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Transportation of U.S. Grains A Modal Share Analysis, 1978-2000

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Abstract

This analysis of grain movements by transport mode updates a 1998 study. It provides 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, barley, and rye 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 the 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 1978-2000, updates a 1998 report, which covered the years 1978-1995.

The amount of grain moved in the United States increased significantly from 1978 to 2000. During this period, significant changes occurred in the types of grain moved and the amount shipped to domestic and export markets.

Grain movement and modal share trends are strongly influenced by the size of the corn, wheat, and soybean crops. These three crops accounted for more than 90 percent of all grain movement during 1978-2000. Movements reached a record total of 402 million tons in 2000, an increase of 69 percent from 238 million tons in 1978. Nearly all of this growth resulted from a large increase in domestic grain movements, which increased 137 percent from 1978. From 1978 to 2000, export movements reached a high of 144 million tons in 1981 and after falling to 87 million tons in 1986 rose to average of 118 million tons during 1987-2000.

Significant changes in modal share occurred during 1978-2000, particularly between rail and truck modes. All modes showed an increase in absolute tons moved. However, rail and barge shares decreased, while truck share increased through 2000, making truck the predominant mode of grain transport in the United States.

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 as suppliers of transportation for grain movements. 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 is very much dependent upon this competitive balance. A highly competitive and efficient transportation system translates into 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 a series of 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 confronted with the absence of truck data. Accurate data exist on barge and rail freight tonnages and commodities, but similar data are not available for truck movements. 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 a specific 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, barley, and rye. The 1998 version of this study also included oats. Oats were taken out of the calculations for this report due to reliability associated with volumes that represent

less than 1 percent of total grain movements. Transport movements are segmented as the final grain movement going to domestic markets and to 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, which begins September 1. The other two reports break the numbers down on a quarterly basis. To get disappearance numbers for calendar years 1995 through 2001, monthly averages were calculated from the quarterly numbers and then 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.

***Total, 1998 Report*.** Total grain tonnages for the 1998 modal share report were estimated using the methodology described above.

***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.

***Grown and Used on Farm, 1998 Report*.** The methodology used for grown and used

on farm data for the 1998 report is described in appendix A.

***Rail Total*.** Rail movements for the updated data (1996 to 2000) come from the Surface Transportation Board's (STB) Master Carload Waybill Sample. 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 when grain is moved by rail to a barge loading facility. 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.

***Rail, 1998 Report*.** The methodology used to estimate rail tonnages for the 1998 report is described in appendix A.

***Barge Total*.** Barge movement data for 1996-2000, 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.

***Barge, 1998 Report*.** Barge grain volumes for 1978-1995 were also taken from the Corps' *Waterborne Commerce of the United States*, 1978-95.

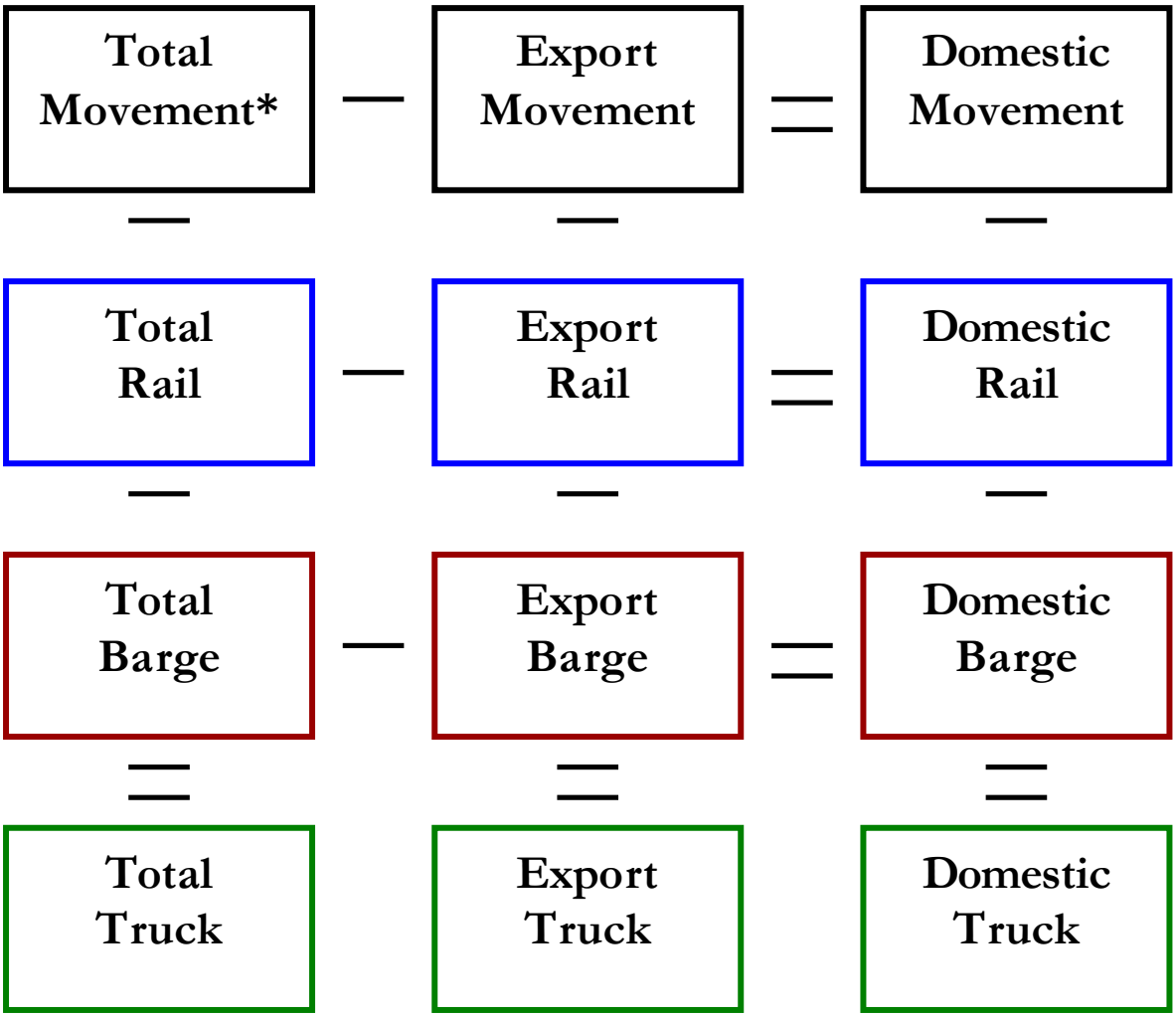
***Truck Total*.** Total truck tonnages are estimated by subtracting total rail and total barge from total disappearance. The method for estimating truck grain tonnages and modal shares assumes that all barge and rail tonnages represent "long-haul" movements. "Short-haul" movements (farm-to-elevator) 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.

***Truck, 1998 Report*.** Truck tonnages from the 1998 report were estimated using the procedures described above.

Figure 1–Model for estimating modal tonnages and share



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

Modal Shares and Grain Tonnages Moved

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, barley, and rye. Oats are not included in this analysis and would only represent about 1 percent of grain movements. Table 1 shows total tonnages, by export and domestic market, for grain movements from 1987 to 2000.

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 1996 to 2000, 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 ethanol industry produced more than 2.81 billion gallons in 2003, up from a record annual production of 2.13 billion gallons in 2002.[1]

All Selected Grains

From 1978 to 2000, the most significant trend in a single mode of moving grain was the 170-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 49 percent of all movements

[1] Renewable Fuels Association, Washington, DC.

(figure 5). The volume of rail movements increased 13 percent while dropping from 48 percent to 31 percent of all movements. Barge volumes increased 43 percent, and the modal share of barged grain dropped slightly from 21 percent to 18 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 2000, truck movements represented almost two-thirds of the domestic grain market, while rail handled about one-third and barge represented a small percentage of all movements. In 2000, barge shipments represented 56 percent of export movements, with rail having 31 percent and truck with 13 percent. Table 2 shows tonnages and modal shares from 1978 to 2000.

From 1978 to 2000, 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 393 million tons in 1995 and eventually peaked at 404 million tons in 2000, a 69-percent increase in 22 years. Significant decreases occurred when widespread drought diminished yields in 1988 and in 1993 when history-making floods devastated the Midwest. A major decrease also occurred in 1996 as a result of tight supplies of corn and wheat and record prices. While production, domestic consumption, and exports of grain can experience year-to-year variations, the volume of grain moved in the United States has almost always increased from year to year. Increasing production along with a decreasing amount of grain that is grown and used on the farm have resulted in an increasing amount of grain that needs to be transported. From 1996 to 2000, most of the grain moved was corn, representing nearly 56 percent of all grain movements. Soybeans were the second most moved grain, with 20 percent of all movements. Wheat was a close third with 18 percent. Together, corn, soybeans, and wheat represented a combined 94 percent of all grain movements. Other grains included were sorghum and barley.

Corn exports are about one-quarter of all corn movements, soybean exports are one-third of all soybean movements, and wheat exports are about one-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 changing U.S. dollar exchange rates and increased competition from foreign grain producers.

