004. Modal share trends for domestic and export sorghum movements are illustrated in figures 12 and 13.

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[6] National Agricultural Statistics Service, USDA, Sorghum http://www.usda.gov/nass/.
[7] Economic Research Service, USDA, Key Topics, Crops, Sorghum www.ers.usda.gov/topics.
[8] *Feed Outlook Report*, Economic Research Service, USDA www.ers.usda.gov.

Table 6–Tonnages and modal shares for U.S. sorghum, 1991-2004

Year & type of movement	Mode of transport					
	Rail		Barge		Truck	
	1,000 tons	Percent	1,000 tons	Percent	1,000 tons	Percent
Total						
1991	6,281	40	2,177	14	7,276	46
1992	6,906	41	2,938	17	7,175	42
1993	6,401	36	2,120	12	9,206	52
1994	5,028	28	2,335	13	10,375	59
1995	5,070	34	1,442	10	8,606	57
1996	4,602	28	1,441	9	10,589	64
1997	5,801	30	1,257	7	11,972	63
1998	4,710	33	1,168	8	8,236	58
1999	5,222	35	1,333	9	8,557	57
2000	4,626	32	1,322	9	8,604	59
2001	4,633	37	1,335	11	6,480	52
2002	4,088	35	1,225	11	6,206	54
2003	2,098	19	1,365	12	7,555	69
2004	2,380	21	852	7	8,188	72
Export:						
1991	3,364	52	2,161	33	1,005	15
1992	3,801	46	2,905	35	1,620	20
1993	2,846	43	2,095	32	1,703	26
1994	1,764	28	2,324	37	2,273	36
1995	2,202	36	1,430	23	2,471	41
1996	2,331	42	1,382	25	1,813	33
1997	3,074	53	1,247	22	1,447	25
1998	3,065	56	1,165	21	1,277	23
1999	4,197	67	1,331	21	782	12
2000	3,650	52	1,317	19	2,070	29
2001	3,880	58	1,326	20	1,513	23
2002	3,621	59	1,218	20	1,247	20
2003	1,784	32	1,362	25	2,401	43
2004	1,859	37	852	17	2,377	47
Domestic:						
1991	2,917	32	16	0	6,271	68
1992	3,105	36	33	0	5,555	64
1993	3,555	32	25	0	7,503	68
1994	3,264	29	11	0	8,102	71
1995	2,868	32	12	0	6,135	68
1996	2,271	20	59	1	8,776	79
1997	2,728	21	10	0	10,525	79
1998	1,645	19	3	0	6,959	81
1999	1,025	12	2	0	7,775	88
2000	976	13	5	0	6,534	87
2001	753	13	8	0	4,966	87
2002	467	9	6	0	4,959	91
2003	315	6	3	0	5,155	94
2004	521	8	0	0	5,810	92

