PORT OF HOUSTON: INTERMODAL GRAIN TRANSFER SYSTEM AND MARKET AREA, 1976-1977

The Texas Agricultural Experiment Station,
Neville P. Clarke, Director, College Station, Texas
The Texas A&M University System

[Blank Page in Original Bulletin]

CONTENTS

SUMMARY

The intermodal grain transfer system at the Port of Houston was studied from June 1976 through May 1977. During that time, the Port of Houston's three export elevators loaded 266.7 million bushels of wheat, grain sorghum, corn, and soybeans aboard ocean-going vessels. Wheat made up 50 percent and grain sorghum, corn, and soybeans 24, 22, and 4 percent, respectively of the exported volume.

Nearly one-third of the Port's exported grain and soybean volume came from Texas origins, while about one-fourth of the receipts were from Oklahoma. Iowa, Nebraska, and Kansas shipped 15, 11, and 10 percent of the Port's respective grain and soybean inflow. Texas ranked first as an originator of grain sorghum (59%) and second as a source of wheat (31%) and soybeans (35%). Iowa was the principal source of corn and soybeans and supplied 56 and 36 percent of the Port's respective receipts of these commodities. Oklahoma supplied about one-half of the Port's total wheat receipts (49%). Nebraska ranked second as a source of grain sorghum (29%) and corn (18%).

During the study period, 81 percent of the grain and soybean inflow was rail-delivered; the remaining 19 percent was delivered by trucks. On the average, about 88 percent of the wheat receipts was transported via railroads. Whether wheat was shipped by an initial assembler (country elevator) or a secondary holder (inland terminal) appeared to influence selected mode. About 99 percent of the wheat shipped from secondary sources was transported via railroads, whereas initial assemblers shipped 58 percent by this mode. Approximately 45 percent of the grain sorghum and soybeans received at the Port were truck-delivered. About 50 percent of these commodities originated within 300 miles of Houston, and 72 and 86 percent of the respective grain sorghum and soybean inflow from this area was hauled by trucks. Nebraska and Kansas were major grain sorghum suppliers, and nearly all of their shipments were via railroads. Nebraska and Iowa supplied the Port with 85 percent of its corn receipts, and nearly 100 percent were rail transported. Railroads were responsible for transporting about 98 percent of the Port's corn inflow.

The primary purpose of port elevator storage capacity is coordination of grain inflow and outflow — accordingly, the similarity in percentages of annual grain receipts and loadings per month. Wheat's temporal receipt and shipment pattern displayed less monthly variation than that of other grains, although there was evidence of a peak in the July-August and February-March periods. Grain sorghum flows were greatest in the July-August, December, and February-March periods. Approximately 29 and 31 percent of the grain sorghum inflow was concentrated in the July-August and February-March time periods, respectively. Corn receipts were concentrated in January-April when 51 percent of this commodity was received. Approximately two-thirds of the soybeans were received in the November-February time period. Generally, the greater the volume of a commodity handled by the Port on an annual basis, the less month-to-month variation in receipts and shipments.

Japan and the United Soviet Socialist Republic (USSR) received 23 and 20 percent of the Port's export grain and soybean volume. The USSR was the leading wheat (27%) and corn (29%) importer; Japan received about 47 percent of the Port's grain sorghum loadings. Approximately 50 percent of the soybeans were destined for Europe.

The Port of Houston is serviced by six class I railroads. During the study period, the Santa Fe carried approximately one-third of the inbound grain cars and the Rock Island about one-fourth. The Ft. Worth and Denver, Missouri-Kansas-Texas, Missouri Pacific, and Southern Pacific carried 14, 14, 12, and 3 percent of the respective inbound grain traffic. The average quantity of grain per car was about 3,200 bushels, and the average haul was 669 miles. It is estimated that 69,517 grain cars were unloaded during the 12-month period.