Table 1–Tonnages of U.S. grains transported by type of crop and type of movement, 1987-2000

Year	Corn	Wheat	Soybeans	Sorghum	Barley and rye	All grains
	1,000 tons					
Total						
1987	165,230	67,694	61,503	16,715	12,406	323,548
1988	177,003	75,698	56,318	22,054	11,304	342,377
1989	165,066	67,977	50,213	20,912	9,451	313,619
1990	171,990	65,123	53,849	19,961	10,517	321,440
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	194,526	68,717	69,267	16,616	9,027	358,153
1997	207,856	63,729	73,549	19,031	8,322	372,486
1998	209,957	68,049	76,848	14,114	7,509	376,477
1999	223,840	69,223	76,631	15,112	7,295	392,102
2000	229,519	69,899	80,652	14,552	7,410	402,032
Export						
1987	44,993	33,772	23,427	5,496	3,344	111,032
1988	51,211	44,640	19,674	7,140	2,405	125,070
1989	62,213	40,237	16,582	9,212	1,984	130,228
1990	57,450	27,445	16,933	7,456	2,386	111,670
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	25,880	5,525	1,216	125,236
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	25,830	6,309	799	123,888
2000	52,957	31,780	29,420	7,037	1,130	122,324
Domestic						
1987	120,237	33,922	38,076	11,219	9,062	212,516
1988	125,792	31,058	36,644	14,914	8,899	217,307
1989	102,853	27,740	33,631	11,700	7,467	183,391
1990	114,540	37,678	36,916	12,505	8,131	209,770
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	137,331	33,297	43,387	11,091	7,811	232,917
1997	161,861	34,769	47,209	13,263	6,554	263,655
1998	165,091	37,979	51,398	8,607	6,853	269,929
1999	166,020	36,093	50,801	8,803	6,496	268,213
2000	176,561	38,119	51,232	7,515	6,280	279,707

Figure 2–Total grain movements to domestic and export markets, 1978-2000

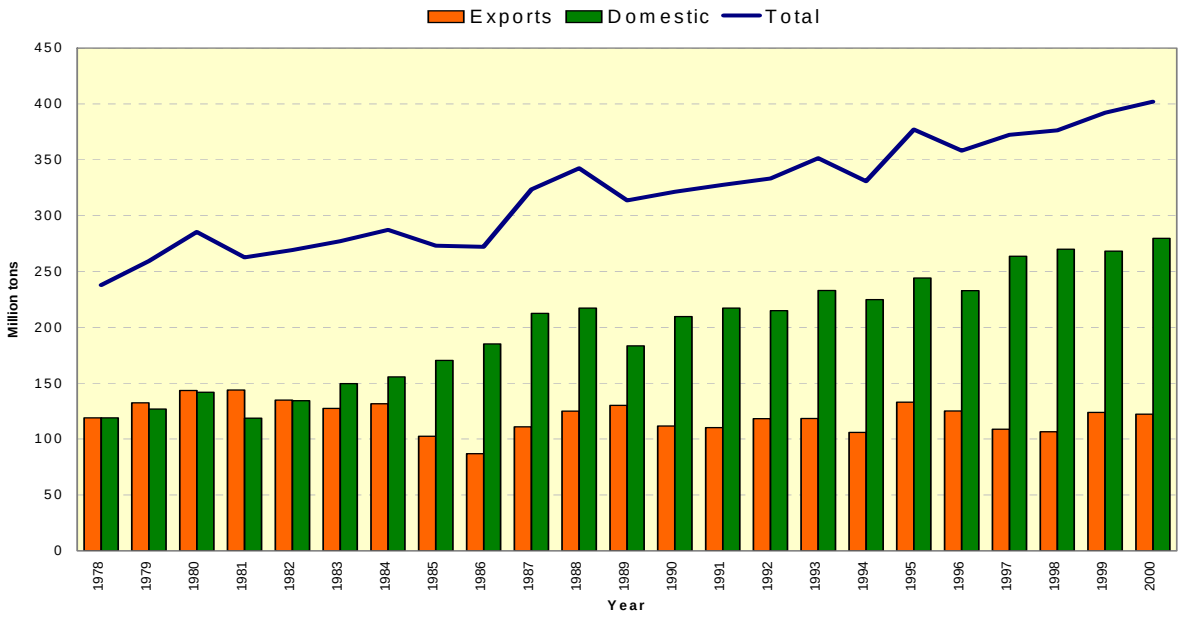


Figure 3–U.S. grain shipments by commodity, 1978-2000

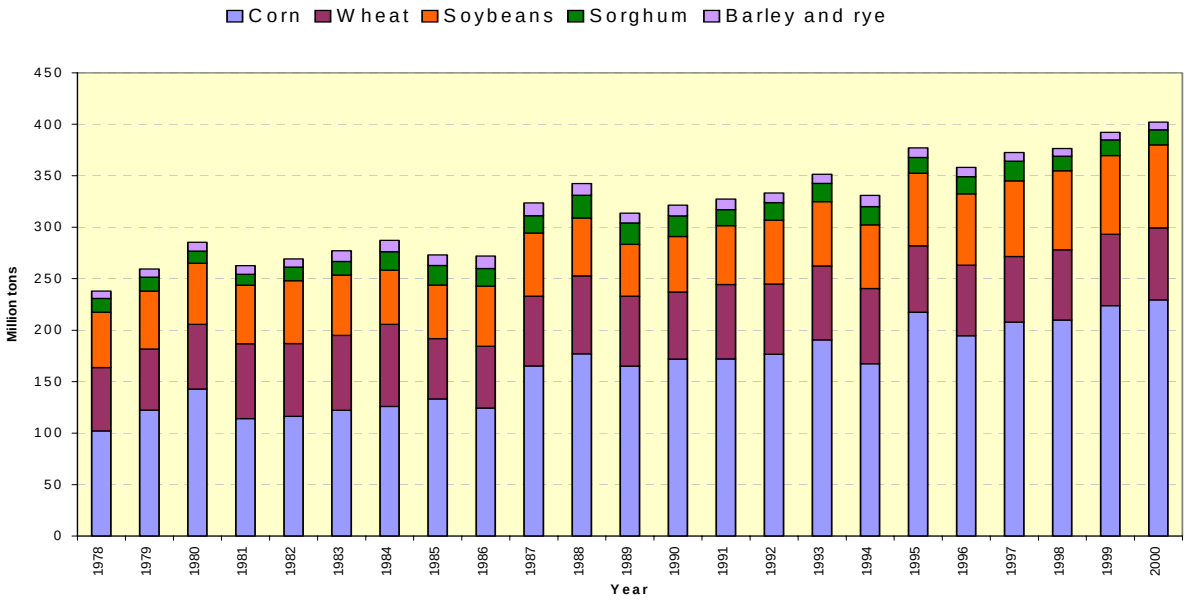


Table 2–Tonnages and modal shares for all U.S. grains, 1987-2000

Year & type of movement	Mode of transport					
	Rail		Barge		Truck	
	1,000 tons	Percent	1,000 tons	Percent	1,000 tons	Percent
Total:						
1987	139,667	42.7	62,447	19.1	125,151	38.2
1988	151,145	43.7	62,753	18.1	132,268	38.2
1989	143,893	45.5	67,313	21.3	105,362	33.3
1990	134,999	41.5	72,001	22.1	118,074	36.3
1991	126,245	38.1	70,168	21.2	134,795	40.7
1992	135,681	40.3	76,162	22.6	124,494	37.0
1993	134,717	38.0	68,563	19.3	151,642	42.7
1994	124,489	37.2	64,968	19.4	144,751	43.3
1995	152,033	40.0	73,725	19.4	154,570	40.6
1996	131,536	36.7	74,426	20.8	152,191	42.5
1997	122,928	33.0	65,992	17.7	183,565	49.3
1998	125,237	33.3	65,092	17.3	186,147	49.4
1999	135,054	34.4	74,806	19.1	182,242	46.5
2000	129,586	32.2	72,619	18.1	199,827	49.7
Export:						
1987	46,175	41.6	56,990	51.3	7,883	7.1
1988	56,204	44.9	58,480	46.8	10,400	8.3
1989	51,882	39.8	62,745	48.2	15,614	12.0
1990	42,301	37.9	62,501	56.0	6,880	6.2
1991	42,543	36.8	63,477	57.6	6,269	5.7
1992	40,827	34.5	68,424	57.9	9,017	7.6
1993	43,119	36.4	60,595	51.1	14,768	12.5
1994	27,722	26.1	57,966	54.7	20,336	19.2
1995	50,616	38.1	67,631	50.9	14,719	11.1
1996	46,956	37.5	67,353	53.8	10,926	8.7
1997	43,812	40.3	58,761	54.0	6,258	5.8
1998	41,787	39.2	57,829	54.3	6,932	6.5
1999	50,760	41.0	68,165	55.0	4,963	4.0
2000	46,069	37.7	67,712	55.4	8,543	7.0
Domestic:						
1987	93,492	43.2	5,457	2.5	117,268	54.2
1988	94,941	42.9	4,273	1.9	121,868	55.1
1989	92,011	49.4	4,568	2.5	89,748	48.2
1990	92,698	43.4	9,500	4.5	111,194	52.1
1991	85,703	38.8	6,690	3.0	128,526	58.2
1992	94,854	43.5	7,738	3.5	115,477	53.0
1993	91,598	38.7	7,968	3.4	136,873	57.9
1994	96,767	42.4	7,002	3.1	124,416	54.5
1995	101,417	41.0	6,094	2.5	139,851	56.5
1996	84,580	36.3	7,072	3.0	141,265	60.7
1997	79,117	30.0	7,231	2.7	177,308	67.2
1998	83,450	30.9	7,263	2.7	179,215	66.4
1999	84,294	31.4	6,641	2.5	177,279	66.1
2000	83,517	29.9	4,906	1.8	191,284	68.4