Figure 12–U.S. sorghum domestic shipments by mode, 1991-2004

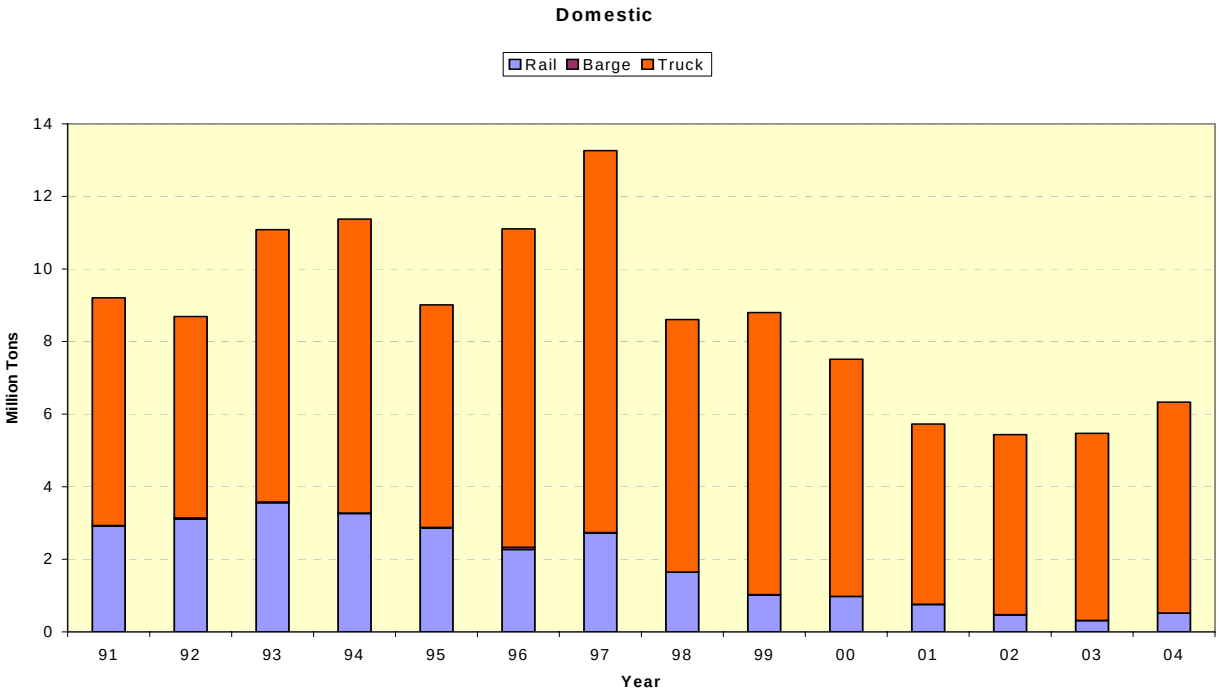
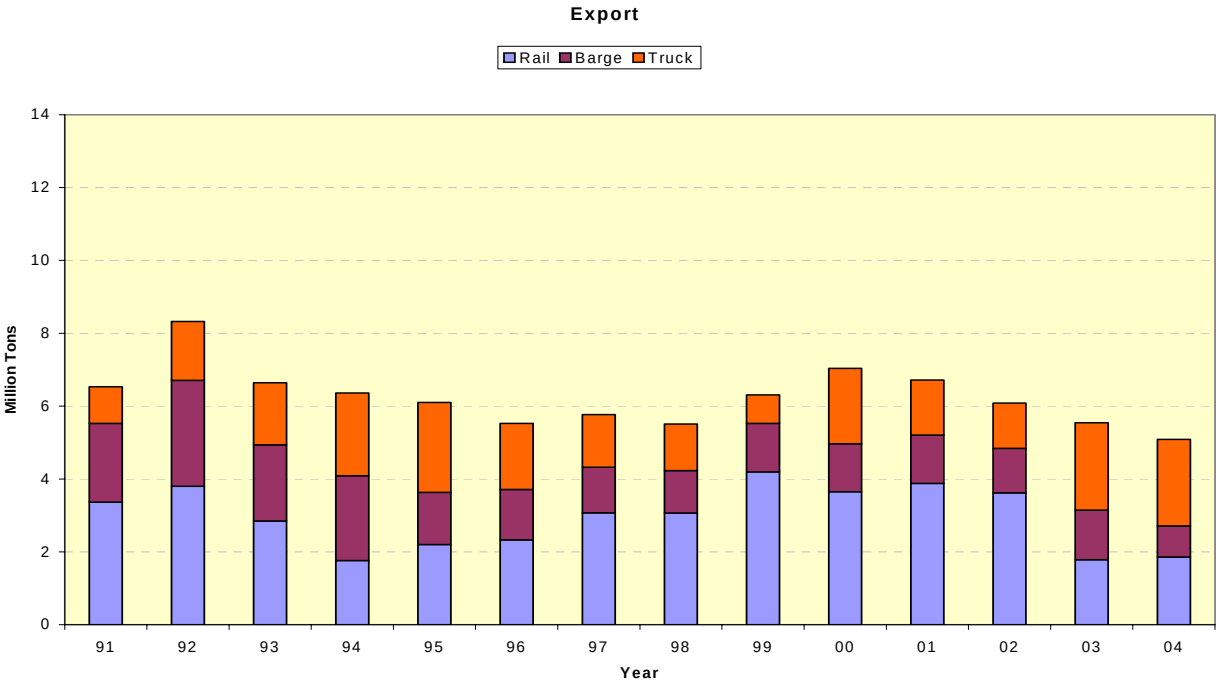


Figure 13–U.S. sorghum export shipments by mode, 1991-2004



Barley

After corn and sorghum, barley is the third major feed grain crop produced in the United States. In 2004, about 4.0 million acres of barley were harvested, mostly in the North Central States and the Pacific Northwest. Barley makes up 1.4 percent of all U.S. grain movements. Table 7 shows tonnages and modal shares for barley from 1991 to 2004.

Tonnages Moved. From 2000 to 2004, barley movements followed a downward trend from 7.3 million tons to 5.5 million tons, a decrease of 25 percent.

Modal Shares. Rail is the dominant transport mode for moving barley to export facilities. About two-thirds of export barley is shipped by rail. Domestic movements of barley split 51 percent by rail and 48 percent by truck. Modal share trends for domestic and export barley movements are illustrated in figures 14 and 15.