During the period of analysis, 44,352 trucks were unloaded with an average load per truck of 65,764 pounds or about 1,120 bushels. The average distance of haul was 280 miles. Approximately 52 percent of the trucks were exempt carriers. The remaining trucks were operated by private carriers (26%) and specialized carriers (22%). Fifty percent of the trucks engaged in grain haulage were operated by firms with three or fewer tractors, while another 22 percent operated four to six trucks. On the average, trucks engaged in grain transportation to Houston traveled 94,202 miles per year.

Bulk carriers comprised 65 percent of the ship types, general cargo ships 25 percent, tankers 7.7 percent, ore carriers 1.9 percent, and container ships 0.4 percent of the grain hauling ship population. The quantities of grain loaded on the various ship types ranged from 9,940 bushels on a general cargo ship to 2,137,333 bushels on a bulk carrier. Ore carriers and tankers, on the average, carried 1,608,324 and 1,241,994 bushels, respectively. Bulk carriers averaged 811,362 bushels per vessel, while the respective general cargo and container ships carried an average of 267,980 and 113,407 bushels. The 365 vessels loaded during the study period carried an average of 730,685 bushels.

PORT OF HOUSTON: INTERMODAL GRAIN TRANSFER SYSTEM AND MARKET AREA, 1976-1977

Stephen W. Fuller and Mechel S. Paggi*

Approximately 20 percent of the U.S. farm sector's income comes from agricultural exports, and up to two-thirds of this revenue is generated from the sales of grains and soybeans (5). In view of producer dependency on foreign markets and the critical importance of the balance-of-payments situation, means of improving the logistical efficiency of the grain export system is a prime research area. It is generally recognized that the transfer of grain from domestic carriage to ships is one of the most crucial elements of the export grain marketing system.[1] Congestion and inefficiencies generated at ports influence the performance of the entire grain transportation system. In recognition of this need, the Cooperative State Research Service and The Texas Agricultural Experiment Station have provided monies to investigate this research area.[2] This publication is the first in a series which examines the intermodal grain transfer system at the Port of Houston. The purpose of this publication is to

1) describe the intermodal grain transfer system at the Port of Houston;
2) identify the spatial and temporal grain flows in and out of the Port; and
3) identify characteristics of transportation modes involved in the intermodal grain transfer process.

Data for the descriptive analysis were obtained through observation of port operations and examination of port elevator records. Information on grain inflows was obtained by taking a 22- and an 18-percent sample of the respective truck and railcar unloading documents. Ship loading data, taken from logs made available by port elevators, were obtained on all ships loaded during the 12-month study period which commenced June 1976 and extended through May 1977.

Background

The Port of Houston's facilities are located adjacent to a ship channel which extends 52 miles inland from the Gulf of Mexico (Figure 1). This Port is the third largest in the United States, and large quantities of oil, petroleum products, oilfield equipment, metallic raw products, grain, coffee beans, wood products, and automobiles are transferred through its facilities annually.

Historically, wheat has been the most important grain exported from the Port of Houston (Table 1). During the 1968-73 period, wheat constituted about 73 percent and grain sorghum 19 percent of the total exported grain volume. Since 1974, unit train rates from Corn Belt origins have substantially altered the relative importance of each exported grain. Wheat retains its first position; however, its share has diminished to about 55 percent of the total volume. In 1974, grain sorghum held a slight volume lead over corn, but in 1975 and 1976, corn exports exceeded grain sorghum exports and represented 21 and 23 percent of the respective exported grain volume.

Approximately 521 million bushels of wheat, corn, grain sorghum, and soybeans were exported from Houston in 1973 — the largest volume ever transferred through this Port (Table 1). In 1975, grain (wheat, corn, and grain sorghum) and soybean exports were valued at $1.65 billion, the largest on record. Approximately $1.4 billion of grain and soybeans were exported in each of the years 1973 and 1974 (4).