Figure 4–Tonnages of all U.S. grains transported by mode, 1978-2000

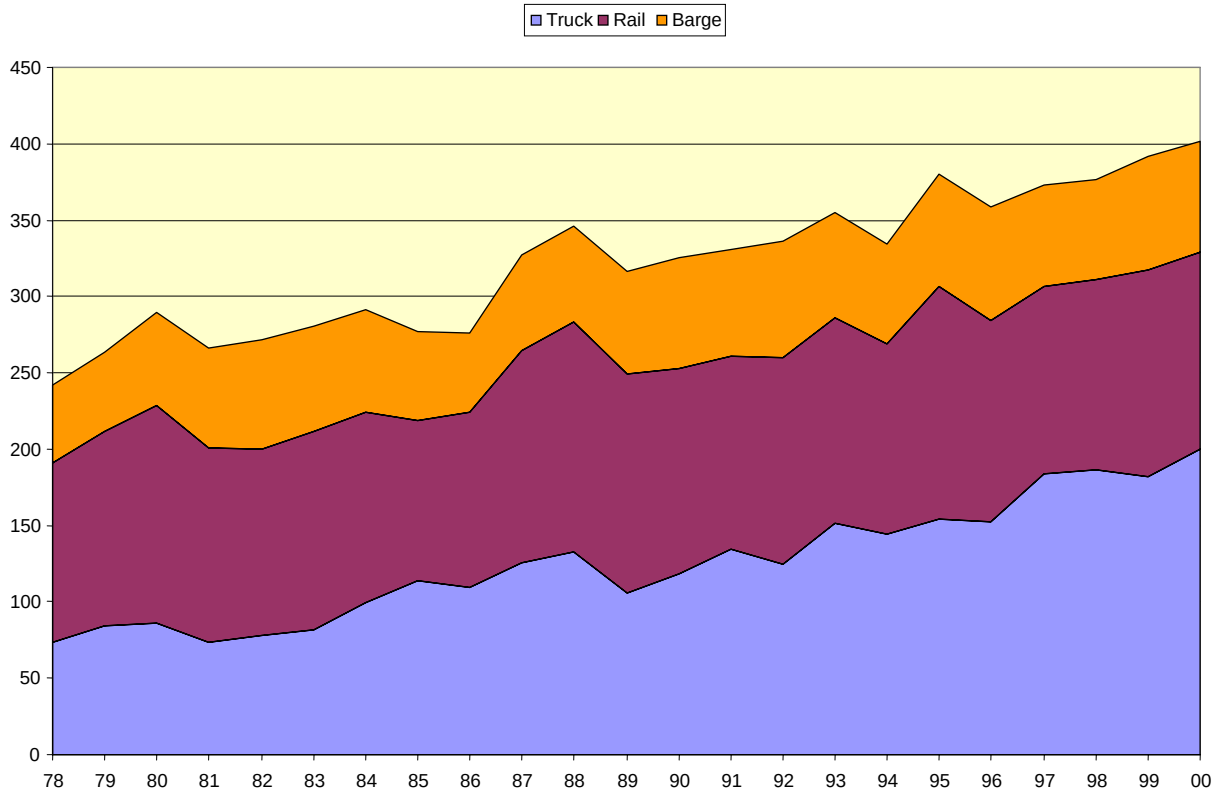
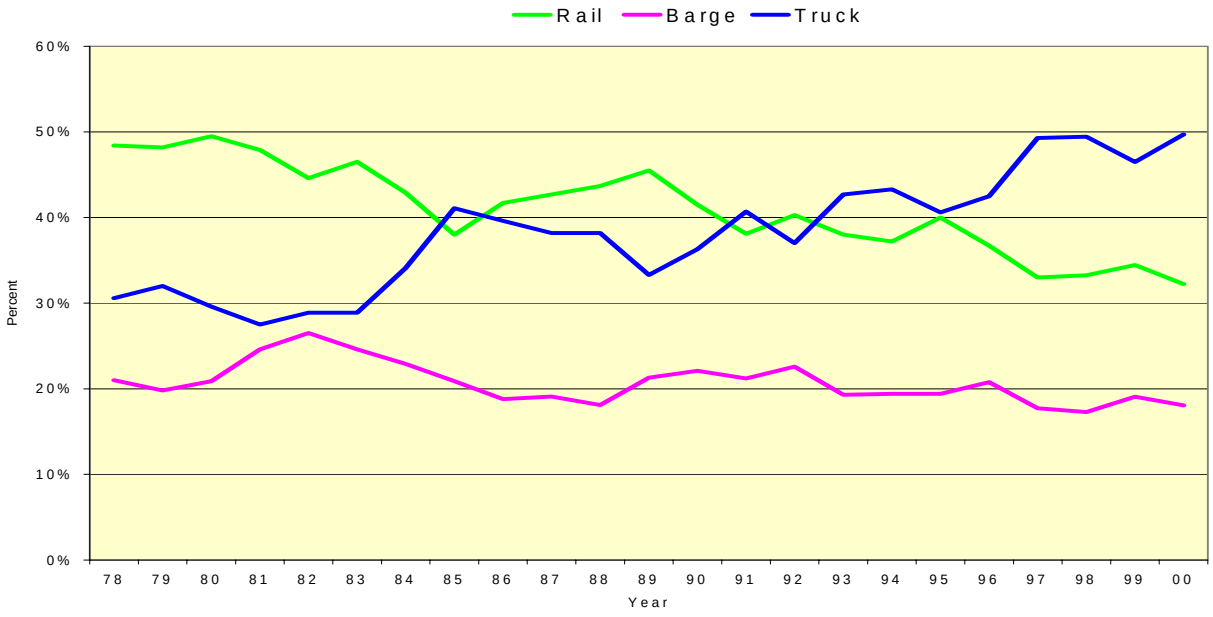


Figure 5–U.S. grain modal shares, 1978-2000



Corn

Corn is the principal feed source for the U.S. livestock industry. Nearly 72 million acres of corn were harvested for grain in 2000. 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 the world's largest producer and exporter of corn. Typically, the United States exports about 20 percent of its corn.[2]

Of all U.S. grains, corn has the highest transportation requirements due to volume. While the typical annual harvested acreage of corn and soybeans is similar (about 70 million acres each),[3] the total volume of production of corn can be more than three and one-half times that of total soybeans (9.2 billion bushels of corn versus 2.6 billion bushels of soybeans). Corn is predominately used as a feed ingredient in livestock rations, and on average, about 19 percent of all corn production is used on farm where grown. For off-farm use, corn, with a much higher per-acre yield than soybeans (129 bushels per acre for corn versus 38 bushels per acre for soybeans), has 3.4 times greater transportation requirements per acre than soybeans. Off-farm use of corn will likely increase due to the continuing trend toward the consolidation of livestock and poultry production into large-scale operations with feed requirements tending to be met through off-farm purchases. Table 3 shows tonnages and modal shares for corn from 1987 to 2000.

Tonnages Moved. From 1996 to 2000, corn movements increased from 195 million tons to 230 million tons, an increase of 17 percent. While export movements fluctuated during this time, domestic corn movements reached record levels 4 out of 5 years.

Modal Shares. Barge is the prominent transport mode for moving corn to export facilities. From 1996 to 2000, barge moved about 65 percent of total inland movements of corn to coastal export locations. Railroads handled about 25 percent of the export corn, and trucks moved the remaining 10 percent.

Domestic movements of corn are dominated by trucks, accounting for roughly 65 percent of the traffic from 1996 to 2000. Railroads move about 33 percent of corn within the United States. Barge is used to handle only small volumes of domestic corn. The modal shares for domestic and export shipments of corn are shown in Figures 6 and 7.

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

[3] Typical figures are average of 1995-2000, Agricultural Statistics Data Base, National Agricultural Statistics Service, USDA, http://www.usda.gov/nass/.

