United States Department of Agriculture

Agricultural Marketing Service

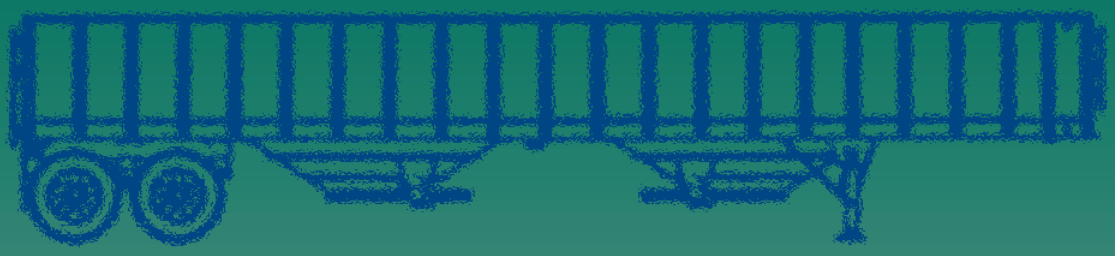
Transportation and Marketing

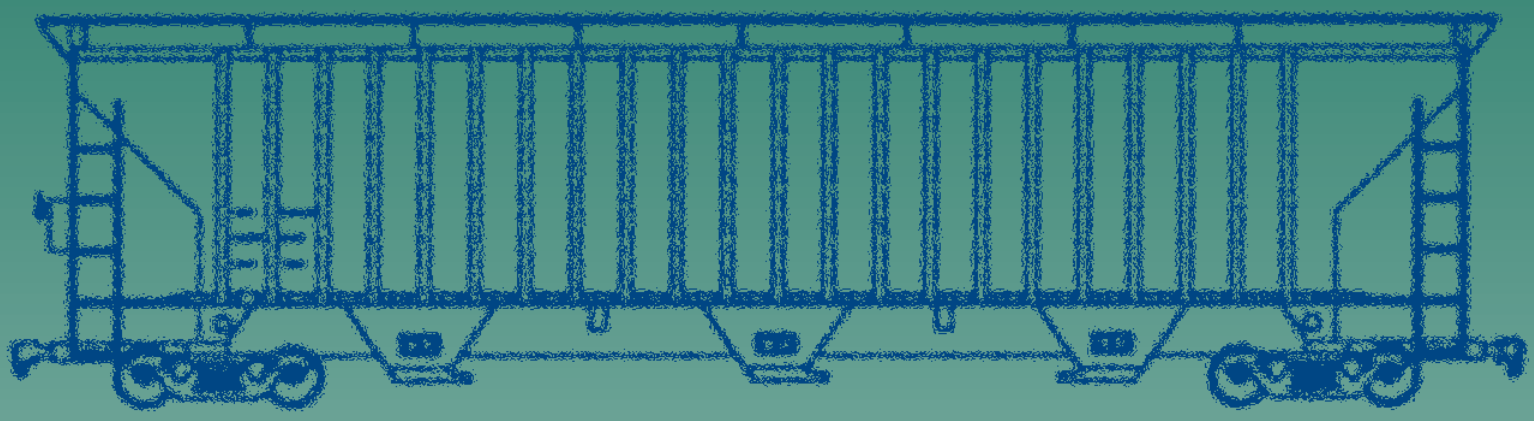
Marketing and Transportation Analysis Program

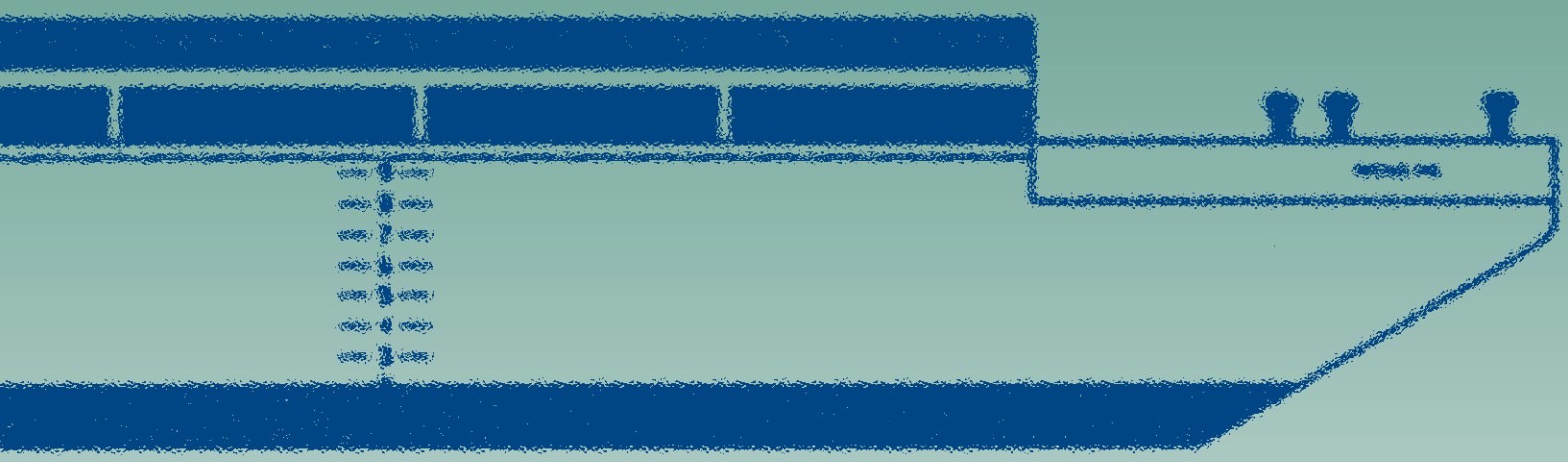
March 1998

Transportation of U.S. Grains

A Modal Share Analysis, 1978-95







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Abstract

This analysis of grain movements by transport mode updates a 1992 study. It provides information about changes in the competitiveness and relative efficiencies between the modes. The goal of this analysis was to estimate the tonnages of grain railed, barged, and trucked, using secondary data sources. The types of grains identified were corn, wheat, soybeans, sorghum, barley and rye, and oats. The types of movements identified were the final grain movements to domestic markets and those to ports for export.

Key words: Grain transportation, grain movements, modal shares

Transportation of U.S. Grains
A Modal Share Analysis, 1978-95

by
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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 between 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 1978-95, updates a 1992 report, which covered the years 1978-89.

The amount of grain moved in the United States increased significantly from 1978 to 1995. 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 1978-95. Movements reached a record total of 380.3 million tons in 1995, up 57 percent from 241.8 million tons in 1978. Nearly all of this growth resulted from a large increase in domestic grain movements, up 101 percent from 1978. Export movements peaked in 1981 at 144 million tons and bottomed in 1986 at just under 87 million tons.

Significant changes in modal share occurred during 1978-95, particularly between rail and truck modes. Although all modes increased tonnages, rail and barge shares decreased, while truck share increased through 1995, making truck the predominant mode of grain transport in the United States. The rail share of domestic and export grain movements decreased during 1984-95, although domestic movements increased in 1989 and the export share increased during 1990-92. The barge share of export movements remained relatively flat, increasing slightly during 1984-95. The barge share of domestic grain traffic decreased from 1984 to 1995. The truck share of export movements decreased from 1984 to 1988; increased in 1989, followed by lower shares during 1990-92; and then increased once again through 1995. The truck share of domestic movements increased from 1984 to 1995.

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 between 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 lack 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.[1] 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, and oats. Transport movements were identified as the final grain movement going to domestic markets and to ports for export.

The estimates of modal tonnages and shares were based on the amount of grain moved to commercial markets. Barge and rail tonnages were taken from secondary sources.[2] Truck tonnages were estimated by subtracting barge

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[1]For a listing of other modal share analyses of U.S. grain, see individual commodity flow and transportation requirement studies from 1977 and 1985 listed in the bibliography.

[2]Rail grain volumes were taken from two sources. Volumes for 1978-87 were taken from the American Association of Railroads, *Commodity Freight Statistics* (Washington, DC: AAR), and for 1988-95 from the Interstate Commerce Commission, *Carload Waybill Sample* (Washington, DC: ICC). Export rail grain volumes between 1984-95 were estimated from the waybill sample. Sampling techniques and reporting methodology of the ICC prior to 1984 were reported at a one percent sample and in 1984, the ICC automated the data sampling technique. Export and domestic rail data for 1984-95, by grain, reported in this report, reflect the ICC’s automated sampling procedure.

Data reported in the waybill prior to 1984 from the Carload Waybill Sample Reporting for export rail grain volumes Export Barge grain volumes were taken from the U.S. Army Corps of Engineers' *Waterborne Commerce of the United States*,

(continued...)

and rail tonnages from total tonnages transported. Estimates of truck tonnages are equivalent to the amount of grain moved, but not transported by barge or rail. This procedure is illustrated in figure 1.

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. There are instances where barge and rail are used in combination to ship grain. One example is the rail movement of corn along the middle and upper Mississippi River and the Illinois River to barge-loading facilities. However, for the scope of this analysis, only the barge movement was included since it was the final mode to transport that grain. Such shipments are small, however, in relation to the total amount of grain transported in the United States. There are other instances where grain shipments are re-billed from one railroad to another at terminal markets. Such a movement would be considered a double count of grain movements. Such re-billed movements were removed from the analysis to eliminate double counting. Again, as with the rail-to-barge movements, these types of shipments represent a small portion of total rail shipments.

Estimated Tonnages Transported

The approach used to estimate modal tonnages and shares required that total tonnages of grain transported to market be determined. It was also necessary to determine the portions of total tonnages transported to domestic and export markets.

Total tonnages of grain transported were defined as the total U.S. grain disappearance[3] less the amount of grain "grown and used on farm."[4] Grain grown and used on farm must be deducted from total disappearance because it generates no commercial transportation demand. Export grain tonnages were defined as the amount of grain exported. Domestic grain tonnages were determined by subtracting export tonnages from total tonnages transported.