Table 7–Tonnages and modal shares for U.S. barley, 1991-2004

Year & type of movement	Mode of transport					
	Rail		Barge		Truck	
	1,000 tons	Percent	1,000 tons	Percent	1,000 tons	Percent
Total						
1991	5,315	52	682	7	4,275	42
1992	5,886	63	602	7	2,800	30
1993	5,260	60	533	6	2,998	34
1994	6,662	61	297	3	3,925	36
1995	6,509	69	690	7	2,195	23
1996	4,202	47	325	4	4,414	49
1997	3,928	48	541	7	3,772	46
1998	3,246	44	280	4	3,819	52
1999	3,586	51	307	4	3,128	45
2000	3,250	44	478	7	3,592	49
2001	2,952	44	204	3	3,558	53
2002	2,866	48	167	3	2,926	49
2003	3,432	61	196	3	1,996	35
2004	2,958	53	130	2	2,457	44
Export:						
1991	758	45	611	37	302	18
1992	982	48	564	28	500	25
1993	557	34	522	31	584	35
1994	738	43	254	15	713	42
1995	701	51	574	42	94	7
1996	446	37	285	23	484	40
1997	854	48	457	26	458	26
1998	271	41	259	39	126	19
1999	409	58	287	41	8	1
2000	652	58	449	40	27	2
2001	585	62	171	18	189	20
2002	398	72	154	28	0	0
2003	501	73	183	27	0	0
2004	249	67	121	33	0	0
Domestic:						
1991	4,557	53	71	1	3,973	46
1992	4,904	68	38	1	2,300	32
1993	4,703	66	11	0	2,414	34
1994	5,924	65	43	1	3,211	35
1995	5,808	72	116	1	2,102	26
1996	3,756	49	40	1	3,929	51
1997	3,075	48	84	1	3,314	51
1998	2,975	44	21	0	3,693	55
1999	3,177	50	20	0	3,120	49
2000	2,599	42	29	0	3,565	58
2001	2,367	41	33	1	3,369	58
2002	2,468	46	13	0	2,926	54
2003	2,931	59	13	0	1,996	40
2004	2,709	52	9	0	2,457	47