During the 1968-76 period, the Port of Houston ranked as a leading wheat port by exporting about 25 percent of the Nation's total outflow (1). It ranked second only to Corpus Christi as a grain sorghum port, and annually 23-43 percent of U.S. grain sorghum exports exited via this port. Since 1973, approximately 4-6 percent of the Nation's annual corn exports have been from Houston. Although this represents a small portion of the U.S.'s total corn exports, the volumes are relatively large (Table 1). Prior to 1973, 0.1-2 percent of the corn ex-

*Respectively, associate professor and research associate, The Texas Agricultural Experiment Station (Department of Agricultural Economics).

[1]See U.S. Senate Committee report *Prelude to Legislation to Solve the Growing Crisis in Rural Transportation*. Prepared by the Economic Research Service of the USDA for Senate Committee on Agriculture and Forestry, February 1975.

[2]To the authors' knowledge, this is the first publicly funded research to examine means of improving efficiency of an entire intermodal transfer system at a grain port. A previous study by Blake and McInnes described rail movement through the Port of Houston. This study resulted in an unpublished manuscript entitled *The Transportation of Export Grain Through the Houston Rail System* and was an information source for the railroad portion of this study.

ports were from this port. Historically, the Port of Houston has been responsible for 0.1-6 percent of the Nation's soybean exports. Since 1973, that amount has increased to 2-5 percent of the U.S.'s total.

Port of Houston's Intermodal Grain Transfer System

The receipt of large volumes of grain and soybeans and their delivery to grain ships require an extensive network of transportation and grain receiving, loading, and storage facilities. The inflow of grain and soybeans by rail and truck and its subsequent delivery to outbound ships by port elevators give rise to the intermodal grain transfer system. The purpose of this section is to present a brief description of this system as it exists at the Port of Houston. Figure 2 provides a generalization of the system's features.

Railroads

The large volume of rail traffic entering the Houston rail terminal complex requires an extensive network to deliver cars to the port's grain elevators. Houston is serviced by six major class I railroads and two local terminal railroads. The six class I railroads servicing Houston are 1) Atchison, Topeka, and Santa Fe, 2) Chicago, Rock Island, and Pacific, 3) Ft. Worth and Denver, 4) Missouri-Kansas-Texas, 5) Missouri Pacific, and 6) Southern Pacific. The two terminal railroads are the Port Terminal Railroad Association, owned by the above six lines, and the Houston Belt and Terminal. The Houston Belt and Terminal is owned by the Missouri Pacific (50%), Santa Fe (25%), Rock Island (12.5%), and Ft. Worth and Denver (12.5%). The Port Terminal Rail Association and Houston Belt and Terminal interline with the above railroads and are responsible for classifying and delivering loaded rail cars to the grain elevators and returning the emptied cars to the connecting rail lines.

The Houston Belt and Terminal system directly serves the Santa Fe, Rock Island, Ft. Worth and Denver, and Missouri Pacific railroads (Figure 3). The Houston Belt and Terminal assembles inbound cars destined for a particular elevator and switches these cars to designated tracks for pickup by the Port Terminal Rail Association, which subsequently makes elevator delivery. Inbound grain cars on the Missouri-Kansas-Texas and Southern Pacific are released directly to the Port Terminal Rail Association for delivery to elevators.

Currently, 29 yards constitute the Houston rail terminal system, which has a total capacity of 23,042 cars (Figure 4). Eleven of these yards are operated by the Houston Belt and Terminal system. The Port Terminal Rail Association and Southern Pacific operate eight and nine yards, respectively, and the Missouri-Kansas-Texas railroad operates one yard. The Eureka (Missouri-Kansas-Texas), Settegast (Missouri Pacific), Englewood (Southern Pacific), Basin (Houston Belt and Terminal), North (Port Terminal Rail Association), New South (Houston Belt and Terminal), and Manchester (Port Terminal Rail Association) yards are primarily responsible for handling grain traffic. The principal purposes of these railyards are classification and interchange of rail traffic.