Estimated Modal Shares

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

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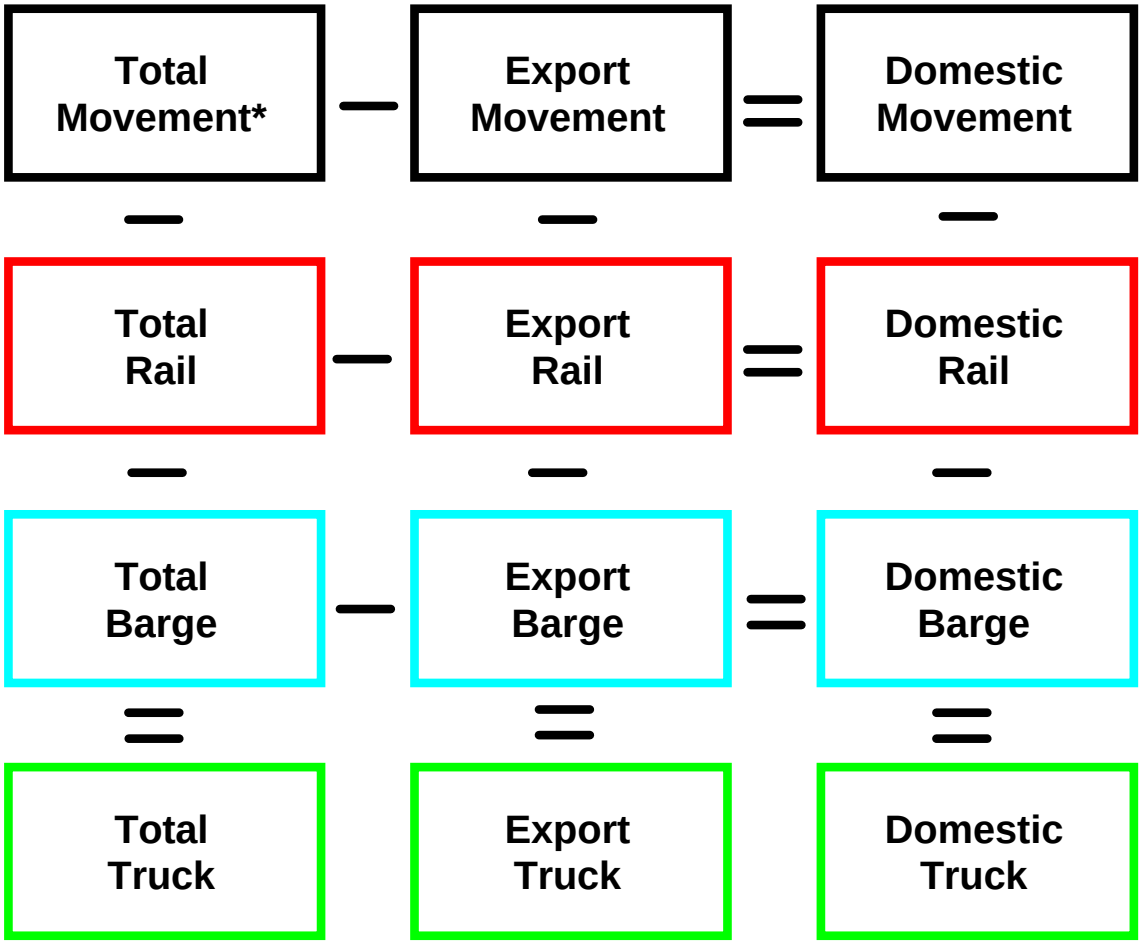
[2](...continued)
1978-95.

[3]Total disappearance is reported by the USDA Economic Research Service, Situation and Outlook Reports, by crop, based on marketing years which vary from crop to crop. These disappearance numbers were converted to calendar-year equivalents by determining each quarter's monthly average and aggregating the appropriate monthly values by calendar year. For a more complete explanation of these movement estimates, see "Appendix B," Jerry D. Norton and Keith A. Klindworth, *Railcars for Grain: Future Need and Availability* (Washington, DC: U.S. Department of Agriculture, Office of Transportation, July 1989), pp. 41.

[4]"Grown and used on farm" data are those reported by the USDA Statistical Reporting Service prior to 1981 as "Used on farms where grown." Data from 1981 through 1995 were supplied by the USDA Economic Research Service and represent an estimated continuation of the earlier "Used on farms where grown" data series.

Figure 1--Model for estimating modal tonnages and share



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

Total Modal Shares Total grain movement modal shares were calculated using shipment tonnage sums for each selected grain.[5]

Export Modal Shares Export barge modal shares were calculated using barge export tonnages based on internal grain and oilseed receipts reported on the Inland Waterway System. Those 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 Intercoastal Waterway; 6) Beaumont and Port Arthur, TX; 7) Galveston Bay (including Houston), TX; 8) Corpus

[5]For this analysis, it is assumed that corn, wheat, soybeans, sorghum, barley and rye, and oats represent all grain movements. These seven grains represent greater than 99 percent of all grain and oilseed production, excluding rice which is not traditionally transported bulk.(USDA National Agriculture Statistic Service,1996).

Christi, TX, and the Gulf Intercoastal Waterway ports between Corpus Christi and the Mexican border; and 9) Hampton Roads and Norfolk, VA, on the Chesapeake Bay.

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 (waybill) and data on grain car releases from ports.[6] [7] 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, to 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.

This approach could not be used to determine rail exports to Mexico or through the Great Lakes ports because data on grain car releases are not available for these export rail movements. Rail exports to Mexico were determined from the waybill based on shipments of grain to U.S./Mexico border-crossing points. Rail exports to the Great Lakes were determined from grain delivery information at Duluth-Superior, MN, and Toledo, OH, and export data for these ports.[8] Total export rail tonnages were determined by aggregating the crops and ports.

Export truck modal shares were determined using estimated truck export tonnages. Total export tonnages minus barge and rail export tonnages determined the estimated truck export tonnages.

Domestic Modal Shares Total rail and barge tonnages minus export rail and barge tonnages equals the estimated domestic rail and barge tonnages. Estimated total truck tonnages minus estimated export truck tonnages equals estimated domestic truck tonnages. This is equivalent to the difference between domestic rail and barge tonnages and total domestic movement tonnages.

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

[7]Association of American Railroads, "PT Report No. 2," 1995 (Washington, DC: AAR, Transportation Division).

[8]Grain delivery information for Duluth-Superior was taken from data reported by the Minneapolis Grain Exchange, Minneapolis, MN. Grain delivery information for Toledo was taken from data reported by the Toledo Board of Trade, Toledo, OH. For a more complete explanation of the method use to estimate rail export tonnages for the Great Lakes ports, see Jerry D. Norton and Keith A. Klindworth, *Railcars for Grain: Future Need and Availability* (Washington, DC: U.S. Department of Agriculture, Office of Transportation, July 1989), pp. 46-47.

Grain Tonnages Moved and Modal Shares

The total amount of grain moved in the United States increased significantly during 1978-95. Significant changes also occurred in the type of grain moved and the amount shipped to domestic and export markets.

All Selected Grains

Corn, wheat, soybeans, sorghum, barley and rye, and oats represent nearly all grain movements in the United States. Movement and modal share trends for all selected grains are influenced by corn, wheat, and soybean crop production trends. Together, these three grains accounted for more than 90 percent of all grain movements during 1978-95.

Tonnages Moved Total grain tonnages transported during 1978-95 showed a strong increase. Movements reached a record total of 380.3 million tons in 1995, up 57 percent from 241.8 million tons in 1978 (table 1). Increased domestic grain movements, up 101 percent from 1978 to 1995, influenced this upward trend (figure 2). These domestic increases are attributable to increased domestic corn movements.

Grain export movements varied considerably while trending downward relative to total grain movements during 1978-95 (figure 2). In 1978, grain exports accounted for 49.3 percent of total movements, and by 1995 had decreased to 35 percent. Export movements peaked in 1981 at 144 million tons and bottomed in 1986 at just under 87 million tons. A strong dollar, increased competition from other grain-producing countries, and a strong domestic market left U.S. grain exports relatively flat during 1987-95. Countries like those of the European Economic Community, which once imported sizeable volumes of U.S. grains, now compete with the United States in foreign markets. Larger production and surpluses in other grain-producing countries like Argentina, Brazil, Canada, and Australia have also increased competitive pressure on U.S. grains in the world market.

General upward trends in grain movements developed between 1978 and 1995 for most grains, despite a decrease in 1989. One factor explaining this decrease is the 1988 drought. Droughts cause production decreases and less grain is available for transport the following year. Livestock feeders tend to increase grain feedings to compensate for the loss in forage production. Droughts also change transportation and storage patterns as processors move grains from different areas or liquidate on-hand stocks. After the low movement year of 1989, it took 4 years to achieve volumes similar to those experienced in 1988. In a similar situation, 1994 data reflect flood impacts of 1993. The 1993 flood caused a decrease in corn and soybean production, two key crops, and affected modal selection for transport. The 1993 flood decreased grain movements in 1994, but they remained above 1989 levels and rebounded in 1995, to establish a new record. These factors not only impact total tonnages, but also modal shares. Changes in grain tonnages moved by commodity for 1978-95 are illustrated in figure 3.

Modal Shares Modal utilization is highly dependent upon the grain mix being transported. Wheat producers, for example, use rail transportation, because most wheat is produced beyond the effective reach of water transportation. As a consequence, changes in the amount of wheat moved affect railroad tonnages much more than barge or truck tonnages. Changes in corn exports, however, affect barge tonnages much more than other modes, because of the proximity of corn production to the Inland Waterway System and the access it offers to port facilities at the mouth of the Mississippi River in Louisiana.The tonnages moved by all modes have increased substantially during 1978-95 (table 2). During this period, rail tonnages increased 29.9 percent, from 117 to 152 million tons and barge tonnages increased 45.1 percent, from 51 to 74 million tons. Truck tonnages, however, more than doubled over the 18-year period, increasing from 74 to 155 million tons (figure 4).

Substantial shifts in modal share took place during 1978-95. Prior to 1985, rail was consistently the dominant mode for grain shipments in the United States. During the late 1980s, truck and rail had similar shares, but by

Table 1--Tonnages of U.S. grains transported by type of crop and type of movement, 1978-95

Year	Corn	Wheat	Soybeans	Sorghum	Barley & Rye	Oats	All Grains
				1,000 Tons			
Total:							
1978	102,198	61,471	53,879	13,281	7,165	3,813	241,807
1979	122,470	59,213	56,408	13,391	7,878	4,419	263,779
1980	142,869	62,725	59,452	11,808	8,493	4,158	289,505
1981	114,028	72,829	56,889	10,611	8,314	3,479	266,150
1982	116,188	70,701	61,177	13,276	7,914	2,170	271,426
1983	122,200	72,655	58,767	13,037	10,461	3,605	280,725
1984	125,854	79,725	52,732	17,837	11,116	3,930	291,194
1985	133,187	58,697	52,050	18,908	10,245	3,893	276,980
1986	124,368	60,078	58,339	17,153	12,177	4,142	276,257
1987	165,230	67,694	61,503	16,715	12,406	3,946	327,494
1988	177,003	75,698	56,318	22,054	11,304	3,789	346,165
1989	165,066	67,977	50,213	20,912	9,451	2,950	316,568
1990	171,990	65,123	53,849	19,961	10,517	3,451	324,890
1991	172,122	72,283	57,038	15,734	10,272	3,759	331,208
1992	176,473	68,392	62,049	17,019	9,288	3,117	336,337
1993	190,562	71,875	62,454	17,727	8,791	3,513	354,922
1994	167,348	72,999	61,855	17,738	10,884	3,385	334,208
1995	217,515	64,583	70,492	15,118	9,394	3,223	380,325
Exports:							
1978	55,162	37,584	22,822	2,680	716	206	119,170
1979	65,233	36,799	23,027	6,524	862	49	132,494
1980	69,492	39,407	24,006	8,813	1,798	107	143,623
1981	60,347	48,409	24,064	8,818	2,350	140	144,128
1982	53,780	44,954	28,081	6,630	1,522	42	135,009
1983	52,391	42,401	25,027	5,821	1,703	23	127,366
1984	53,947	46,566	21,476	7,487	2,187	16	131,679
1985	48,559	27,342	18,617	7,333	779	13	102,643
1986	29,795	27,152	23,566	4,559	1,803	34	86,909
1987	44,993	33,772	23,427	5,496	3,344	17	111,049
1988	51,211	44,640	19,674	7,140	2,405	14	125,084
1989	62,213	40,237	16,582	9,212	1,984	13	130,241
1990	57,450	27,445	16,933	7,456	2,386	11	111,681
1991	48,683	34,072	19,324	6,530	1,671	9	110,289
1992	47,349	38,647	21,820	8,326	2,047	79	118,268
1993	44,288	44,395	21,410	6,645	1,663	81	118,482
1994	39,198	33,647	25,096	6,362	1,706	16	106,024
1995	65,200	35,515	24,760	6,103	1,368	18	132,964
Domestic:							
1978	47,036	23,887	31,057	10,601	6,449	3,607	122,637
1979	57,237	22,414	33,381	6,867	7,016	4,370	131,285
1980	73,377	23,318	35,446	2,995	6,695	4,051	145,882
1981	53,681	24,420	32,825	1,793	5,964	3,339	122,022
1982	62,408	25,747	33,096	6,646	6,392	2,128	136,417
1983	69,809	30,254	33,740	7,216	8,758	3,582	153,359
1984	71,907	33,159	31,256	10,350	8,929	3,914	159,515
1985	84,628	31,355	33,433	11,575	9,466	3,880	174,337
1986	94,573	32,926	34,773	12,594	10,374	4,108	189,348
1987	120,237	33,922	38,076	11,219	9,062	3,929	216,445
1988	125,792	31,058	36,644	14,914	8,899	3,775	221,081
1989	102,853	27,740	33,631	11,700	7,467	2,937	186,327
1990	114,540	37,678	36,916	12,505	8,131	3,440	213,209
1991	123,439	38,211	37,714	9,204	8,601	3,750	220,920
1992	129,124	29,745	40,229	8,693	7,241	3,038	218,069
1993	146,274	27,480	41,043	11,082	7,128	3,432	236,439
1994	128,150	39,352	36,759	11,376	9,178	3,369	228,184
1995	152,315	29,068	45,732	9,015	8,026	3,205	247,361