Table 3–Tonnages and modal shares for U.S. corn, 1987-2000

Year & type of movement	Mode of transport					
	Rail		Barge		Truck	
	1,000 tons	Percent	1,000 tons	Percent	1,000 tons	Percent
Total:						
1987	62,237	37.7	31,343	19.0	71,650	43.4
1988	65,634	37.1	32,063	18.1	79,306	44.8
1989	73,575	44.6	35,804	21.7	55,686	33.7
1990	67,538	39.3	39,676	23.1	64,776	37.7
1991	58,542	34.0	36,398	21.1	77,181	44.8
1992	61,601	34.9	38,907	22.0	75,966	43.0
1993	60,997	32.0	35,346	18.5	94,219	49.4
1994	56,285	33.6	31,939	19.1	79,124	47.3
1995	79,333	36.5	40,778	18.7	97,407	44.8
1996	66,015	33.9	39,598	20.4	88,912	45.7
1997	61,582	29.6	31,719	15.3	114,554	55.1
1998	63,470	30.2	34,431	16.4	112,055	53.4
1999	71,807	32.1	40,884	18.3	111,149	49.7
2000	68,984	30.1	37,960	16.5	122,575	53.4
Export:						
1987	14,495	32.2	28,441	63.2	2,057	4.6
1988	18,606	36.3	29,834	58.3	2,770	5.4
1989	21,572	34.7	33,970	54.6	6,672	10.7
1990	18,196	31.7	35,573	61.9	3,681	6.4
1991	13,366	27.5	33,505	68.8	1,812	3.7
1992	11,176	23.6	34,568	73.0	1,605	3.4
1993	10,403	23.5	30,907	69.8	2,977	6.7
1994	6,884	17.6	28,678	73.2	3,636	9.3
1995	21,665	33.2	38,098	58.4	5,438	8.3
1996	16,179	28.3	36,001	62.9	5,015	8.8
1997	15,061	32.7	27,811	60.5	3,123	6.8
1998	12,240	27.3	30,726	68.5	1,900	4.2
1999	18,307	31.7	37,568	65.0	1,945	3.4
2000	15,213	28.7	35,205	66.5	2,539	4.8
Domestic:						
1987	47,742	39.7	2,902	2.4	69,593	57.9
1988	47,028	37.4	2,229	1.8	76,536	60.8
1989	52,004	50.6	1,835	1.8	49,014	47.7
1990	49,342	43.1	4,103	3.6	61,095	53.3
1991	45,176	36.6	2,893	2.3	75,369	61.1
1992	50,424	39.1	4,339	3.4	74,360	57.6
1993	50,594	34.6	4,439	3.0	91,242	62.4
1994	49,401	38.5	3,261	2.5	75,488	58.9
1995	57,668	37.9	2,680	1.8	91,969	60.4
1996	49,837	36.3	3,597	2.6	83,897	61.1
1997	46,521	28.7	3,908	2.4	111,432	68.8
1998	51,230	31.0	3,706	2.2	110,156	66.7
1999	53,501	32.2	3,316	2.0	109,204	65.8
2000	53,771	30.5	2,754	1.6	120,036	68.0

Figure 6–U.S. corn domestic shipments by mode, 1987-2000

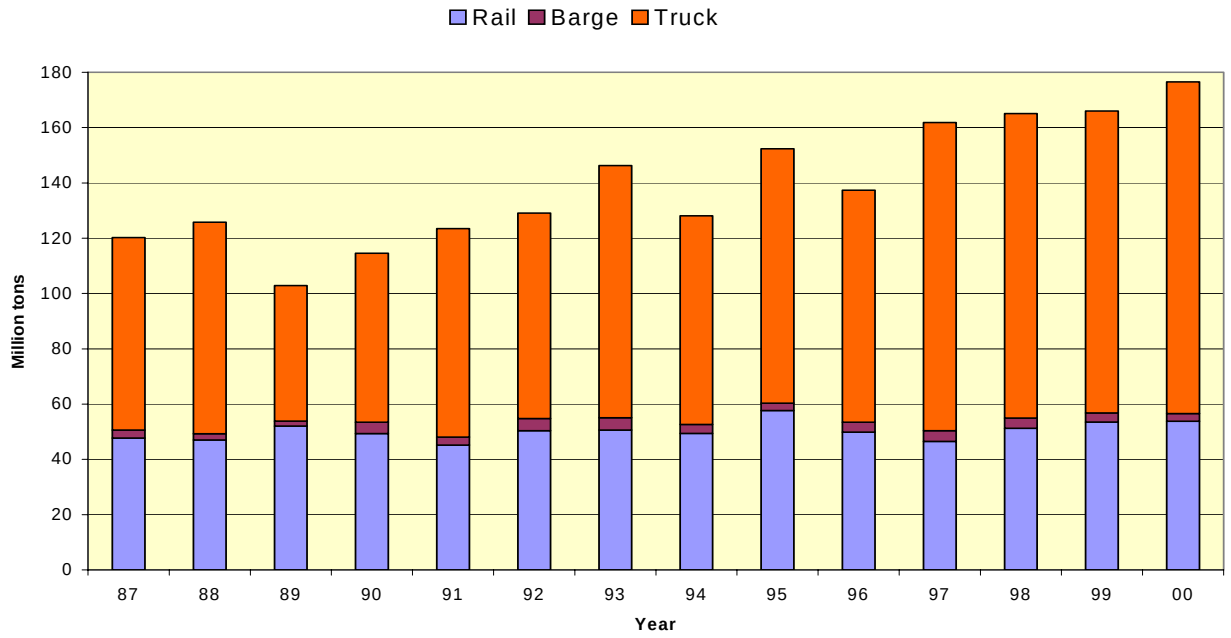
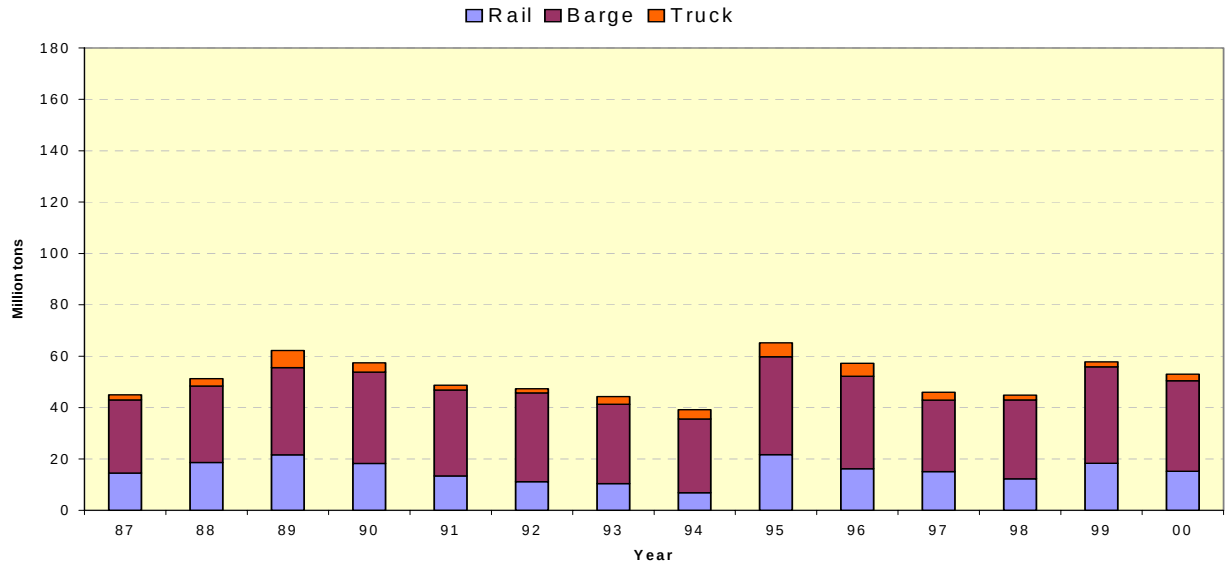


Figure 7–U.S. corn export shipments by mode, 1987-2000



Wheat

The United States is one of the top wheat producers in the world. China, India, the European Union, and the former Soviet Union are also significant wheat growers. In 2000, wheat (53 million acres) ranked third among U.S. field crops in harvested acreage 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 in certain circumstances. Table 4 shows tonnages and modal shares for wheat from 1987 to 2000.

Tonnages Moved. From 1990 to 2000, wheat movements increased from 65 million tons to nearly 70 million tons, an increase of 7 percent.

Modal Shares. Rail is the prominent transport mode for moving wheat to export facilities. From 1996 to 2000, rail moved about 51 percent of total inland movements of wheat to coastal export locations. Barge handled about 36 percent of the export wheat, and trucks moved the remaining 13 percent.