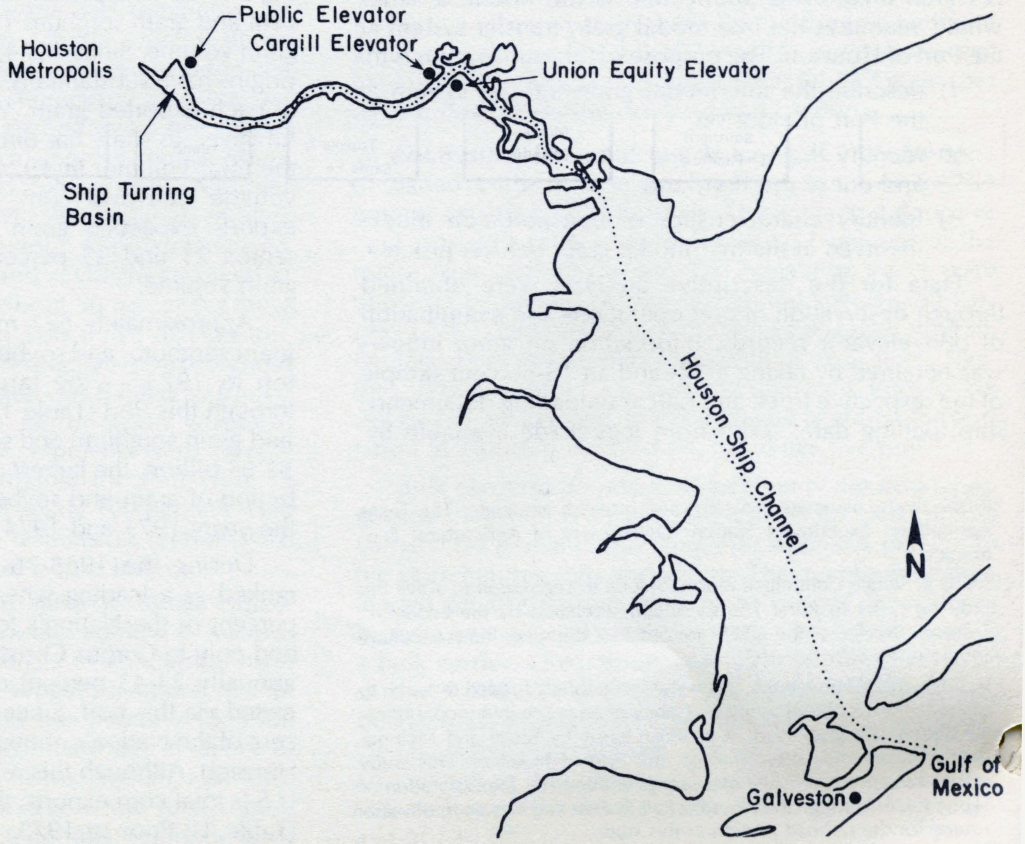

Figure 1: Houston Ship Channel.