Figure 2--Total grain movements to domestic and export markets, 1978-95

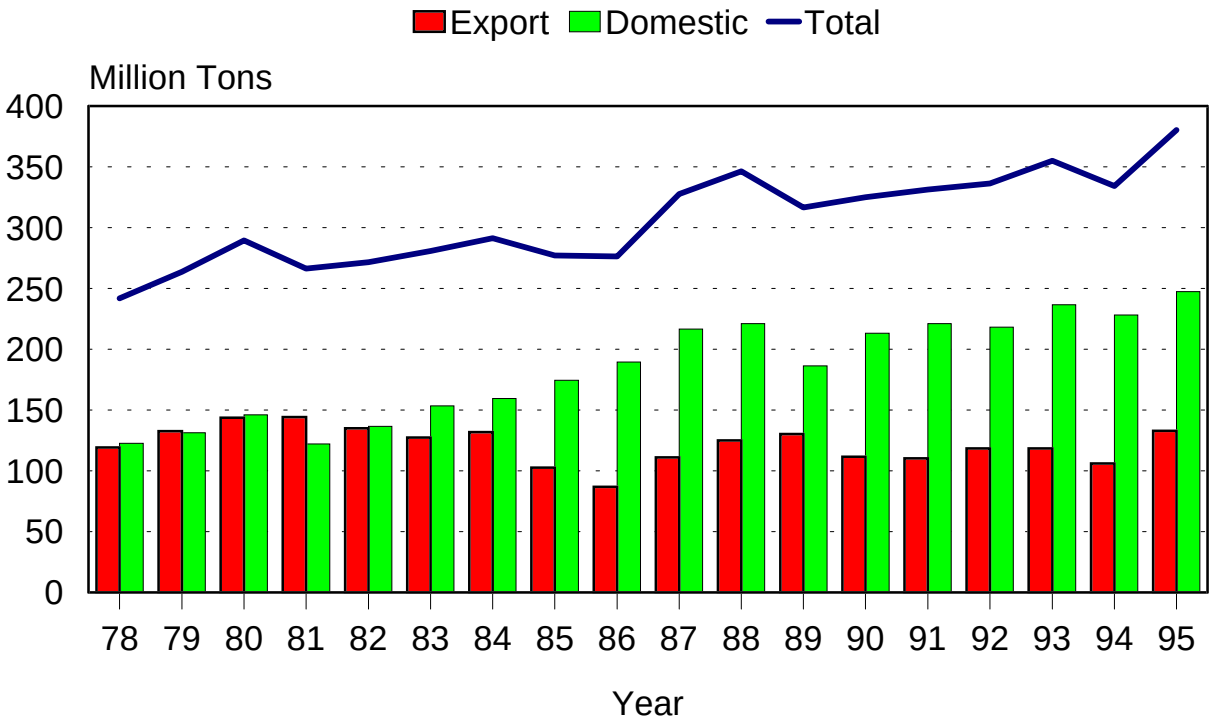


Figure 3--U.S. grain shipments by commodity, 1978-95

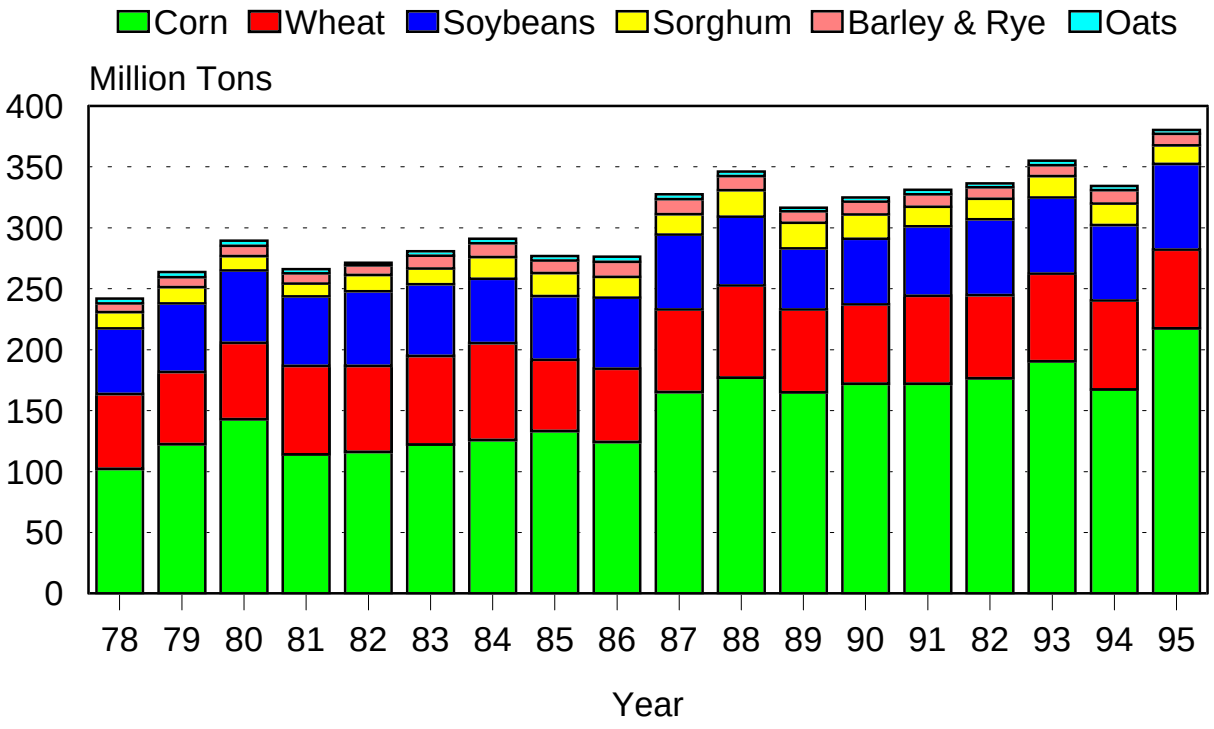
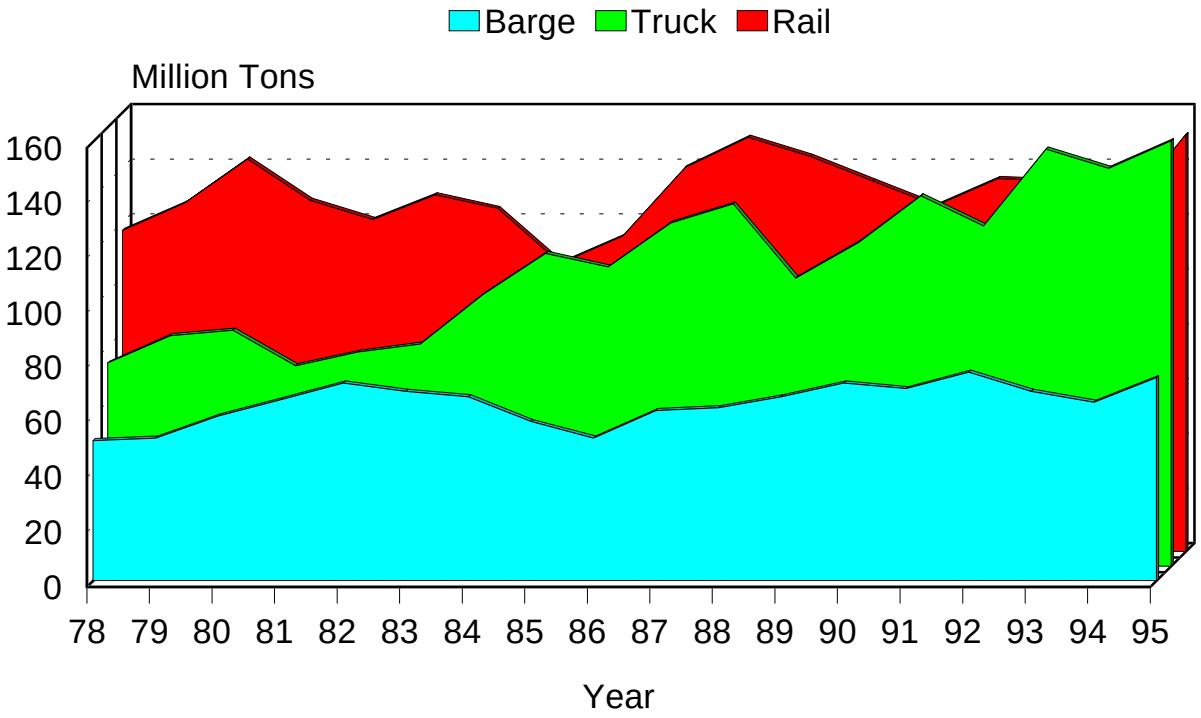


Table 2--Tonnages and modal shares for all U.S. grains, 1978-95

Year & Type of Movement	Mode of Transport					
	Rail		Barge		Truck	
	1,000 Tons	Percent	1,000 Tons	Percent	1,000 Tons	Percent
Total:						
1978	117,087	48.4%	50,814	21.0%	73,905	30.6%
1979	127,177	48.2%	52,207	19.8%	84,396	32.0%
1980	143,402	49.5%	60,495	20.9%	85,608	29.6%
1981	127,581	47.9%	65,504	24.6%	73,065	27.5%
1982	121,188	44.6%	71,855	26.5%	78,383	28.9%
1983	130,457	46.5%	69,078	24.6%	81,191	28.9%
1984	124,984	42.9%	66,808	22.9%	99,401	34.1%
1985	105,086	38.0%	57,806	20.9%	113,823	41.1%
1986	115,094	41.7%	51,835	18.8%	109,327	39.6%
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%
Export:						
1984	58,247	44.2%	60,194	45.7%	13,238	10.1%
1985	40,466	39.4%	51,554	50.2%	10,623	10.3%
1986	34,892	40.1%	45,108	51.9%	6,908	7.9%
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%
Domestic:						
1984	66,737	41.8%	6,614	4.1%	86,163	54.0%
1985	64,620	37.1%	6,252	3.6%	103,200	59.3%
1986	80,202	42.4%	6,726	3.6%	102,419	54.1%
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%