Domestic movements of wheat are dominated by rail, with about 57 percent of the traffic from 1996 to 2000. Trucks move about 40 percent of wheat within the United States. Barge handles only about 3 percent of domestic wheat. 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, 1987-2000

Year & type of movement	Mode of transport					
	Rail		Barge		Truck	
	1,000 tons	Percent	1,000 tons	Percent	1,000 tons	Percent
Total:						
1987	45,339	67.0	10,081	14.9	12,274	18.1
1988	54,788	72.4	13,706	18.1	7,204	9.5
1989	42,435	62.4	15,434	22.7	10,109	14.9
1990	38,101	58.5	12,472	19.2	14,550	22.3
1991	40,587	56.2	13,688	18.9	18,007	24.9
1992	44,165	64.6	14,964	21.9	9,263	13.5
1993	46,581	64.8	12,516	17.4	12,778	17.8
1994	40,336	55.3	12,620	17.3	20,043	27.5
1995	42,692	66.1	12,153	18.8	9,738	15.1
1996	37,668	54.8	12,567	18.3	18,482	26.9
1997	34,421	54.0	11,836	18.6	17,471	27.4
1998	37,170	54.6	11,071	16.3	19,808	29.1
1999	37,599	54.3	12,353	17.8	19,271	27.8
2000	35,380	50.6	12,610	18.0	21,910	31.3
Export:						
1987	21,472	63.6	9,218	27.3	3,082	9.1
1988	28,600	64.1	12,888	28.9	3,151	7.1
1989	20,776	51.6	14,553	36.2	4,907	12.2
1990	15,937	58.1	11,260	41.0	248	0.9
1991	19,088	56.0	12,234	35.9	2,750	8.1
1992	19,805	51.2	13,831	35.8	5,011	13.0
1993	24,639	55.5	11,589	26.1	8,167	18.4
1994	14,883	44.2	11,932	35.5	6,832	20.3
1995	20,470	57.6	11,221	31.6	3,824	10.8
1996	19,985	56.4	11,629	32.8	3,805	10.7
1997	16,796	58.0	10,962	37.9	1,203	4.2
1998	18,824	62.6	10,177	33.8	1,069	3.6
1999	19,556	59.0	11,701	35.3	1,873	5.7
2000	17,934	56.4	12,021	37.8	1,825	5.7
Domestic:						
1987	23,867	70.4	863	2.5	9,192	27.1
1988	26,188	84.3	818	2.6	4,053	13.0
1989	21,659	78.1	880	3.2	5,201	18.7
1990	22,164	58.8	1,212	3.2	14,302	38.0
1991	21,499	56.3	1,454	3.8	15,257	39.9
1992	24,359	81.9	1,133	3.8	4,252	14.3
1993	21,942	79.8	927	3.4	4,611	16.8
1994	25,453	64.7	688	1.7	13,211	33.6
1995	22,222	76.4	932	3.2	5,914	20.3
1996	17,683	53.1	938	2.8	14,677	44.1
1997	17,626	50.7	875	2.5	16,268	46.8
1998	18,346	48.3	894	2.4	18,739	49.3
1999	18,043	50.0	652	1.8	17,398	48.2
2000	17,446	45.8	589	1.5	20,085	52.7

Figure 8–U.S. wheat domestic shipments by mode, 1987-2000

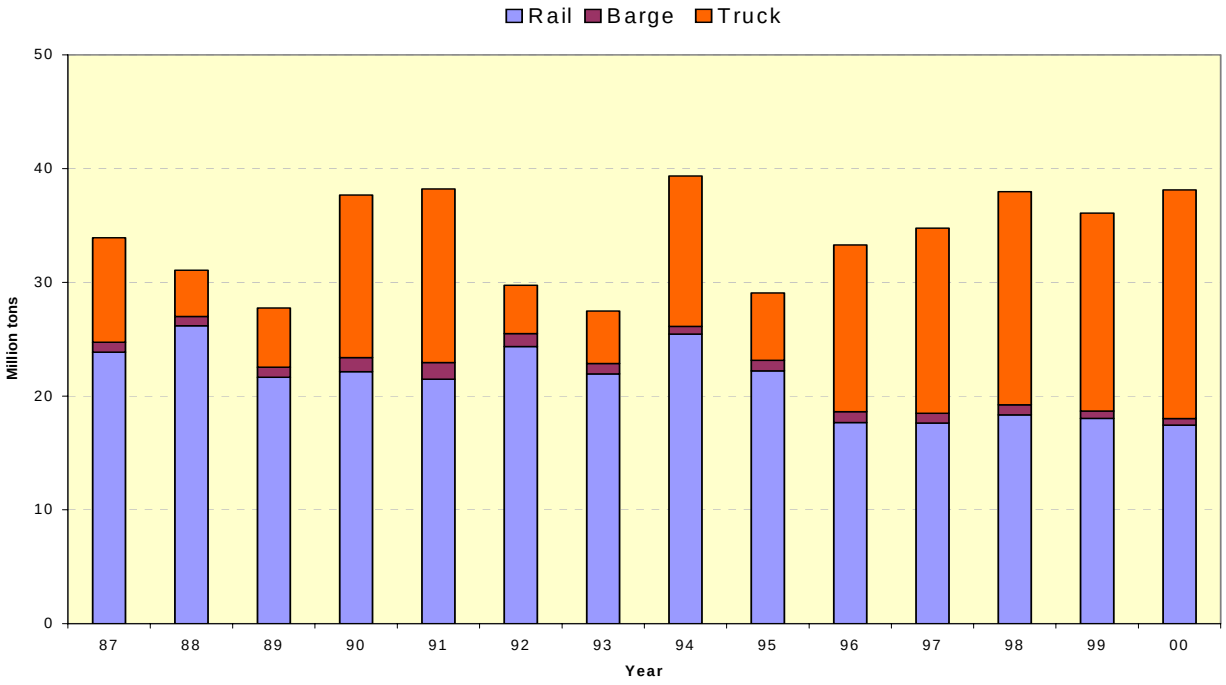
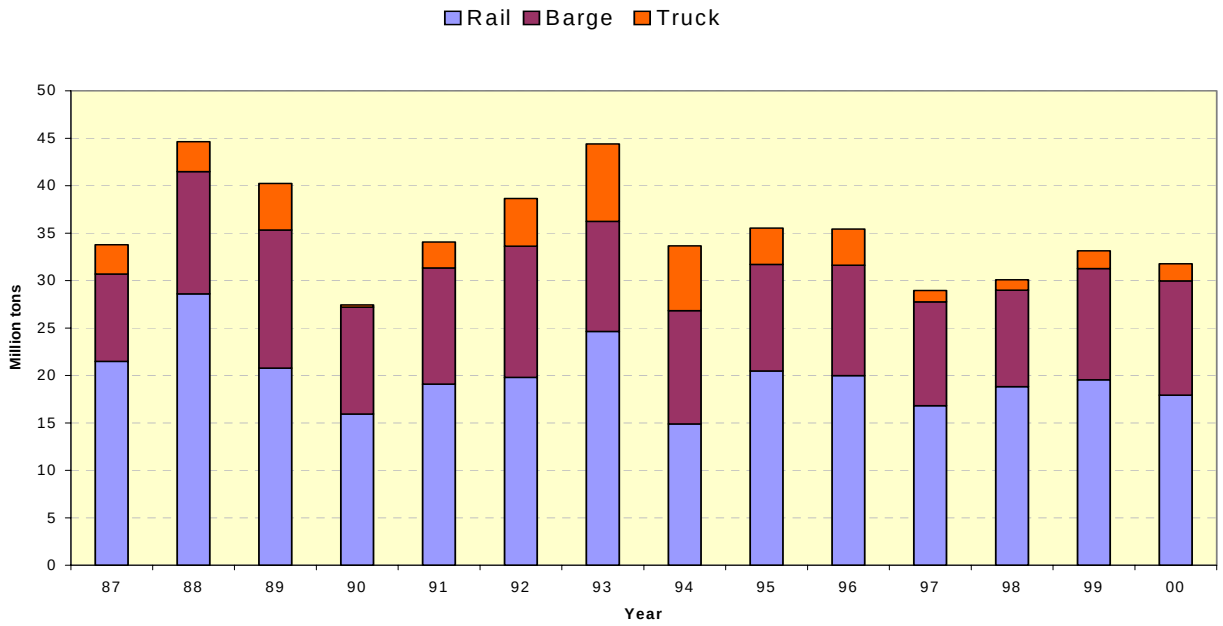


Figure 9–U.S. wheat export shipments by mode, 1987-2000



Soybeans

Soybeans are the predominantly grown oilseed in the United States. The United States is the world's largest producer and exporter of whole soybeans and typically exports 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 a number of industrial applications such as plastics, coatings and inks, lubricants, adhesives, and solvents. Soybean meal is primarily used as the major source of feed protein in the livestock industry but is used in small amounts for food products, such as bakery goods and meat substitutes.

Since 1998, the harvested acres of U.S. soybeans have exceeded 70 million acres. 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 1987 to 2000.

Tonnages Moved. From 1990 to 2000, soybean movements have increased from 54 million tons to 80 million tons, an increase of 48 percent.

Modal Shares. Barge is the prominent transport mode for moving soybeans to export facilities. From 1996 to 2000, barges moved about 66 percent of total inland movements of soybeans to coastal export locations. Railroads handled about 22 percent of exported soybeans, and trucks moved the remaining 12 percent.