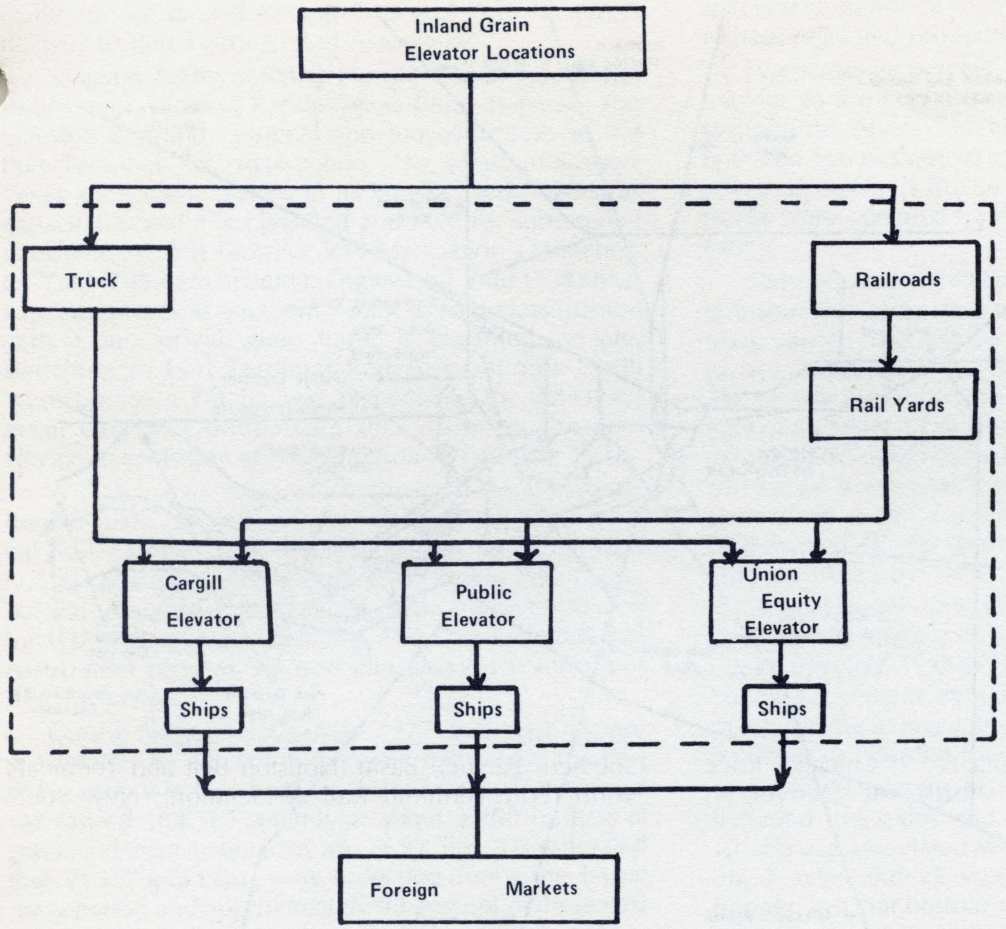

Figure 2: Port of Houston's intermodal grain transfer system.