Figure 4--Tonnages of all U.S. grains transported by mode, 1978-95



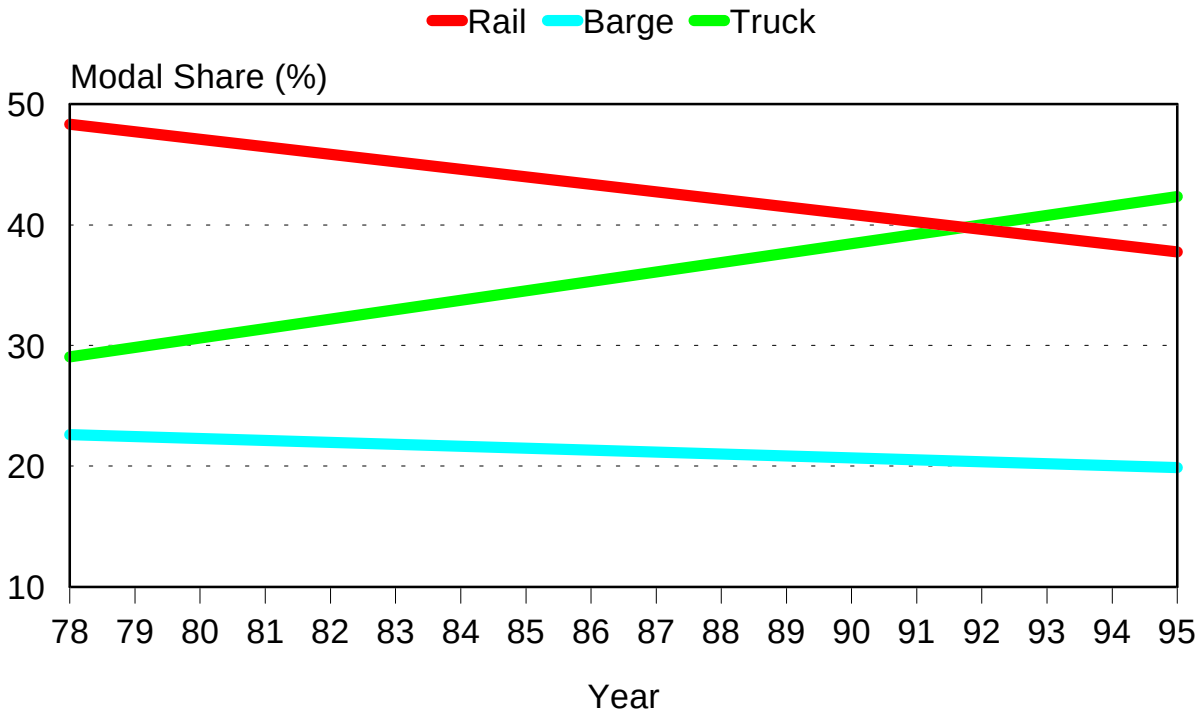
the early 1990s, truck became the predominant mode of grain transportation (figure 5). Rail share averaged 48 percent of all grain shipments during the first 5 years of the 1978-95 period (1978-82). During the last 5 years (1991-95), rail share dropped to 39 percent. Using these same years for comparison, barge share dropped from an average 23 percent during 1978-82, to 20 percent during 1991-95. These losses in modal share were gained by truck. The average truck share increased from an average 30 percent during 1978-82, to 41 percent during 1991-95.

These shifts in modal share for all grains were driven by similar, but even larger, shifts in modal shares for corn movements (table 3). Rail share of corn shipments dropped from an average of 44 percent during 1978-82, to 34 percent during 1991-95. Barge share for corn dropped from an average 25 percent during 1978-82, to 20 percent during 1991-95. Truck, again, substantially increased its share of corn movements from an average of 30 percent during 1978-82 to 46 percent during 1991-95.

These overall shifts in modal share have been the result of a number of factors. Changes in the structure of the livestock feeding industry have created larger truck markets for many shippers. Increases in corn processing have created larger and new truck markets in many areas once reliant on rail. Changes in rates and services offered by the railroads themselves may have also brought on some of this adjustment. Improved rate and service incentives for larger train-load facilities have reduced the importance of rail in the grain collection function at many country points. This has forced many smaller and older shipping facilities, particularly on branch lines, to shift from rail to truck.

Modal shares vary greatly between export and domestic movements. The rail share of grain movements decreased during 1978-95. Export rail share ranged from a high of 47.6 percent in 1991 to a low of 26.1 percent in 1994. In the domestic market, rail share decreased from 41.8 percent in 1984 to 41.0 in 1995. Rail share, however, rebounded in 1989, capturing 49.4 percent of the domestic market but with lower volumes than the previous year. Domestic rail tonnages increased from 67 million tons in 1984 to 101 million tons in 1995.

Figure 5--Linear trends for all U.S. grain modal shares, 1978-95



The barge share of export movements remained relatively flat during 1984-95. Barge export share went from a low of 45.7 percent in 1984 to a high of 54.7 percent in 1994. The barge share of domestic grain traffic decreased from 4.1 percent in 1984 to 2.5 percent in 1995. The export share of total barge tonnages remained above 90 percent, demonstrating the importance of export grain to barge tonnages.

The relationship between truck export and domestic movements is inverse to that for barges. From 1984 to 1988, trucks accounted for roughly 55 percent of all domestic movements and 9 percent or less of all export movements. Domestic truck share increased from 54 percent in 1984 to 64.9 percent in 1991 and retreated to 56.5 percent in 1995. Export truck share dropped to a low of 4.7 percent in 1991, but jumped to a high of 19.2 percent in 1994.

Corn

Of all U.S. grains, corn has the greatest transportation demand. During 1978-89 corn represented, on average, 46.4 percent of all U.S. grain movements and during 1990-95, 53 percent. It accounted for 49 percent of all export grain movements and 61.6 percent of all domestic grain movements in 1995.

Corn dominates the U.S. grain transportation market by virtue of its large production volumes. It has the largest acreage of any grain crop, and per-acre yields in some areas average as much as four times that of wheat or soybeans. From 1990 to 1995, annual U.S. corn production averaged more than three times that of wheat, the

Table 3--Tonnages and modal shares for U.S. corn, 1978-95

Year & Type of Movement	Mode of Transport					
	Rail		Barge		Truck	
	1,000 Tons	Percent	1,000 Tons	Percent	1,000 Tons	Percent
Total:						
1978	48,471	47.4%	25,873	25.3%	27,854	27.3%
1979	56,467	46.1%	28,366	23.2%	37,636	30.7%
1980	64,885	45.4%	30,804	21.6%	47,180	33.0%
1981	51,979	45.6%	31,628	27.7%	30,420	26.7%
1982	43,066	37.1%	33,856	29.1%	39,266	33.8%
1983	52,196	42.7%	34,174	28.0%	35,830	29.3%
1984	51,663	41.0%	31,336	24.9%	42,855	34.1%
1985	44,482	33.4%	28,906	21.7%	59,799	44.9%
1986	44,023	35.4%	21,101	17.0%	59,244	47.6%
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%
Export:						
1984	21,863	40.5%	28,421	52.7%	3,663	6.8%
1985	18,219	37.5%	26,533	54.6%	3,808	7.8%
1986	10,405	34.9%	18,019	60.5%	1,372	4.6%
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%
Domestic:						
1984	29,800	41.4%	2,915	4.1%	39,192	54.5%
1985	26,263	31.0%	2,374	2.8%	55,991	66.2%
1986	33,618	35.5%	3,082	3.3%	57,872	61.2%
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%

next largest grain crop.[9] Structural changes in the livestock and poultry industries have also served to increase the demand for corn transportation.

Tonnages Moved Corn moved in the United States increased from 102 million tons in 1978 to 217 million tons in 1995 (table 1). The corn share of total movements increased, from 42.3 percent in 1978 to 57.2 percent in 1995. Domestic share of corn movements also increased from 38.4 percent to 61.6 percent. These trends in corn movements are mostly attributable to corn use changes.

While still highly used as a primary feed ingredient in livestock rations, corn is increasingly used in processed products. Industrial use of corn nearly tripled during 1978-95. This category of consumption increased from 15.9 million tons to 46.8 million tons.[10] The use of corn fructose as a food sweetener and corn alcohol as an ingredient in ethanol gasoline blends has contributed largely to this increase.

The demand for corn as a feed crop has also increased. Corn used for feed in the United States increased by 48.9 percent, from 104.1 million tons to 155 million tons, during 1978-95. These increases have occurred, in part, because of increased poultry production. Broiler chicken production increased from 14 million live weight pounds in 1978 to 34 million in 1995.[11]

Shifts in the location of feeding have been equally important for corn transportation. In 1978, 79.4 million tons of corn were used on the same farms where they were grown. By 1995, this amount had dropped 46 percent to 42.9 million tons. This decrease in on-farm use resulted almost entirely from the decrease in livestock feeding on corn-producing farms. This fact is evidenced by shifts in the cattle industry. In 1970, the number of cattle marketed from feedlots with fewer than 1,000-head capacities accounted for over 40 percent of all marketings. In 1980, this proportion had dropped to 25 percent; by 1988, these smaller feedlots marketed only 16 percent of all cattle. While the number of cattle fed in small feedlots has decreased, the number of cattle in the largest commercial feedlots increased.[12] These decreases in the on-farm use of corn have increased the need to move grain off the farm and into commercial markets.

As indicated earlier, droughts and floods strongly influence the transportation of grain, especially corn. The 1988 drought and 1993 flood had pronounced impacts on the corn market. Total tonnages of corn available for movement decreased by nearly 35 million tons between 1988 and 1989 and 23 million tons between 1993 and 1994 (table 1). Total ending stocks, government and privately owned, fell from 119 million tons during 1987/88 marketing year to 54 million tons in 1988/89 and from 57.2 million tons during the 1993/94 marketing year to 23.8 million tons in 1994/95.[13] Ending stocks did not return to historical levels after the 1988/89 marketing year.

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[9]U.S. Department of Agriculture, *Agricultural Statistics 1995* (Washington DC: U.S. Government Printing Office, 1995).

[10]U.S. Department of Agriculture, *Feed Situation and Outlook Report* (Washington, DC: USDA, Economic Research Service), various issues.

[11]U.S. Department of Agriculture, *Livestock and Poultry Situation and Outlook Report* (Washington, DC: USDA, Economic Research Service, 1979 and 1995).

[12]Steve Reed, "An Analysis of Fed Cattle Marketings by Region and Feedlot," *Livestock and Feed Situation* (Washington, DC: U.S. Department of Agriculture, Economic Research Service, February 1989), pp. 39-40.

[13]U.S. Department of Agriculture, *Feed Situation and Outlook Report* (Washington, DC: USDA, Economic Research Service), various issues.