Domestic movements of soybeans are dominated by truck, with about 71 percent of the traffic from 1996 to 2000. Rail moves about 24 percent of soybeans within the United States. Barge handles only about 5 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, 1987-2000

Year & type of movement	Mode of transport					
	Rail		Barge		Truck	
	1,000 tons	Percent	1,000 tons	Percent	1,000 tons	Percent
Total:						
1987	17,054	27.7	18,081	29.4	26,368	42.9
1988	16,382	29.1	13,706	24.3	26,230	46.6
1989	11,916	23.7	12,806	25.5	25,491	50.8
1990	13,440	25.0	15,965	29.6	24,443	45.4
1991	14,605	25.6	16,717	29.3	25,716	45.1
1992	16,118	26.0	18,265	29.4	27,665	44.6
1993	14,237	22.8	17,731	28.4	30,486	48.8
1994	14,754	23.9	17,049	27.6	30,052	48.6
1995	17,067	24.2	18,399	26.1	35,026	49.7
1996	18,863	27.2	20,408	29.5	29,996	43.3
1997	16,976	23.1	20,493	27.9	36,080	49.1
1998	16,476	21.4	18,072	23.5	42,300	55.0
1999	16,685	21.8	19,922	26.0	40,025	52.2
2000	17,257	21.4	20,242	25.1	43,153	53.5
Export:						
1987	5,155	22.0	16,640	71.0	1,632	7.0
1988	4,561	23.2	12,888	65.5	2,225	11.3
1989	3,480	21.0	11,393	68.7	1,709	10.3
1990	3,261	19.3	12,569	74.2	1,103	6.5
1991	3,962	20.5	14,966	77.4	396	2.0
1992	5,005	22.9	16,547	75.8	268	1.2
1993	4,657	21.8	15,476	72.3	1,277	6.0
1994	3,452	13.8	14,773	58.9	6,870	27.4
1995	5,572	22.5	16,308	65.9	2,880	11.6
1996	7,895	30.5	17,985	69.5	0 *	0.0 *
1997	7,912	30.0	18,152	68.9	277	1.0
1998	7,299	28.7	15,463	60.8	2,688	10.6
1999	8,189	31.7	17,271	66.9	370	1.4
2000	8,591	29.2	18,712	63.6	2,117	7.2
Domestic:						
1987	11,899	31.3	1,441	3.8	24,736	65.0
1988	11,821	32.3	818	2.2	24,005	65.5
1989	8,436	25.1	1,413	4.2	23,782	70.7
1990	10,179	27.6	3,396	9.2	23,340	63.2
1991	10,643	28.2	1,751	4.6	25,320	67.1
1992	11,113	27.6	1,718	4.3	27,397	68.1
1993	9,580	23.3	2,255	5.5	29,208	71.2
1994	11,302	30.7	2,276	6.2	23,182	63.1
1995	11,495	25.1	2,091	4.6	32,145	70.3
1996	10,968	25.3	2,423	5.6	29,996	69.2
1997	9,064	19.2	2,341	5.0	35,803	75.8
1998	9,177	17.9	2,609	5.1	39,612	77.1
1999	8,496	16.7	2,651	5.2	39,655	78.1
2000	8,666	16.9	1,529	3.0	41,036	80.1

* - insignificant amounts

Figure 10–U.S. soybean domestic shipments by mode, 1987-2000

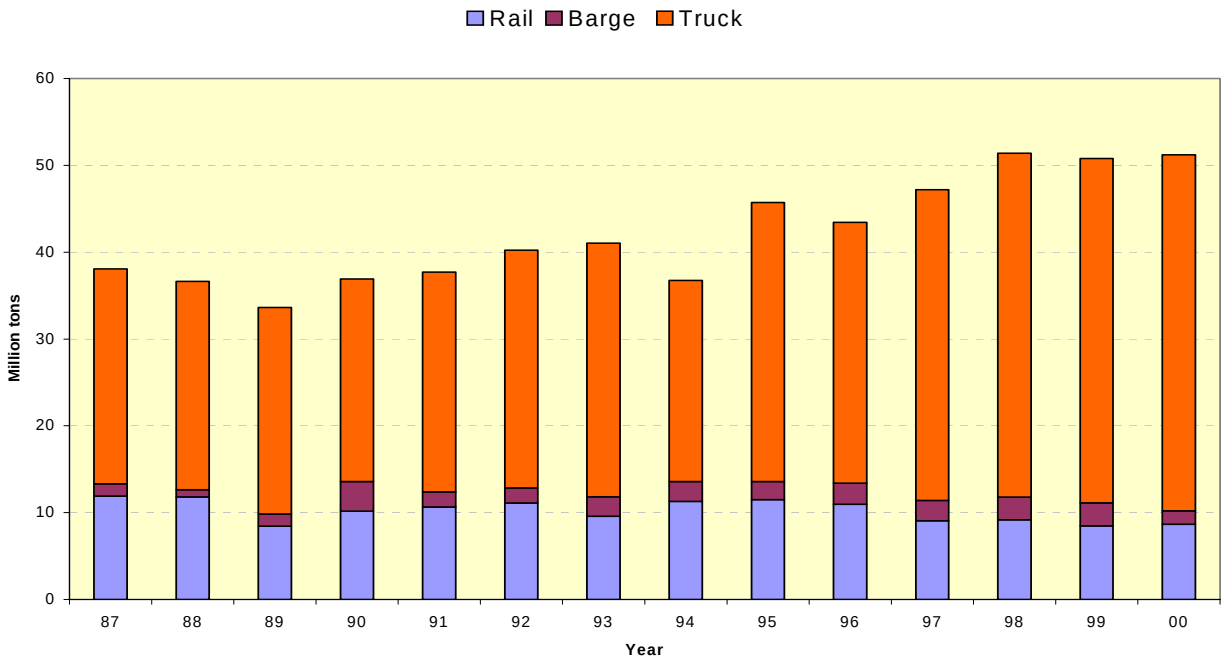
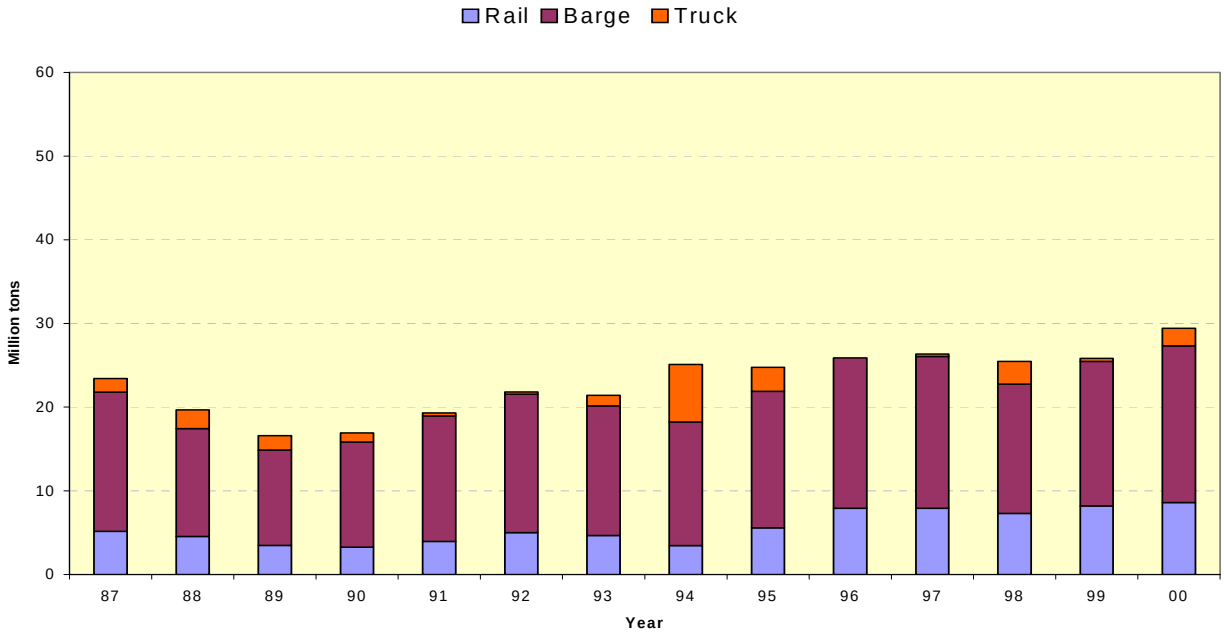


Figure 11–U.S. soybean export shipments by mode, 1987-2000



Sorghum

In 2000, there were 7.7 million acres of sorghum harvested in the United States.[6] Sorghum makes up about 5 percent of feed grain production in the United States.[7]

On average from 1995 to 2000, the United States exported 38 percent of its sorghum crop.[8] Table 6 shows tonnages and modal shares for sorghum from 1987 to 2000.

Tonnages Moved. From 1996 to 2000, sorghum movements have decreased from 16 million tons to 14 million tons. This is a decrease of nearly 13 percent.

Modal Shares. Truck is the prominent transport mode for moving sorghum to export facilities. From 1996 to 2000, trucks moved an average of 40 percent of total inland movements of sorghum to coastal export locations. Railroads handled about 37 percent of export sorghum, and barge moved the remaining 23 percent.

Domestic movements of sorghum are dominated by truck, with about 68 percent of the traffic from 1996 to 2000. Rail moved an average 32 percent of sorghum within the United States from 1996 to 2000. Barge handled less than 1 percent of domestic sorghum. Modal share trends for domestic and export sorghum movements are illustrated in figures 12 and 13.