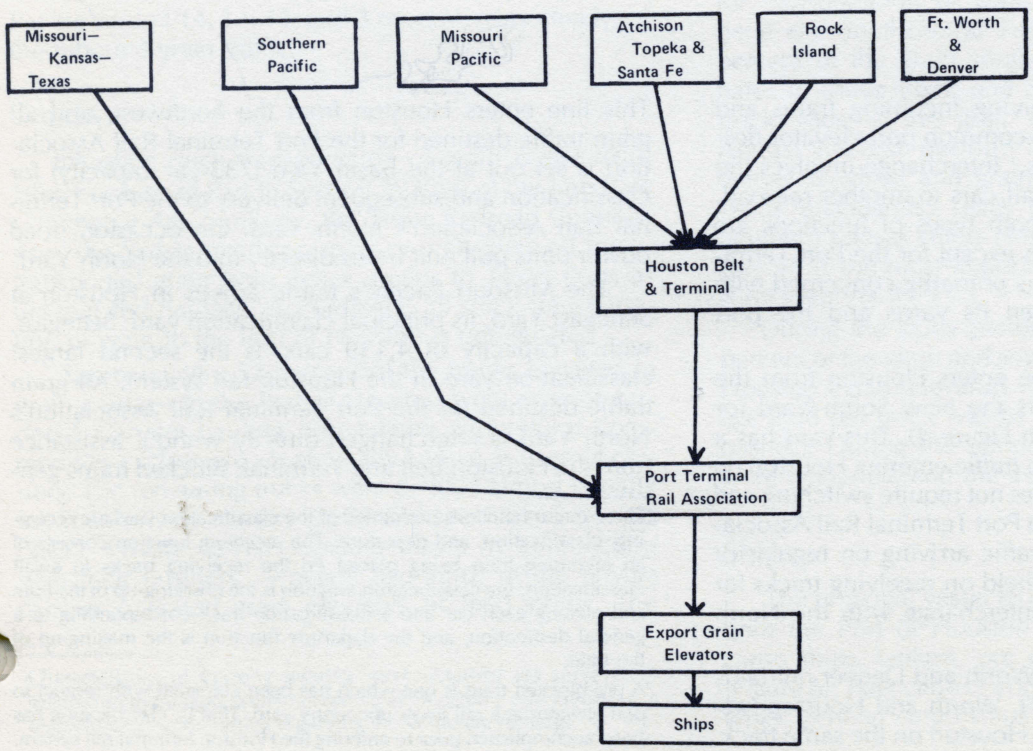

Figure 3: Relationship of six road lines and two terminal railroads.