Modal Shares Trucks were the predominant mode of transport for corn with 45 percent of total movement in 1995, up from 27.3 percent in 1978 (table 3). The truck share of the corn movement increased, because truck corn tonnage increased by nearly four times between 1978 and 1995. While rail and barge corn tonnages increased considerably from 1978 to 1995, 63.7 and 57.6 percent respectively, both modes had decreased shares of total corn movements. Rail share dropped from 47.4 percent in 1978 to 36.5 in 1995. Between these same years, barge share dropped from 25.3 to 18.7 percent.

The increased truck share between 1978 and 1995 was driven almost entirely by increases in domestic corn transportation. Truck share of domestic corn movement increased from 54.5 percent in 1984 to 60.4 in 1995. At the same time, rail share of domestic traffic dropped from 41.4 to 37.9 percent. Rail tonnages of domestic corn, however, actually increased by 93.5 percent from 1984 to 1995. Domestic barge share, already small, dropped from 4.1 percent to 1.8 between 1984 and 1995 with almost no change in domestic barge tonnages.

Barge and truck both showed increases in share resulting from export corn movements during 1984-95. Barges continued to be the largest transporter of export corn, with more than 60 percent of these movements. Between 1984 and 1995, barge's share of corn exports increased from 52.7 to 58.4 percent. Truck share increased during this period from 6.8 to 8.3 percent. Rail share decreased from 40.5 to 33.2 percent. In response to increased exports, barge and truck export shares increased. The modal shares for the domestic and export shipments of corn are shown in figure 6.

Wheat

Wheat is the second largest crop transported in the United States. During 1978-95, wheat accounted for 22 percent of all grain movement--31 percent of all export movements and 17 percent of all domestic movements (table 1).

The demand for wheat transportation is substantially different from that for corn. Most wheat production is concentrated in the Plains States, which have virtually no direct access to waterway transportation. Although barge transportation on the Columbia-Snake River system is available for white wheat grown in the Pacific Northwest, and the Mississippi River system provides barge transportation for soft red winter wheat grown in the eastern Corn Belt and Mississippi River Valley, the bulk of wheat production still occurs in those regions where rail is the dominant mode of transport. Demand for wheat transportation is also driven much more extensively by the export market. During 1978-95, 55.6 percent of all U.S. wheat produced was exported.[14] This is significantly higher than the 36.7 percent of corn production exported during the same period.[15]

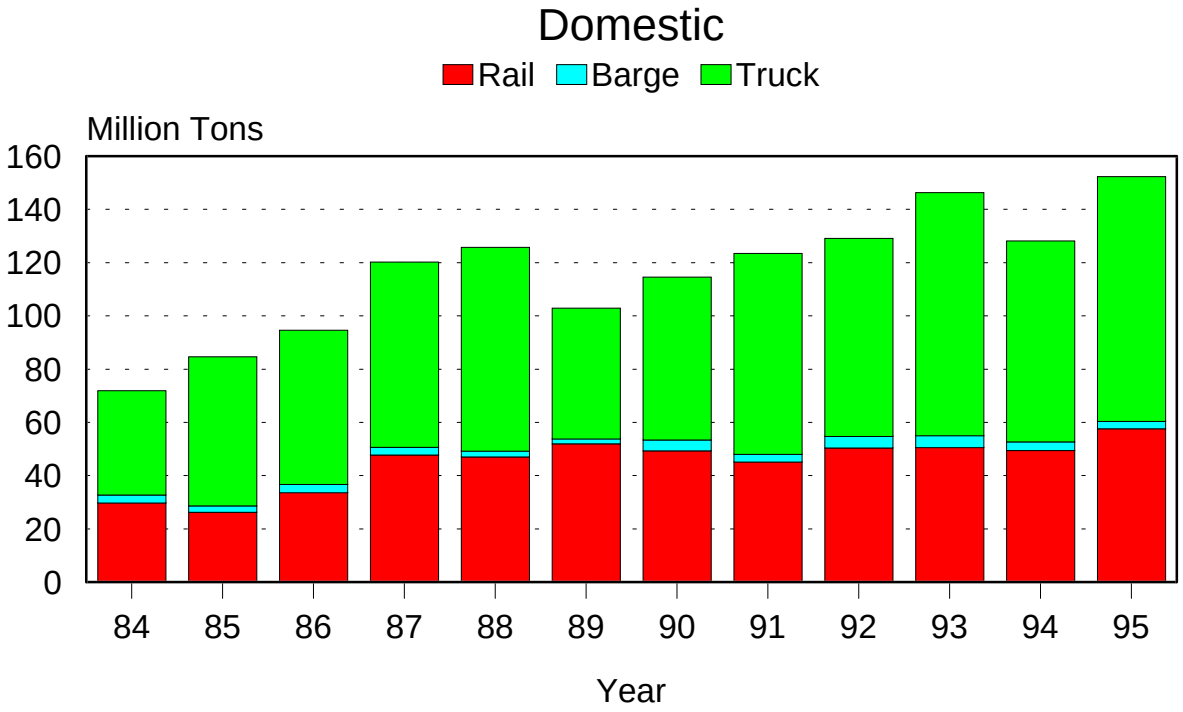
Tonnages Moved Total wheat tonnages moved in the United States varied considerably. Wheat tonnages, which averaged 68 million tons during 1978-95, reached a high of 79.7 million tons in 1984 (table 1). In 1985, tonnages were lowest at 58.7 million tons and climbed back to 72.9 million tons by 1994.

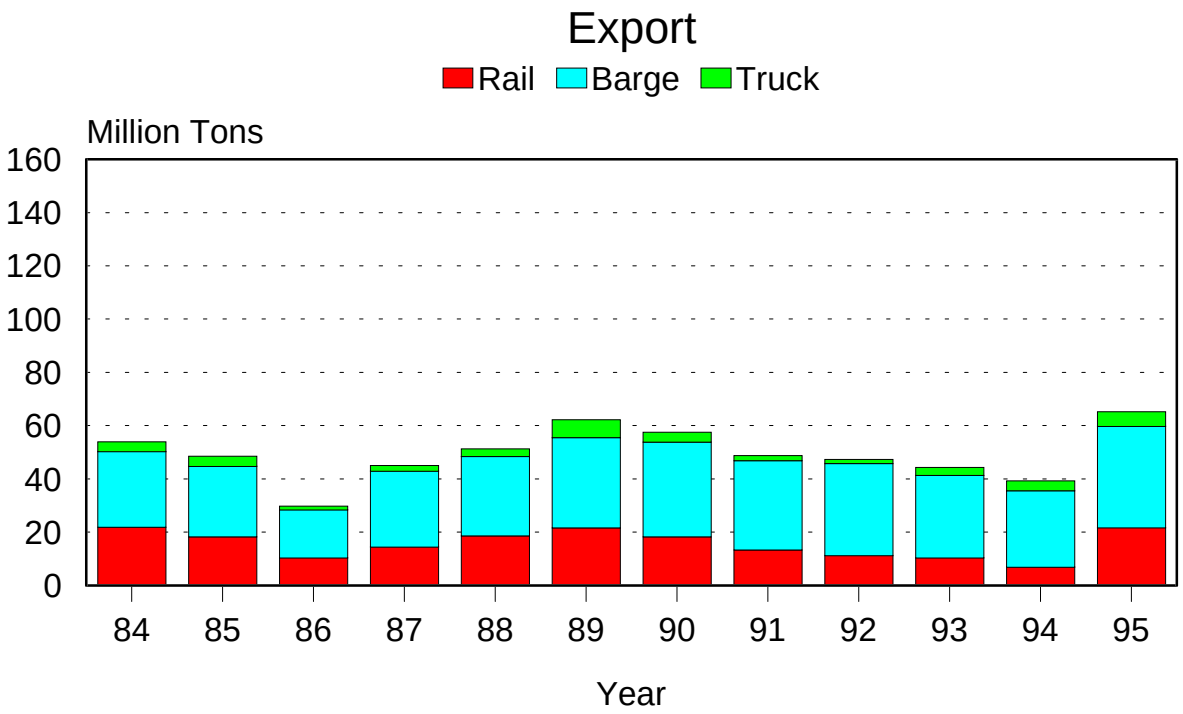
Domestic wheat tonnages increased from 23.9 million tons in 1978 to 29.1 million tons in 1995, with a high of 39.4 million tons in 1994. Export tonnages during this period varied more than domestic tonnages. Export tonnages reached a high of 48.4 million tons in 1981, then fell to a low of 27.2 million tons in 1986.

[14]U.S. Department of Agriculture, *Wheat Situation and Outlook Report* (Washington, DC: USDA, Economic Research Service), various issues.

[15]U.S. Department of Agriculture, *Feed Situation and Outlook Report* (Washington, DC: USDA, Economic Research Service), various issues.

Figure 6--U.S. corn shipments by mode, 1984-95





Modal Shares Rail dominated the movement of wheat, accounting for 66.7 percent of all wheat moved during 1978-95. Rail wheat tonnages and modal share were relatively flat, peaking at 54.8 million tons with a modal share of 79.1 percent in 1980 (table 4). Barge and truck also displayed a relatively flat trend in tonnages and modal shares. However, after 1988, rail modal share has trended downward accounting for 61 percent of all wheat moved during 1989-95.

During 1978-95, barge accounted for 19 percent of all wheat movements, peaking in 1981 at 16.9 million tons with a 23.2 percent share of wheat movements. During this same period, trucks moved 14.3 percent of all wheat.

Rail's share of wheat export movements decreased from 61.1 percent in 1984 to 57.6 percent in 1995. Barge export share increased from 30.4 percent in 1984 to 31.6 percent in 1995. Truck export share increased from 8.5 percent in 1984 to 10.8 percent in 1995. Truck absorbed some barge share in 1993 and some rail share in 1994.

Rail was the dominant carrier for domestic wheat shipments. During 1984-95, rail accounted for 71 percent of all domestic movements, as compared to 3.6 percent for barge and 25.5 percent for truck. The trends in domestic and export wheat shipments are depicted in figure 7.

Soybeans

Soybeans accounted for 19.2 percent of all grain movements during 1978-95. With the exception of soybeans used for seed, virtually all soybeans grown in the United States are moved to domestic processors or to the export market. The location of processing plants throughout the Midwest and the concentration of soybean production along the Mississippi River system have led to truck domination of the domestic soybean market and barge domination of the export soybean market.

Tonnages Moved Soybean movements were relatively flat, ranging from a low of 50.2 million tons in 1989 to a high of 70.5 million tons in 1995 (table 1). The proportion of soybean movements for export dropped. In 1978, export movements accounted for 42.4 percent of all soybean movements. In 1995, this percentage dropped to 35.1 percent. Domestic soybean tonnages increased 47.2 percent, from 31 million tons to 45.7 million tons, during 1978-95.

Modal Shares Truck movements dominated soybean transport, accounting for 49 percent of all movements during 1978-95 (table 5). During that period, barge and rail accounted for 28.2 and 22.8 percent of soybean movements, respectively. Overall, barge share decreased slightly from 26.4 percent in 1978 to 26.1 percent in 1995. Rail share increased from 18.2 percent in 1978 to 24.2 percent in 1995. Truck share of soybean movements decreased from 55.4 percent in 1978 to 49.7 percent in 1995.