Figure 14–U.S. barley domestic shipments by mode, 1991-2004

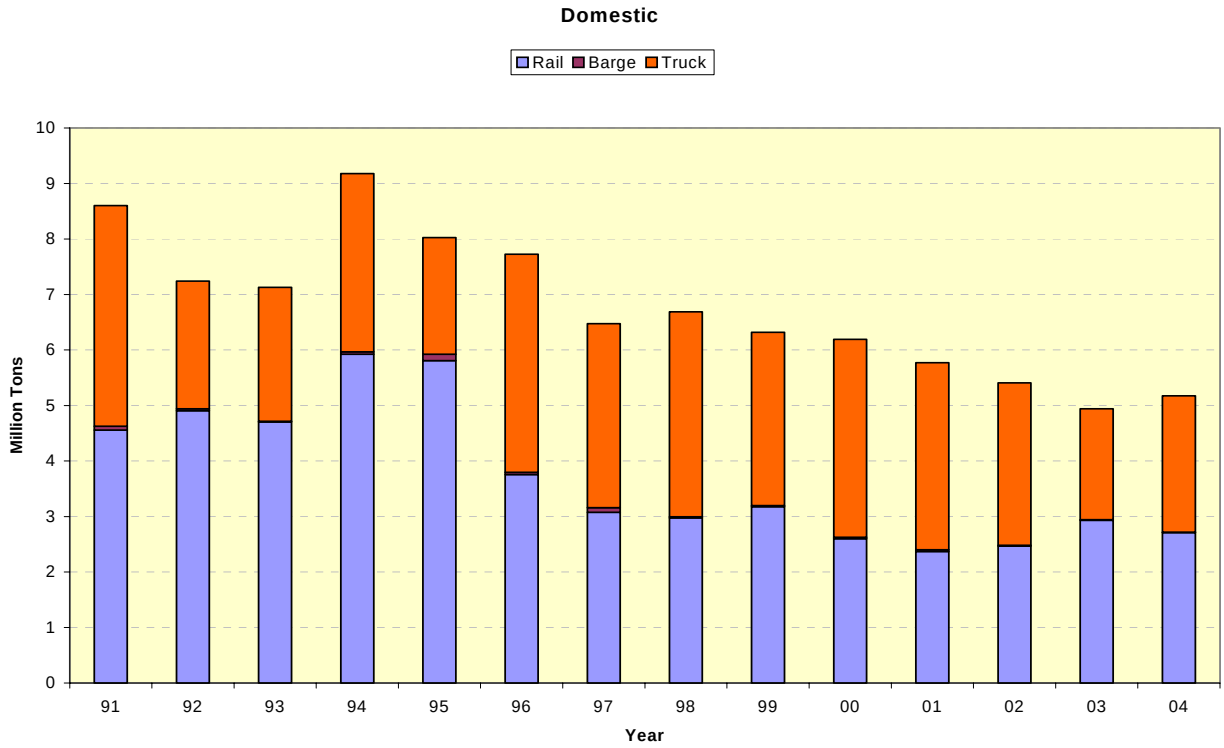
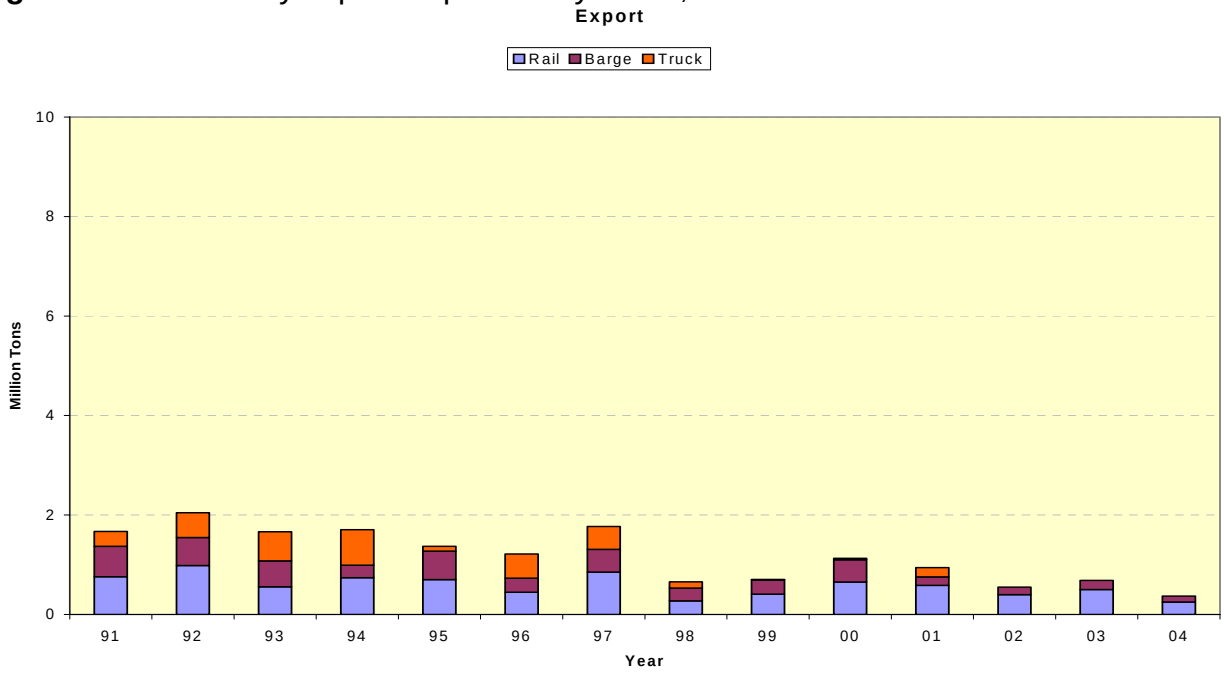


Figure 15–U.S. barley export shipments by mode, 1991-2004



Conclusion

The most significant trends during 1978-2004 were the upward growth in tonnages of all grains moved and an increased truck share in moving that grain. These trends were driven by increases in production and domestic off-farm grain use, particularly for corn. The tonnages of grain moved to export showed a high degree of variability during the 26-year period. After declining somewhat from record-high levels during the early 1980s, exports again expanded in the late 1980s and 1990s.

The tonnages of all grain transported domestically and to export locations increased 63 percent from 242 million tons in 1978 to 394 million tons in 2004. The absolute tonnages transported by each mode also increased. Between 1978 and 2004, rail movements increased 16 percent, from 117 million tons to 136 million tons; barge volumes increased 31 percent, from 51 million tons to 67 million tons and truck tonnages increased 157 percent, from 74 million tons to 198 million tons.

The modal share analysis for the final movement of all grains indicates that, despite significant changes in truck and rail modal share during the period, modal shares for barge remained very much the same in 2004 as in 1978. Rail was the predominant grain transportation mode in the United States until 1985, when truck surpassed rail share for the first time, and then again in 1993. Rail share, which was 48 percent in 1978, had decreased to 35 percent by 2004. Barge share—21 percent in 1978—had decreased slightly to 17 percent by 2004. Truck share displayed a general upward trend from 30 percent in 1978 to 48 percent in 2004.