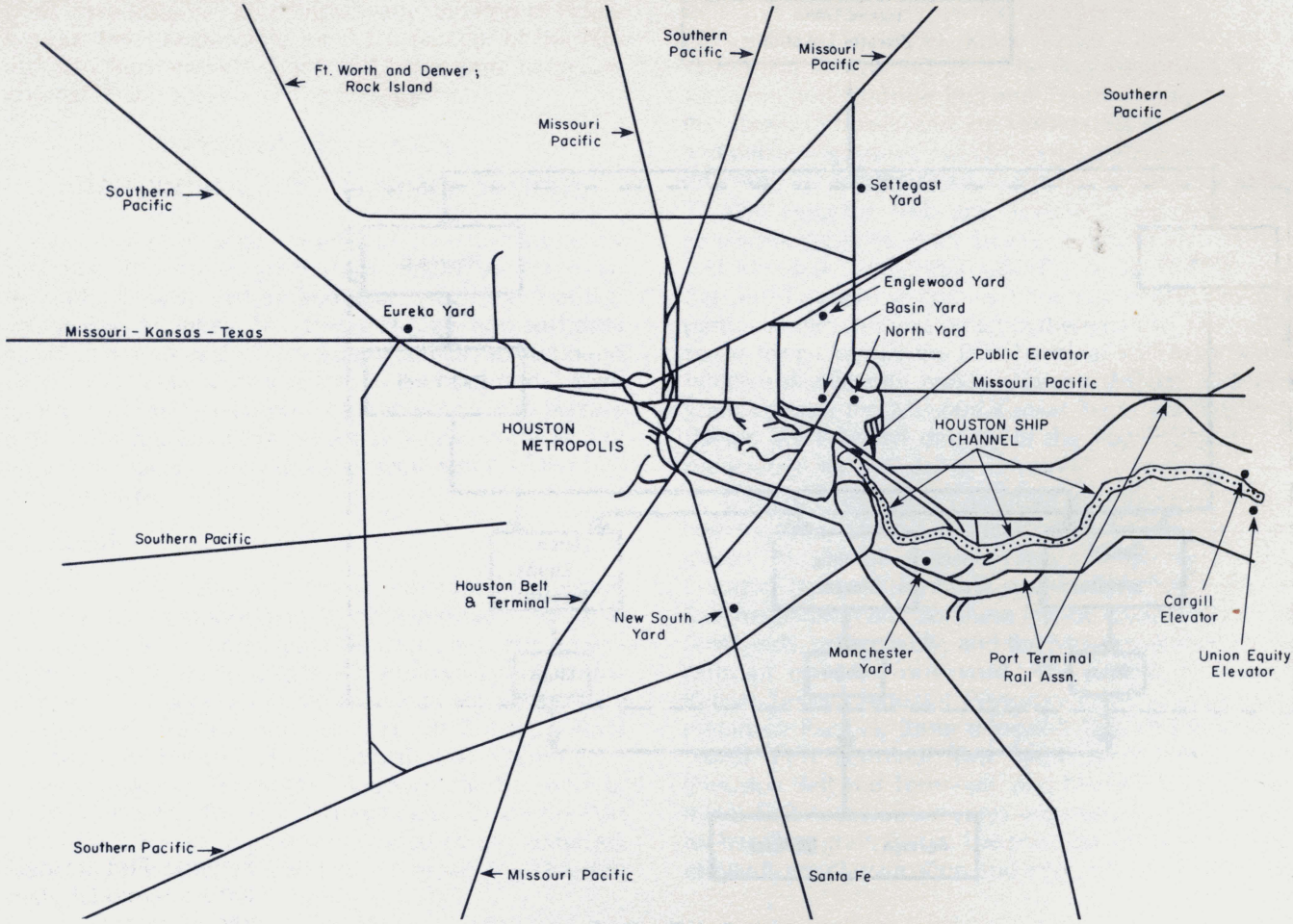

Figure 4: Houston Rail Terminal complex with location of principal grain traffic yards.

Classification involves receiving incoming trains and reassembling the cars with a common port elevator destination into outbound trains.[3] Interchange involves the transfer of these outbound rail cars to another railroad. To a considerable extent, both types of functions are accomplished by these yards except for the Port Terminal Rail Association, which is primarily concerned with interchange of cars between its yards and the port elevators' rail yards.

The Santa Fe's main line enters Houston from the south where all traffic enters the New South Yard for classification (*see* location in Figure 4). This yard has a capacity of 1,386 cars. Grain traffic entering Houston on pre-blocked or unit trains does not require switching and may be transferred directly to Port Terminal Rail Association's North Yard.[4] Grain traffic arriving on regular or non-blocked trains must be held on receiving tracks for switching and subsequent interchange with the North Yard.

The Rock Island and Ft. Worth and Denver railroads share track rights between Ft. Worth and Houston; accordingly, their traffic enters Houston on the same track. This line enters Houston from the northwest, and all grain traffic destined for the Port Terminal Rail Association is set out at the Basin Yard (733-car capacity) for classification and subsequent delivery to the Port Terminal Rail Association's North Yard. On occasion, road power units pull unit trains directly into the North Yard.

The Missouri Pacific's traffic arrives in Houston at Settegast Yard, its principal classification yard. Settegast, with a capacity of 4,139 cars, is the second largest classification yard in the Houston rail system. All grain traffic destined for the Port Terminal Rail Association's North Yard is interchanged directly without assistance from the Houston Belt and Terminal. Blocked trains gen-

[3]Three major functions performed in the classification yard are receiving, classification, and departure. The receiving function consists of an incoming train being placed on the receiving tracks to await classification; the classification function is the breaking-up of the train and placing each car into a classification track corresponding to a general destination, and the departure function is the making-up of the train.

[4]A pre-blocked train is one which has been classified with respect to port elevator at a rail line's upcountry yard. That is, classification has been accomplished prior to entering the Houston terminal rail system.

erally are not moved through Settegast Yard for direct delivery to Port Terminal Rail Association.

All grain traffic entering Houston on the Southern Pacific and Missouri-Kansas-Texas lines by-passes the Houston Belt and Terminal and moves directly to the Port Terminal Rail Association. The Missouri-Kansas-Texas grain traffic arrives in its Eureka Yard (1,200-car capacity) where it is classified and held for subsequent transfer to the Port Terminal Rail Association's Manchester Yard (749-car capacity). Englewood Yard (5,000-car capacity) serves as Southern Pacific's main classification yard. Upon arrival, grain traffic is classified for later switching to Port Terminal Rail Association's North Yard. Southern Pacific was responsible for delivering grain cars to Goodpasture Inc., prior to the port elevator's explosion and destruction in February 1976.

With the exception of traffic from the Missouri-Kansas-Texas, all inbound grain traffic to the Port Terminal Rail Association is interchanged at its North Yard (2,190-car capacity). Trains received by the Port Terminal Rail Association are placed on an inbound holding track prior to elevator delivery. The Port Terminal Rail Association services the port elevators three times per 24-hour period.