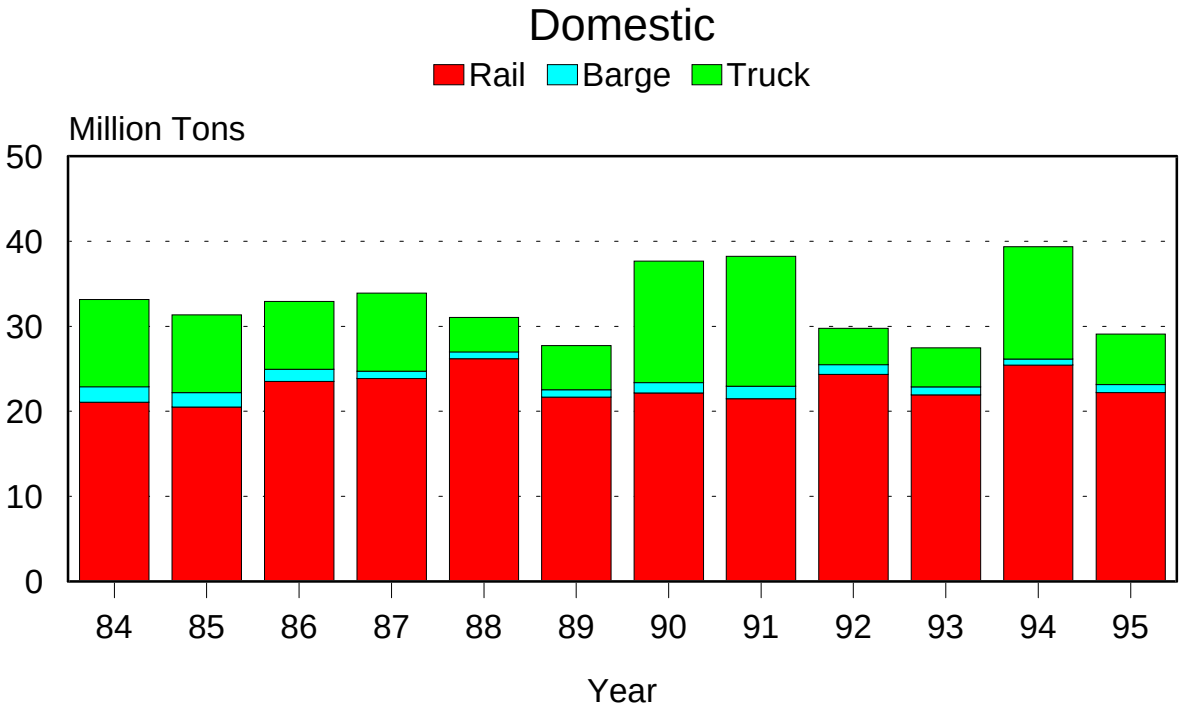
Despite a general decrease, barge remained the predominant carrier for soybean exports. Barge export tonnages remained relatively flat; barge share decreased from 66.1 percent in 1984 to 65.9 percent in 1995, with a high of 77.4 percent in 1991. Similarly, rail tonnages remained relatively flat, while rail share increased from 18.8 to 22.5 percent. Rail increases came at the expense of truck tonnages and share, which both dropped. During 1984-95, export truck tonnages decreased by 11.2 percent, and truck export share decreased from 15.1 to 11.6 percent. However, truck eroded rail and barge tonnages and modal share in 1994.

Trucks remained the dominant carrier in the domestic soybean market. Truck tonnages of domestic soybeans remained fairly constant during 1978-94 and increased substantially in 1995. Truck share, however, dropped from 73.5 percent in 1984 to a low of 63.2 percent in 1990. It rebounded to 71.2 percent in 1993 and ended 1995 at 70.3 percent. Domestic rail tonnages of soybeans increased 65.9 percent from 1984 to 1995, but fell sharply in 1989 and 1993. Rail share of domestic movements increased from 22.2 percent in 1984 to 25.1 in 1995, after peaking at 32.3 percent in 1988. Barge tonnages remained flat during 1984-95, accounting for roughly 5 percent

Table 4--Tonnages and modal shares for U.S. wheat, 1978-95

Year & Type of Movement	Mode of Transport					
	Rail		Barge		Truck	
	1,000 Tons	Percent	1,000 Tons	Percent	1,000 Tons	Percent
Total:						
1978	44,449	72.3%	10,248	16.7%	6,773	11.0%
1979	45,661	77.1%	10,222	17.3%	3,331	5.6%
1980	49,631	79.1%	12,876	20.5%	218	0.3%
1981	50,432	69.2%	16,889	23.2%	5,508	7.6%
1982	52,590	74.4%	16,330	23.1%	1,781	2.5%
1983	51,500	70.9%	13,867	19.1%	7,289	10.0%
1984	49,507	62.1%	15,992	20.1%	14,226	17.8%
1985	36,904	62.9%	9,796	16.7%	11,997	20.4%
1986	39,578	65.9%	9,465	15.8%	11,035	18.4%
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%
Export:						
1984	28,429	61.1%	14,168	30.4%	3,969	8.5%
1985	16,402	60.0%	8,081	29.6%	2,859	10.5%
1986	16,050	59.1%	8,043	29.6%	3,059	11.3%
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%
Domestic:						
1984	21,078	63.6%	1,824	5.5%	10,257	30.9%
1985	20,502	65.4%	1,715	5.5%	9,138	29.1%
1986	23,528	71.5%	1,423	4.3%	7,976	24.2%
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%

Figure 7--U.S. wheat shipments by mode, 1984-95



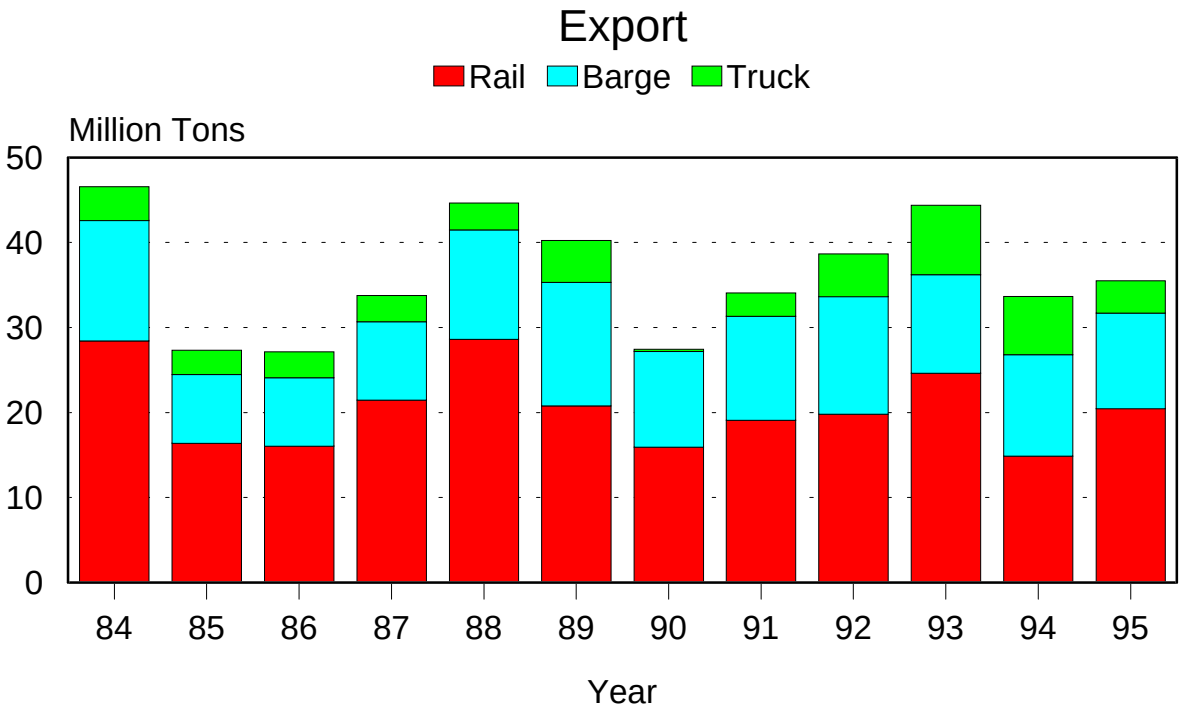


Table 5--Tonnages and modal shares for U.S. soybeans, 1978-95

Year & Type of Movement	Mode of Transport					
	Rail		Barge		Truck	
	1,000 Tons	Percent	1,000 Tons	Percent	1,000 Tons	Percent
Total:						
1978	9,804	18.2%	14,235	26.4%	29,840	55.4%
1979	10,102	17.9%	13,242	23.5%	33,064	58.6%
1980	11,420	19.2%	16,089	27.1%	31,943	53.7%
1981	10,173	17.9%	15,341	27.0%	31,374	55.1%
1982	12,411	20.3%	19,803	32.4%	28,964	47.3%
1983	13,117	22.3%	19,300	32.8%	26,351	44.8%
1984	10,977	20.8%	15,544	29.5%	26,211	49.7%
1985	9,799	18.8%	14,881	28.6%	27,370	52.6%
1986	16,185	27.7%	18,054	30.9%	24,100	41.3%
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%
Export:						
1984	4,048	18.8%	14,186	66.1%	3,242	15.1%
1985	3,033	16.3%	13,340	71.7%	2,244	12.1%
1986	5,654	24.0%	16,329	69.3%	1,583	6.7%
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%
Domestic:						
1984	6,929	22.2%	1,358	4.3%	22,969	73.5%
1985	6,766	20.2%	1,541	4.6%	25,126	75.2%
1986	10,531	30.3%	1,725	5.0%	22,517	64.8%
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%

of all domestic soybean traffic. These modal share trends for domestic and export soybean movements are illustrated in figure 8.

Sorghum

Sorghum accounted for 5.3 percent of all grain movement in the United States during 1978-95. As a feed grain, sorghum is an important crop. Sorghum's adaptability to the hotter and drier regions of the country, which are unsuitable for corn production, and its use as a main ingredient in livestock rations, especially cattle feed, have made sorghum movements much more reliant upon truck and rail transportation than barge.

Tonnages Moved Sorghum tonnages moved in the United States increased by 13.8 percent during 1978-95 to 15.1 million tons in 1995 (table 1). However, movements peaked at 22.1 million tons in 1988. Domestic tonnages accounted for 56.7 percent of all sorghum moved. The domestic share of sorghum movements decreased from 79.8 percent in 1978 to 16.9 percent in 1981, then increased to 59.6 percent by 1995. Domestic tonnages decreased from 10.6 million to 9 million tons during the same time period. Export tonnages increased from 2.7 million to 6.1 million tons.

Modal Shares During 1978-95, rail accounted for the largest share of sorghum traffic, with 46.7 percent of total movements, as compared to truck, with 42.1 percent, and barge, with 11.2 percent (table 6). Major shifts occurred between the modes. Rail tonnages of sorghum decreased 36.4 percent, from 8 million tons in 1978 to 5.1 million tons in 1995, and rail share decreased from 60 to 33.5 percent. During the same period, truck tonnages increased 67.4 percent, from 5.1 million tons in 1978 to 8.6 million tons in 1995. Truck share increased from 38.7 to 56.9 percent. Truck movements of sorghum supplanted rail in 1983 for the first time, and after 1991, trucks continued to move more sorghum than rail. Barge tonnages and share increased. Barge tonnages increased from 172,000 tons in 1978 to 1.4 million tons in 1995. Barge share increased from 1.3 to 9.5 percent.