[6] National Agrictultural Statitstics 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, 1987-2000

Year & type of movement	Mode of transport					
	Rail		Barge		Truck	
	1,000 tons	Percent	1,000 tons	Percent	1,000 tons	Percent
Total:						
1987	7,456	44.6	1,964	11.8	7,295	43.6
1988	7,040	31.9	2,200	10.0	12,814	58.1
1989	9,336	44.6	2,409	11.5	9,166	43.8
1990	9,088	45.5	2,912	14.6	7,961	39.9
1991	6,281	39.9	2,177	13.8	7,276	46.2
1992	6,906	40.6	2,938	17.3	7,175	42.2
1993	6,401	36.1	2,120	12.0	9,206	51.9
1994	5,028	28.3	2,335	13.2	10,375	58.5
1995	5,070	33.5	1,442	9.5	8,606	56.9
1996	4,602	27.7	1,521	9.2	10,493	63.2
1997	5,801	30.5	1,391	7.3	11,839	62.2
1998	4,710	33.4	1,208	8.6	8,197	58.1
1999	5,222	34.6	1,340	8.9	8,549	56.6
2000	4,626	31.8	1,329	9.1	8,597	59.1
Export:						
1987	3,044	55.4	1,924	35.0	527	9.6
1988	2,812	39.4	2,164	30.3	2,163	30.3
1989	5,044	54.8	2,345	25.5	1,823	19.8
1990	3,659	49.1	2,637	35.4	1,161	15.6
1991	3,364	51.5	2,161	33.1	1,005	15.4
1992	3,801	45.7	2,905	34.9	1,620	19.5
1993	2,846	42.8	2,095	31.5	1,703	25.6
1994	1,764	27.7	2,324	36.5	2,273	35.7
1995	2,202	36.1	1,430	23.4	2,471	40.5
1996	2,331	42.2	1,453	26.3	1,742	31.5
1997	3,074	53.3	1,379	23.9	1,316	22.8
1998	3,065	55.7	1,204	21.9	1,237	22.5
1999	4,197	66.5	1,338	21.2	774	12.3
2000	3,650	51.9	1,324	18.8	2,063	29.3
Domestic:						
1987	4,412	39.3	40	0.4	6,768	60.3
1988	4,228	28.3	36	0.2	10,651	71.4
1989	4,292	36.7	65	0.6	7,343	62.8
1990	5,429	43.4	276	2.2	6,800	54.4
1991	2,917	31.7	16	0.2	6,271	68.1
1992	3,105	35.7	33	0.4	5,555	63.9
1993	3,555	32.1	25	0.2	7,503	67.7
1994	3,264	28.7	11	0.1	8,102	71.2
1995	2,868	31.8	12	0.1	6,135	68.1
1996	2,271	20.5	68	0.6	8,752	78.9
1997	2,728	20.6	12	0.1	10,523	79.3
1998	1,645	19.1	3	0.0	6,959	80.9
1999	1,025	11.6	2	0.0	7,775	88.3
2000	976	13.0	5	0.1	6,534	87.0

Figure 12–U.S. sorghum domestic shipments by mode, 1987-2000

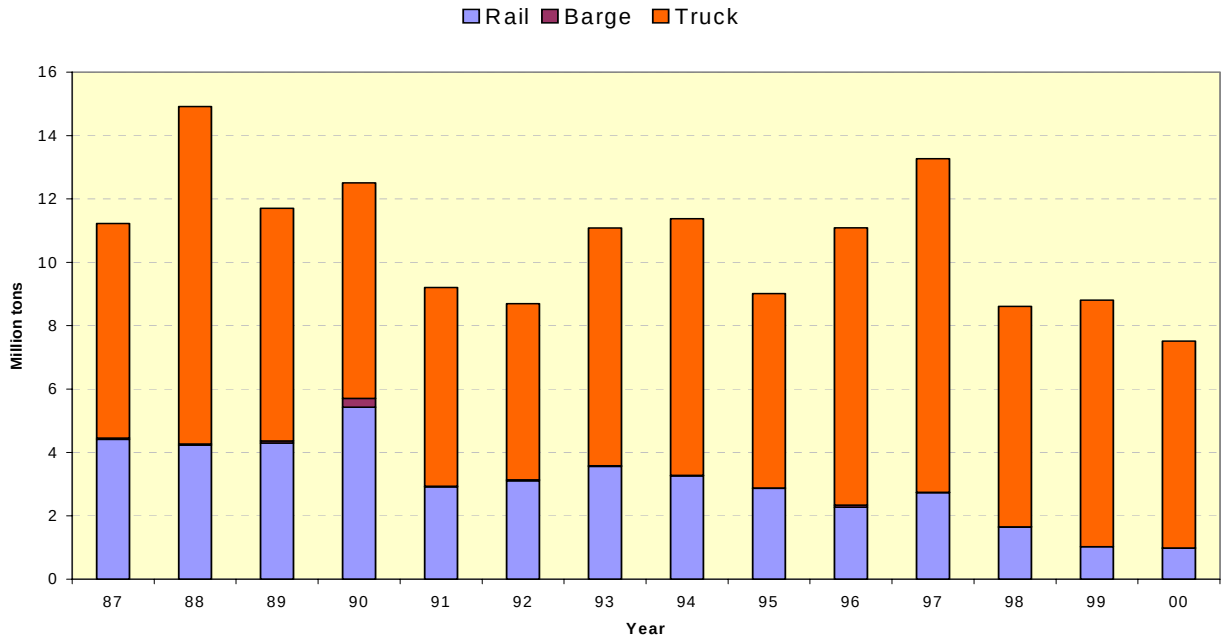
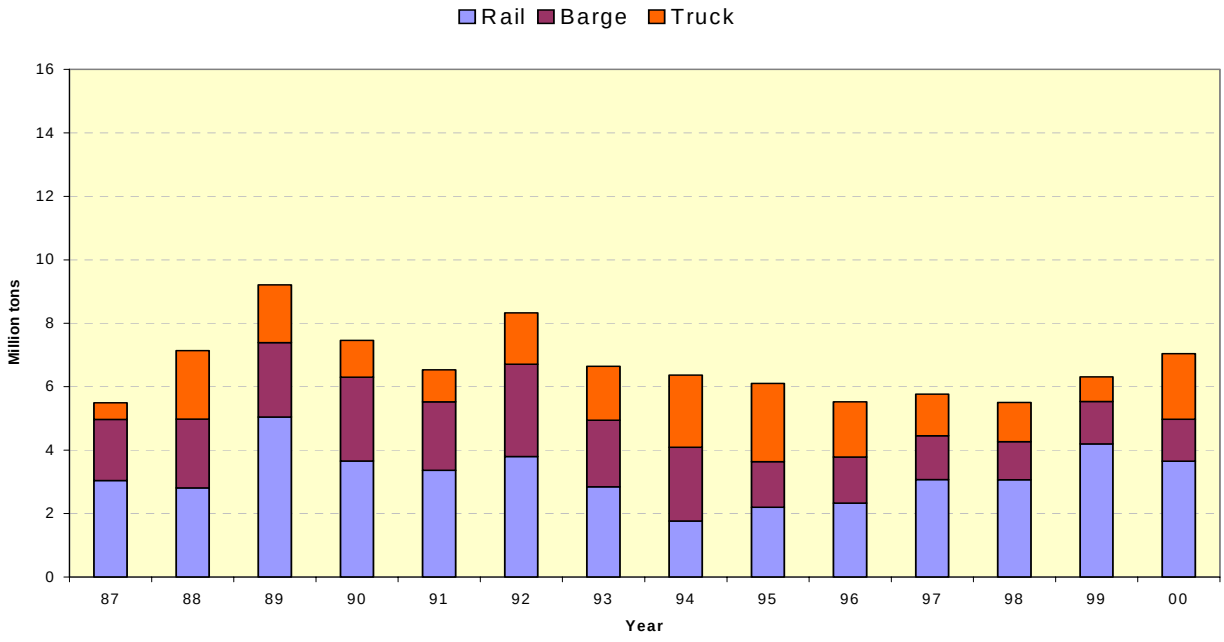


Figure 13–U.S. sorghum export shipments by mode, 1987-2000



Barley and Rye

Barley and rye make up 3.2 percent of all U.S. grain movements (table 1). These commodities are primarily consumed in the domestic market.

The United States harvested 5.5 million acres of barley and rye in 2000.[9]

On average from 1995 to 2000, the United States exported 14 percent of its barley and rye crops.[10] Table 7 shows tonnages and modal shares for barley and rye from 1987 to 2000.

Tonnages Moved. From 1990 to 2000, barley and rye movements followed a downward trend from 10 million tons to 7 million tons, a decrease of 30 percent.

Modal Shares. Rail is the prominent transport mode for moving barley and rye to export facilities. Domestic movements of barley and rye are dominated by rail, with about 59 percent of the traffic from 1996 to 2000. Truck moved an average of 40 percent of barley and rye within the United States from 1996 to 2000. Barge handled about 1 percent of domestic barley and rye. Modal share trends for domestic and export barley and rye movements are illustrated in figures 14 and 15.

[9] National Agrictultural Statitstics Service, USDA, Barley and Rye http://www.usda.gov/nass/.
[10] *Feed Outlook Report*, Economic Research Service, USDA www.ers.usda.gov.