As the study indicates, modal share of the final movement of grain is highly dependent upon the type of grain being transported and shipment origination and destination markets. Fundamental economic theory shows that prices in areas of scarcity are high as compared with areas of abundance. The price of corn is higher in Louisiana than the Midwest. That price difference, and the possibility to profit by moving the commodity by lowest transportation cost, is the incentive to market grain. The movement of grain to export facilities is best handled with high-volume long haul modes of transportation, such as barge or rail. Therefore, high levels of grain exports increase demand for rail and barge transportation. Increased domestic off-farm feed use and increased domestic demand for processed grain products drive up demand for truck transportation. Adequate rail, barge, and truck transportation are all essential to a grain transportation infrastructure that supports the domestic and export market expansion of U.S. grain.

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Appendix A: Data Explanation for 1998 Report

Grown and Used on Farm, 1998 Report: Data for 1978-1980 are reported by USDA as "Used on farms where grown." Data for 1981-1995 were supplied by the USDA Economic Research Service and represent an estimated continuation of the earlier "used on farms where grown" data series.

Rail, 1998 Report: Rail grain volumes for the 1998 report were taken from two sources. Volumes for 1978-1987 were taken from the American Association of Railroads, *Commodity Freight Statistics,* and for 1988-1995 from the Interstate Commerce Commission (ICC), *Carload Waybill Sample*. (The ICC is now called the Surface Transportation Board, which was created by the Interstate Commerce Commission Termination Act of 1995 and is the successor agency to the ICC.) Export rail grain volumes between 1984 and 1995 were estimated from the Waybill Sample. Sampling techniques and reporting methodology of the ICC prior to 1984 were reported at a 1-percent sampling rate, and in 1984, the ICC automated the data sampling technique. Export and domestic rail data for 1984-1995, by grain, reported in the 1998 report, reflect the ICC's automated sampling procedure. Export rail modal shares were determined using rail export tonnages to the Atlantic, Gulf of Mexico, and Pacific Coasts. These tonnages were estimated from the *Carload Waybill Sample* and data on grain car releases from ports.[9] [10] Rail tonnages by grain type were estimated for the above three regions by multiplying the percentage of each grain type railed to that region, as determined from the waybill, by the number of cars reported released from that region. The number of cars for each commodity at each port region was then multiplied by the per-car tonnages for each grain type at each port region. The per-car tonnages were also determined from the waybill.

[9] Interstate Commerce Commission, *Carload Waybill Sample,* 1995 (Washington, DC: ICC).
[10] Association of American Railroads, PT Report No. 2, 1995 (Washington, DC: AAR, Transportation Division).

Appendix B: FIPS[11] Regions Included in Rail Export Tonnages[12]

State/country	FIPS code	County
Canada & Mexico	0	All areas
Alabama	1003	Baldwin
Alabama	1097	Mobile
Arizona	4023	Santa Cruz
California	6025	Imperial
California	6073	San Diego
Georgia	13051	Chatham
Georgia	13127	Glynn
Louisiana	22019	Calcasieu
Louisiana	22023	Cameron
Louisiana	22033	East Baton Rouge
Louisiana	22051	Jefferson
Louisiana	22063	Livingston
Louisiana	22071	Orleans
Louisiana	22075	Plaquemines
Louisiana	22089	St. Charles
Louisiana	22093	St. James
Louisiana	22095	St. John the Baptist
Louisiana	22121	West Baton Rouge
Minnesota	27137	St. Louis
Mississippi	28045	Hancock
Mississippi	28047	Harrison
Mississippi	28059	Jackson
Ohio	39043	Erie
Ohio	39095	Lucas
Oregon	41009	Columbia
Oregon	41051	Multnomah
South Carolina	45019	Charleston
South Carolina	45053	Jasper
Texas	48061	Cameron
Texas	48141	El Paso
Texas	48167	Galveston
Texas	48201	Harris
Texas	48245	Jefferson
Texas	48323	Maverick
Texas	48355	Nueces
Texas	48361	Orange
Texas	48377	Presidio
Texas	48409	San Patricio
Texas	48479	Webb

[11] Federal Information Processing Standards

[12] Bureau of Transportation Statistics, 2002. United States Department of Transportation, *Atlas Databases 2002*, CD-ROM: BTS.

State/country	FIPS code	County
Virginia	51710	Norfolk
Washington	53011	Clark
Washington	53015	Cowlitz
Washington	53033	King
Washington	53053	Pierce
Wisconsin	55031	Douglas
Wisconsin	55079	Milwaukee