Domestic movements accounted for the predominant share of rail and truck sorghum tonnages during 1984-95. Of all railed sorghum, 59 percent was shipped to domestic markets. For trucks, 81.1 percent was shipped for domestic consumption. Barge shipments of sorghum were primarily to export. Export shipments accounted for 96.4 percent of all barged movements. Modal share trends for domestic and export sorghum movements are illustrated in figure 9.

Barley and Rye

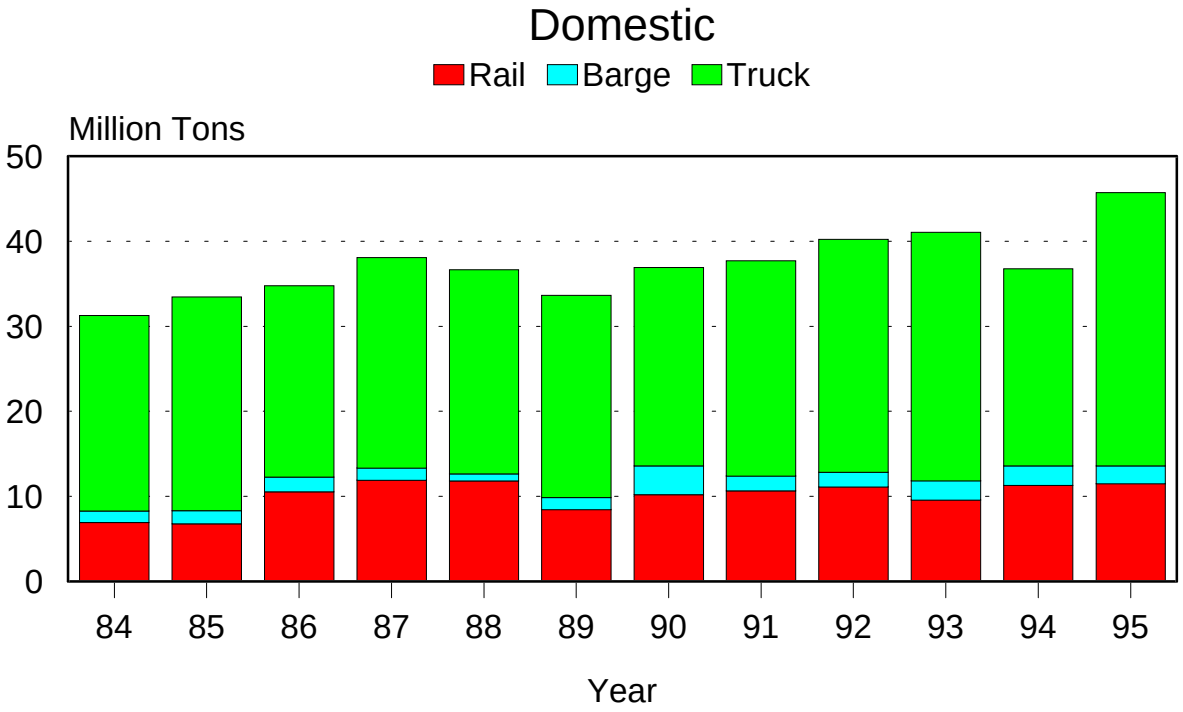
Barley and rye make up 3.2 percent of all U.S. grain movements (table 1).[16] These commodities are primarily consumed in the domestic market. They generate 6.8 percent of all domestic grain traffic and less than one percent of the export traffic. During 1978-95, more than 50 percent of all barley and 42 percent of all rye were consumed as animal feed. During these years, food, alcohol, and industrial use consumed more than 40 percent of all barley and 34 percent of all rye.[17]

Tonnages Moved Barley and rye movements increased 31.1 percent to 9.4 million tons during 1978-95. Although the domestic barley and rye market is about five times greater than the export market, exports

[16]Barley and rye were aggregated in this analysis for consistency with secondary barge data. Barley accounts for more than 95 percent of the total in this aggregation.

[17]U.S. Department of Agriculture, *Feed Situation and Outlook Report* (Washington, DC: USDA, Economic Research Service), various issues.

Figure 8--U.S. soybean shipments by mode, 1984-95



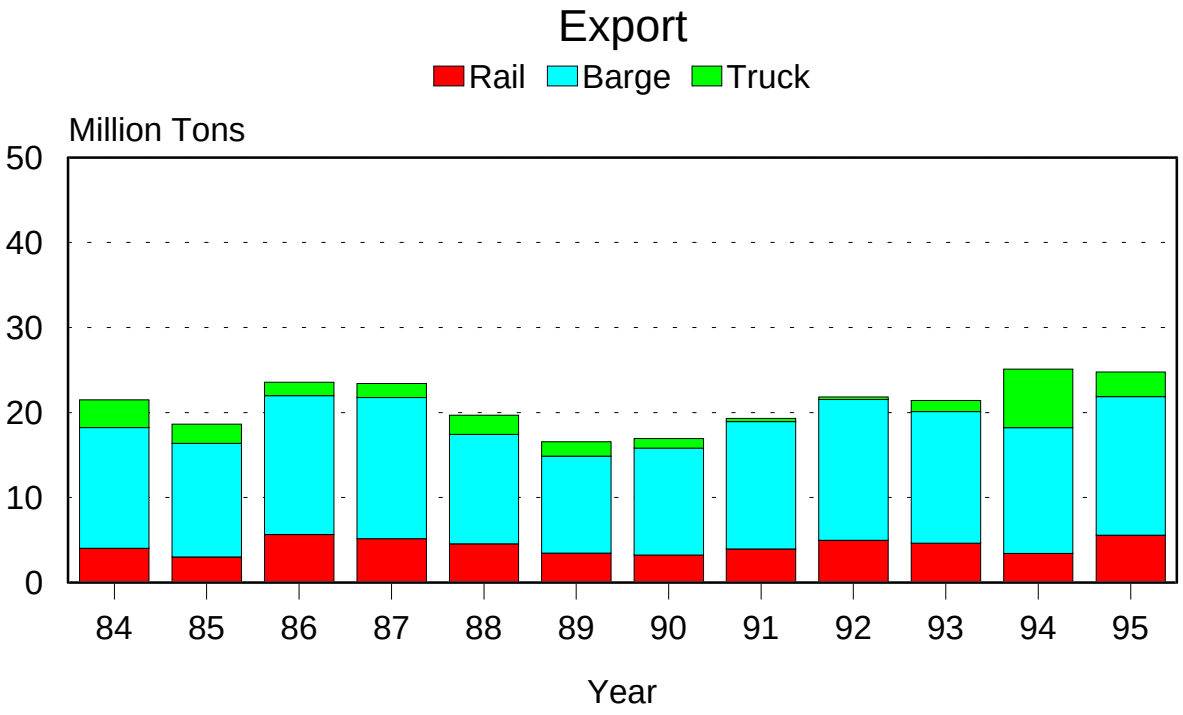
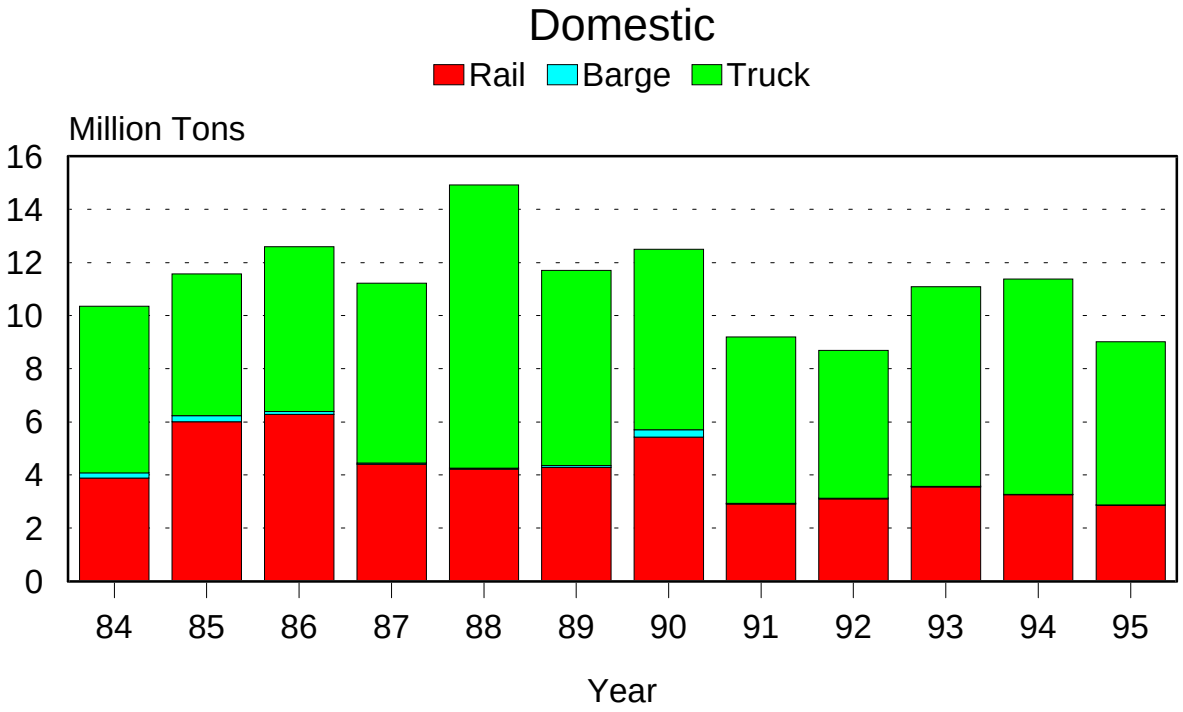
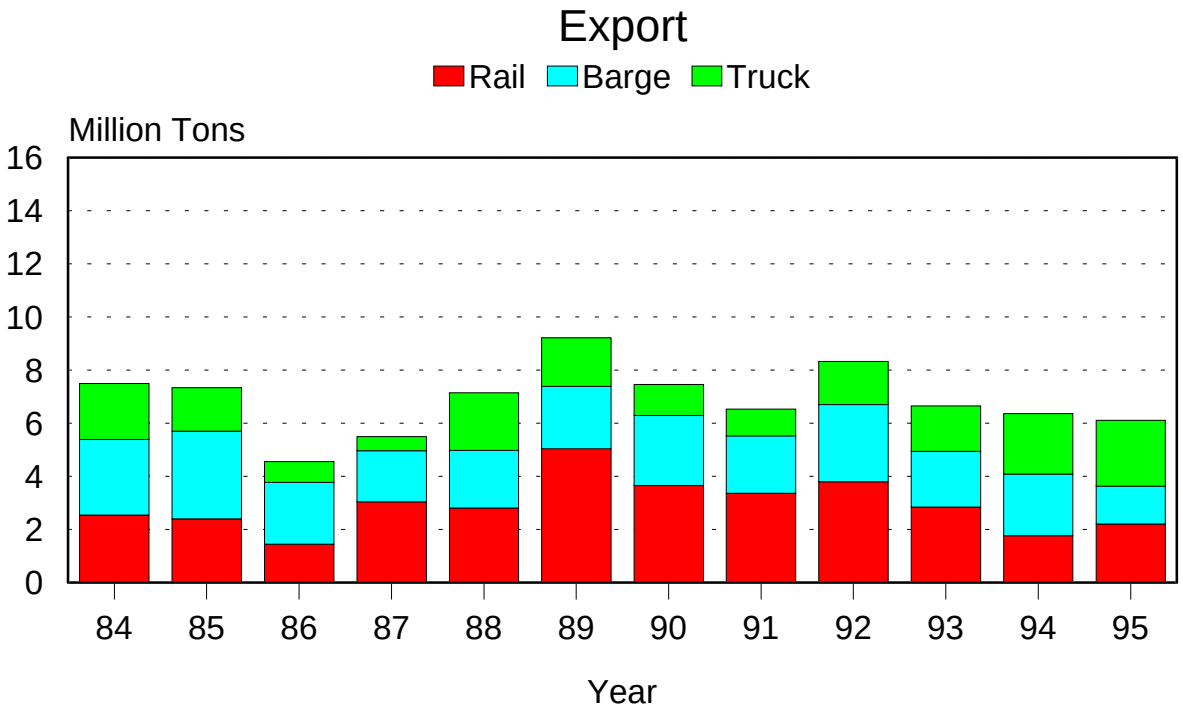