Table 7–Tonnages and modal shares for U.S. barley and rye, 1987-2000

Year & type of movement	Mode of transport					
	Rail		Barge		Truck	
	1,000 tons	Percent	1,000 tons	Percent	1,000 tons	Percent
Total:						
1987	6,717	55.2	765	6.3	4,695	38.6
1988	6,433	56.9	703	6.2	4,168	36.9
1989	5,565	58.9	486	5.1	3,401	36.0
1990	5,962	56.7	488	4.6	4,068	38.7
1991	5,315	51.7	682	6.6	4,275	41.6
1992	5,886	63.4	602	6.5	2,800	30.1
1993	5,260	59.8	533	6.1	2,998	34.1
1994	6,662	61.2	297	2.7	3,925	36.1
1995	6,509	69.3	690	7.3	2,195	23.4
1996	4,388	48.6	331	3.7	4,308	47.7
1997	4,147	49.8	553	6.6	3,622	43.5
1998	3,411	45.4	310	4.1	3,788	50.4
1999	3,741	51.3	307	4.2	3,247	44.5
2000	3,339	45.1	478	6.4	3,593	48.5
Export:						
1987	2,009	60.1	763	22.8	571	17.1
1988	1,621	67.4	703	29.2	81	3.4
1989	1,002	50.5	483	24.3	499	25.1
1990	1,241	52.0	462	19.4	684	28.6
1991	758	45.4	611	36.6	302	18.1
1992	982	48.0	564	27.6	500	24.5
1993	557	33.5	522	31.4	584	35.1
1994	738	43.3	254	14.9	713	41.8
1995	701	51.2	574	41.9	94	6.9
1996	567	46.6	285	23.5	364	29.9
1997	969	54.8	458	25.9	340	19.3
1998	359	54.7	259	39.5	38	5.8
1999	512	64.1	287	35.9	0 *	0.0 *
2000	681	60.3	449	39.7	0 *	0.0 *
Domestic:						
1987	4,708	53.3	2	0.0	4,124	46.7
1988	4,812	54.1	0	0.0	4,087	45.9
1989	4,563	61.1	3	0.0	2,902	38.9
1990	4,721	58.1	26	0.3	3,384	41.6
1991	4,557	53.0	71	0.8	3,973	46.2
1992	4,904	67.7	38	0.5	2,300	31.8
1993	4,703	66.0	11	0.2	2,414	33.9
1994	5,924	64.5	43	0.5	3,211	35.0
1995	5,808	72.4	116	1.4	2,102	26.2
1996	3,821	48.9	46	0.6	3,943	50.5
1997	3,178	48.5	95	1.4	3,281	50.1
1998	3,052	44.5	51	0.7	3,749	54.7
1999	3,229	50.2	20	0.3	3,247	49.5
2000	2,657	42.3	29	0.5	3,593	57.2

* - insignificant amounts

Figure 14–U.S. barley and rye domestic shipments by mode, 1987-2000

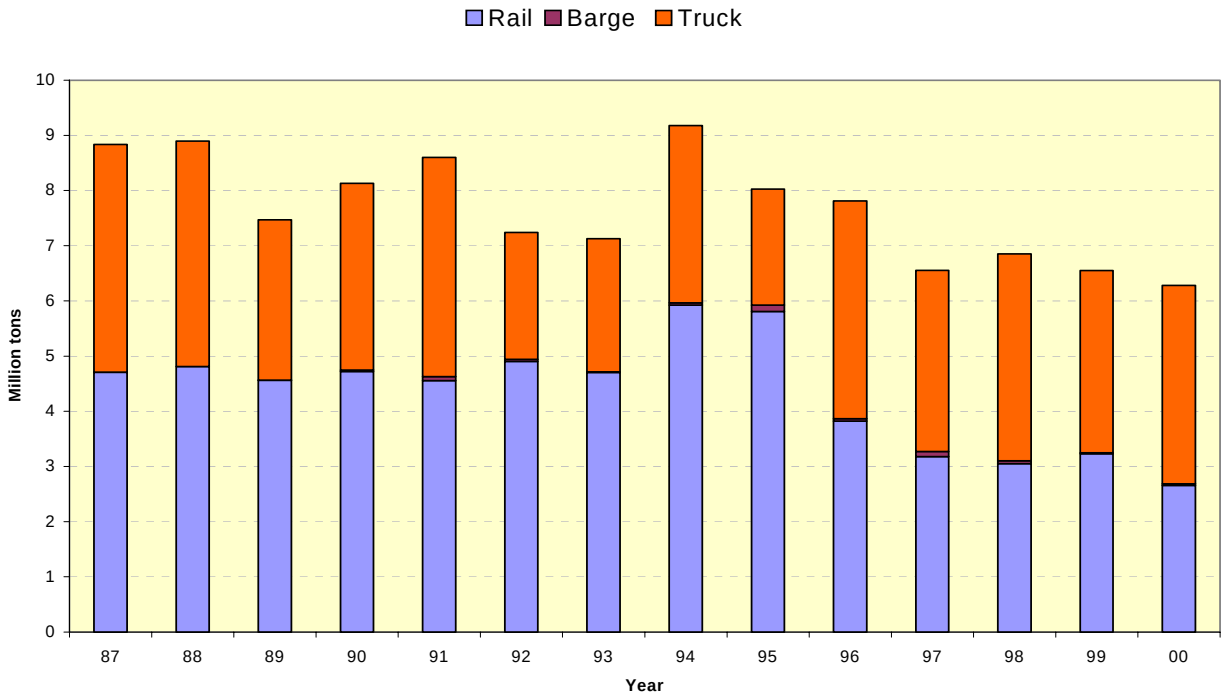
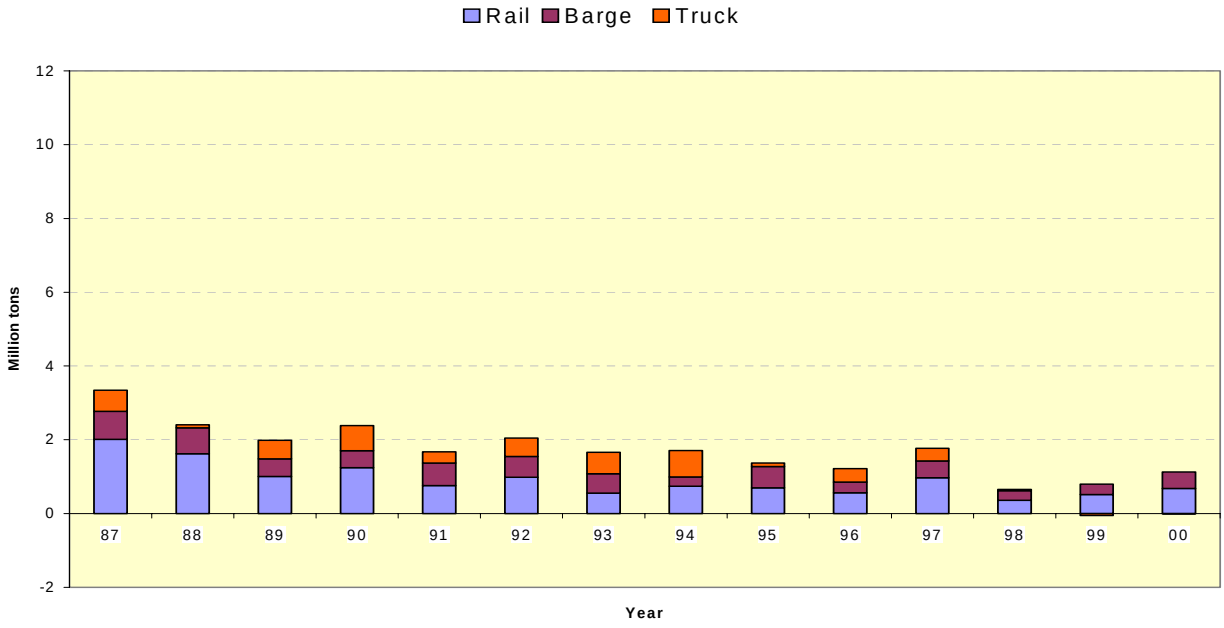


Figure 15–U.S. barley and rye export shipments by mode, 1987-2000



Conclusion

The most significant trends during 1978-2000 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. Off-farm feeding increased as the livestock industry, in general, expanded through a variety of structural changes that have meant fewer but larger feeders located outside traditionally surplus grain production regions. Off-farm demand for grain also increased as industrial uses, especially those for corn and its processed products, expanded. The tonnages of grain moved to export showed a high degree of variability during the 23-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 69 percent from 238 million tons in 1978 to 402 million tons in 2000. The absolute tonnages transported by each mode also increased. Between 1978 and 2000, rail tonnages increased 5 percent from 117 million tons to 123 million tons, barge tonnages increased 43 percent from 51 million tons to 73 million tons, and truck tonnages increased 168 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 2000 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 began in 1978 at 48.4 percent, had decreased to 33 percent by 2000. Rail share gains in soybeans were negated by losses in corn, wheat, and sorghum movements. Barge share, 21 percent in 1978, had decreased slightly to 18 percent by 2000. Truck share displayed a general upward trend from 30.6 percent in 1978 to 49 percent in 2000. Truck share increased in all grain movements except soybeans, where it held steady throughout the 23-year period.

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. 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* (Washington, DC: AAR), and for 1988-1995 from the Interstate Commerce Commission (ICC), *Carload Waybill Sample* (Washington, DC: 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.[11] [12] 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.

[11] Interstate Commerce Commission, *Carload Waybill Sample*, 1995 (Washington, DC: ICC).

[12] Association of American Railroads, APT Report No. 2,@ 1995 (Washington, DC: AAR, Transportation Division).

Appendix B: FIPS Regions Included in Rail Export Tonnages[13]

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

[13] 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