Table 6--Tonnages and modal shares for U.S. sorghum, 1978-95

Year & Type of Movement	Mode of Transport					
	Rail		Barge		Truck	
	1,000 Tons	Percent	1,000 Tons	Percent	1,000 Tons	Percent
Total:						
1978	7,967	60.0%	172	1.3%	5,142	38.7%
1979	8,296	62.0%	165	1.2%	4,930	36.8%
1980	9,876	83.6%	419	3.6%	1,512	12.8%
1981	8,138	76.7%	1,187	11.2%	1,286	12.1%
1982	6,619	49.9%	1,474	11.1%	5,184	39.0%
1983	4,980	38.2%	1,205	9.2%	6,853	52.6%
1984	6,425	36.0%	3,056	17.1%	8,356	46.8%
1985	8,406	44.5%	3,534	18.7%	6,968	36.9%
1986	7,738	45.1%	2,429	14.2%	6,986	40.7%
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%
Export:						
1984	2,542	34.0%	2,850	38.1%	2,095	28.0%
1985	2,399	32.7%	3,302	45.0%	1,633	22.3%
1986	1,453	31.9%	2,318	50.9%	787	17.3%
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%
Domestic:						
1984	3,883	37.5%	206	2.0%	6,261	60.5%
1985	6,007	51.9%	232	2.0%	5,335	46.1%
1986	6,285	49.9%	111	0.9%	6,199	49.2%
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%

Figure 9--U.S. sorghum shipments by mode, 1984-95





contributed the most to total movements by increasing 91 percent to 1.4 million tons during 1978-95. Domestic movements accounted for 81.8 percent of all barley and rye traffic, increasing 29.5 percent to 8 million tons during 1978-95.

Modal Shares Rail dominated barley and rye modal share movements with 62.3 percent of the share during 1978-95. Truck and barge transported 28.6 and 4.4 percent, respectively, during the same period. Rail increased its barley and rye tonnages 23 percent, from 4.9 million tons in 1978 to 6 million tons in 1995 (table 7). Truck tonnages increased 23.6 percent to 2.7 million tons in 1995. Barge tonnages increased nearly six times to 690,000 tons in 1995.

Rail and truck shares remained constant at 62.3 percent and 33.3, respectively, during 1978-95, while barge share increased from 1.4 percent in 1978 to 7.3 in 1995. During 1984-95, rail transported 53.3 percent of all exported barley and rye. Barge and truck accounted for 27.8 and 18.9 percent, respectively, of this export traffic. Rail and truck dominated domestic transport with 99.6 percent of the traffic. The domestic rail share of barley and rye movements increased from 48.8 percent in 1984 to 72.4 percent in 1995. For the same years, domestic truck share decreased from 50.8 to 26.2 percent.

Oats

Oat movements in the United States accounted for 1.2 percent of total grain movements during 1978-95. Nearly all oats shipped went to the domestic market. With the exception of a small amount of oats used in milling for food consumption, most oats are consumed as animal feed. During 1978-95, more than 78 percent of all oats were consumed as feed.[18]

Tonnages Moved Despite a 72.2 percent reduction in U.S. oat production, oat tonnages moved in the United States decreased slightly from 3.8 million tons in 1978 to 3.2 million tons in 1995 (table 1). During this period, total oat consumption decreased 4.8 million tons, or 50.9 percent. Imports increased from 11,000 tons to more than 650,000 tons annually.[19] Oat tonnages moved remained stable; however, the amount of oats grown and used on-farm decreased 84.4 percent from 9 million tons in 1978 to 1.4 million tons in 1995.[20]

Modal Shares Oats move predominantly by truck, which made up 62.7 percent of total oat movement during 1978-95. Rail and barge movements accounted for 28.5 and 8.9 percent, respectively, for the same period (table 8). Rail tonnages decreased 8.3 percent from 1978 to 1995. Rail share fluctuated from 39 percent in 1978 to 15.4 percent in 1986 and 42.3 percent in 1995. Barge share remained constant through 1983, increased to 15.6 percent in 1992, then to 21.5 percent in 1994, and decreased to 8.2 percent in 1995. During 1984-95, export movements accounted for less than 1.5 percent of all oat traffic. In the domestic market, truck, rail, and barge movements made up 61.4, 27.4, and 11.2 percent, respectively, of oat movements during 1984-95.

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[18]U.S. Department of Agriculture, *Feed Situation and Outlook Report* (Washington, DC: USDA, Economic Research Service), various issues.

[19]U.S. Department of Agriculture, *Feed Situation and Outlook Report* (Washington, DC: USDA, Economic Research Service), various issues.

[20]Based on "Used on farms where grown" data reported by the USDA Statistical Reporting Service prior to 1981 and data supplied by the USDA Economic Research Service for 1981 through 1995.

Table 7--Tonnages and modal shares for U.S. barley and rye, 1978-95

Year & Type of Movement	Mode of Transport					
	Rail		Barge		Truck	
	1,000 Tons	Percent	1,000 Tons	Percent	1,000 Tons	Percent
Total:						
1978	4,910	68.5%	99	1.4%	2,157	30.1%
1979	5,469	69.4%	89	1.1%	2,321	29.5%
1980	6,495	76.5%	133	1.6%	1,865	22.0%
1981	5,969	71.8%	342	4.1%	2,003	24.1%
1982	5,663	71.6%	289	3.6%	1,962	24.8%
1983	7,666	73.3%	403	3.9%	2,392	22.9%
1984	5,724	51.5%	589	5.3%	4,803	43.2%
1985	4,870	48.8%	324	3.2%	4,786	48.0%
1986	6,933	56.9%	407	3.3%	4,837	39.7%
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%
Export:						
1984	1,362	62.3%	562	25.7%	262	12.0%
1985	414	53.1%	298	38.2%	68	8.7%
1986	1,325	73.5%	388	21.5%	90	5.0%
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%
Domestic:						
1984	4,362	48.8%	27	0.3%	4,541	50.8%
1985	4,456	48.4%	26	0.3%	4,718	51.3%
1986	5,608	54.1%	19	0.2%	4,747	45.8%
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%

Table 8--Tonnages and modal shares for U.S. oats, 1978-95

Year & Type of Movement	Mode of Transport					
	Rail		Barge		Truck	
	1,000 Tons	Percent	1,000 Tons	Percent	1,000 Tons	Percent
Total:						
1978	1,486	39.0%	187	4.9%	2,139	56.1%
1979	1,182	26.7%	123	2.8%	3,114	70.5%
1980	1,095	26.3%	173	4.2%	2,890	69.5%
1981	889	25.6%	117	3.4%	2,473	71.1%
1982	841	38.7%	104	4.8%	1,225	56.5%
1983	999	27.7%	130	3.6%	2,476	68.7%
1984	688	17.5%	292	7.4%	2,950	75.1%
1985	625	16.1%	365	9.4%	2,903	74.6%
1986	638	15.4%	379	9.1%	3,125	75.5%
1987	864	21.9%	213	5.4%	2,869	72.7%
1988	868	22.9%	375	9.9%	2,546	67.2%
1989	1,066	36.2%	374	12.7%	1,510	51.2%
1990	871	23.5%	488	13.2%	2,339	63.3%
1991	915	24.3%	505	13.4%	2,339	62.2%
1992	1,006	32.3%	486	15.6%	1,625	52.1%
1993	1,241	35.3%	317	9.0%	1,955	55.6%
1994	1,424	42.1%	728	21.5%	1,233	36.4%
1995	1,362	42.3%	263	8.2%	1,598	49.6%
Export:						
1984	3	16.6%	7	44.1%	6	39.3%
1985	0	0.0%	0	1.2%	12	98.8%
1986	6	16.9%	12	34.2%	17	49.0%
1987	0	0.0%	4	22.5%	13	77.5%
1988	2	17.8%	2	14.2%	9	68.0%
1989	8	62.3%	1	7.5%	4	30.2%
1990	8	69.8%	0	0.0%	3	30.2%
1991	5	53.4%	0	3.1%	4	43.4%
1992	57	72.0%	9	12.0%	13	15.9%
1993	15	18.8%	6	7.4%	60	73.8%
1994	0	1.1%	4	27.7%	12	71.2%
1995	6	32.3%	0	0.1%	12	67.6%
Domestic:						
1984	685	17.5%	285	7.3%	2,944	75.2%
1985	625	16.1%	365	9.4%	2,891	74.5%
1986	632	15.4%	367	8.9%	3,108	75.7%
1987	864	22.0%	209	5.3%	2,856	72.7%
1988	866	22.9%	373	9.9%	2,537	67.2%
1989	1,058	36.0%	373	12.7%	1,506	51.3%
1990	863	23.4%	488	13.2%	2,336	63.4%
1991	911	24.3%	505	13.5%	2,335	62.3%
1992	949	31.2%	476	15.7%	1,612	53.1%
1993	1,226	35.7%	311	9.1%	1,895	55.2%
1994	1,424	42.3%	724	21.5%	1,221	36.3%
1995	1,356	42.3%	263	8.2%	1,586	49.5%

Conclusion

The most significant trends during 1978-95 were the upward growth in tonnages of all grains moved and increased truck share 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 18-year period. After falling from record high levels during the early 1980s, exports again expanded in the late 1980s and 1990s.

The tonnages of all grain transported increased 57 percent, from 242 million tons in 1978 to 380 million tons in 1995. The tonnages transported by each mode also increased. Between 1978 and 1995, rail tonnages increased 29.9 percent, from 117 million tons to 152 million tons; barge tonnages increased 43.1 percent, from 51 million tons to 73 million tons; and truck tonnages increased 109.5 percent, from 74 million tons to 155 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 1995 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 supplanted rail as the dominant mode in 1993. Rail share, which began in 1978 at 48.4 percent, ended the period in 1995 at 40 percent. Rail share gains in soybeans, barley and rye, and oats were negated by losses in corn, wheat, and sorghum movements. Barge share, 21 percent in 1978, ended the period in 1995 at 19.4 percent. The decrease in barge share is, in part, attributable to a decrease in corn share from 25.3 to 18.7 percent. Truck share, which displayed a general upward trend from 30.6 percent in 1978 to a high of 43.3 percent in 1994, settled to 40.6 percent in 1995. Truck share increased in corn, wheat, and sorghum movements, but lost share in all other grain movements. Increased barge and truck shares of wheat movements are the direct result of increased production and marketing of soft red winter wheat.

As this study indicates, modal share of the final movement of grain is highly dependent upon the type of grains 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 essential to a grain transportation infrastructure that supports the domestic and export market expansion of U.S. grain.

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