During the June 1976-May 1977 study period, approximately 81 percent of the grain received at the Port of Houston was delivered via the railroads. The average car carried 188,165 pounds or about 3,200 bushels of grain, and the average haul was 669 miles. It is estimated that 69,517 grain cars were unloaded during the 1-year study period and approximately 93 percent of these cars were covered hoppers; the remainder were box cars. During the study period, the Santa Fe carried approximately one-third of the inbound grain cars and the Rock Island about one-fourth. The Ft. Worth and Denver, Missouri-Kansas-Texas, Missouri Pacific, and Southern Pacific carried 14, 14, 12, and 3 percent, respectively, of the inbound grain traffic.

Trucks

Interstate truck transportation of grain is not regulated because of Part II, Section 203(b)6 of the Interstate Commerce Act. Similarly, the Texas Railroad Commission, the State's regulatory agency, considers all truck-transported grain from Texas origins to Texas Ports as unregulated haulage. Accordingly, all truck transportation of grain to the Port of Houston is unregulated.

Approximately 52 percent of the trucks engaged in grain haulage to the Port of Houston were exempt carriers.[5] Carriers hauling unregulated agricultural commodities exclusively are generally known as exempt carriers. The remaining trucks were divided almost equally between private carriers (26%) and specialized carriers (22%). Private carriers operate trucks in conjunction with their business — nearly two-thirds of the private carriers operated grain elevators or feed stores. The specialized motor carriers hold Texas intrastate permits to haul regulated products.

Twenty-seven percent of the trucks engaged in grain haulage to the Port of Houston were operated by one-tractor firms. Approximately 23 percent of the truck firms operated two or three tractors, while another 22 percent operated four to six trucks. Slightly over one-fourth of the trucks were operated by firms with seven or more tractors.

Some expected relationships existed between firm size (number of tractors operated per firm) and type of truck carrier. The smaller firms were generally exempt carriers, while the larger firms were specialized carriers. The private motor carriers tended to be larger firms than agricultural exempt carriers, but smaller than specialized carriers. Two-thirds of the exempt carriers operated three trucks or fewer, whereas only 12 percent of the specialized motor carriers were of this size category. Slightly over 40 percent of the private carriers had three or fewer trucks per firm.

Approximately one-third of the trucks traveled less than 75,000 miles per year. About 50 percent of the trucks traveled 75,000-125,000 miles per year, while nearly 12 percent annually traveled 125,000-150,000 miles. On the average, the trucks engaged in grain transportation to Houston traveled 94,202 miles per year.

Over 99 percent of the truck-trailer configurations included five axles and 18 wheels. Two axles and 6 wheels are associated with the tractor, and the remaining 3 axles and 12 wheels constitute the trailer. The hopper and flat-bottom trailers represented 23 and 76 percent of the respective trailer designs.

Figure 5 shows the major highway arteries into Houston and their proximity to the port elevators. Highways 290, 10, 59, 288, and 35 are the principal arteries used for transportation of grain sorghum from the Coastal Bend and Southcentral Texas areas. Approximately 40 percent of the grain sorghum entering Houston originates in these areas, and 83 percent is transported by truck. Most of this grain is received during the July-August harvest period. The majority of the truck-delivered wheat and grain sorghum originating in the Texas Blacklands, Texas Panhandle, Oklahoma, and Southern Kansas enters Houston via Highway 45. Highway 45 is the most important artery for truck-delivered grain entering the Port.

During the study period (July 1976-May 1977), 19 percent of the grain and soybeans received by the Port of Houston's grain elevators was truck-delivered. The average load per truck was 65,764 pounds or about 1,120 bushels. During the period of analysis, 44,352 trucks were unloaded, and the average haul was 280 miles.

Ships

The principal vessel types employed in grain haulage from the Port of Houston were bulk carriers, general cargo ships, tankers, ore carriers, and container ships (Figure 6). Bulk carriers comprised 65 percent of the ship types, general cargo ships 25 percent, tankers 7.7 per-

[5]Characteristics of trucking industry were obtained via surveys administered to truckers while unloading at Houston's port elevators. A publication is forthcoming regarding the complete findings.

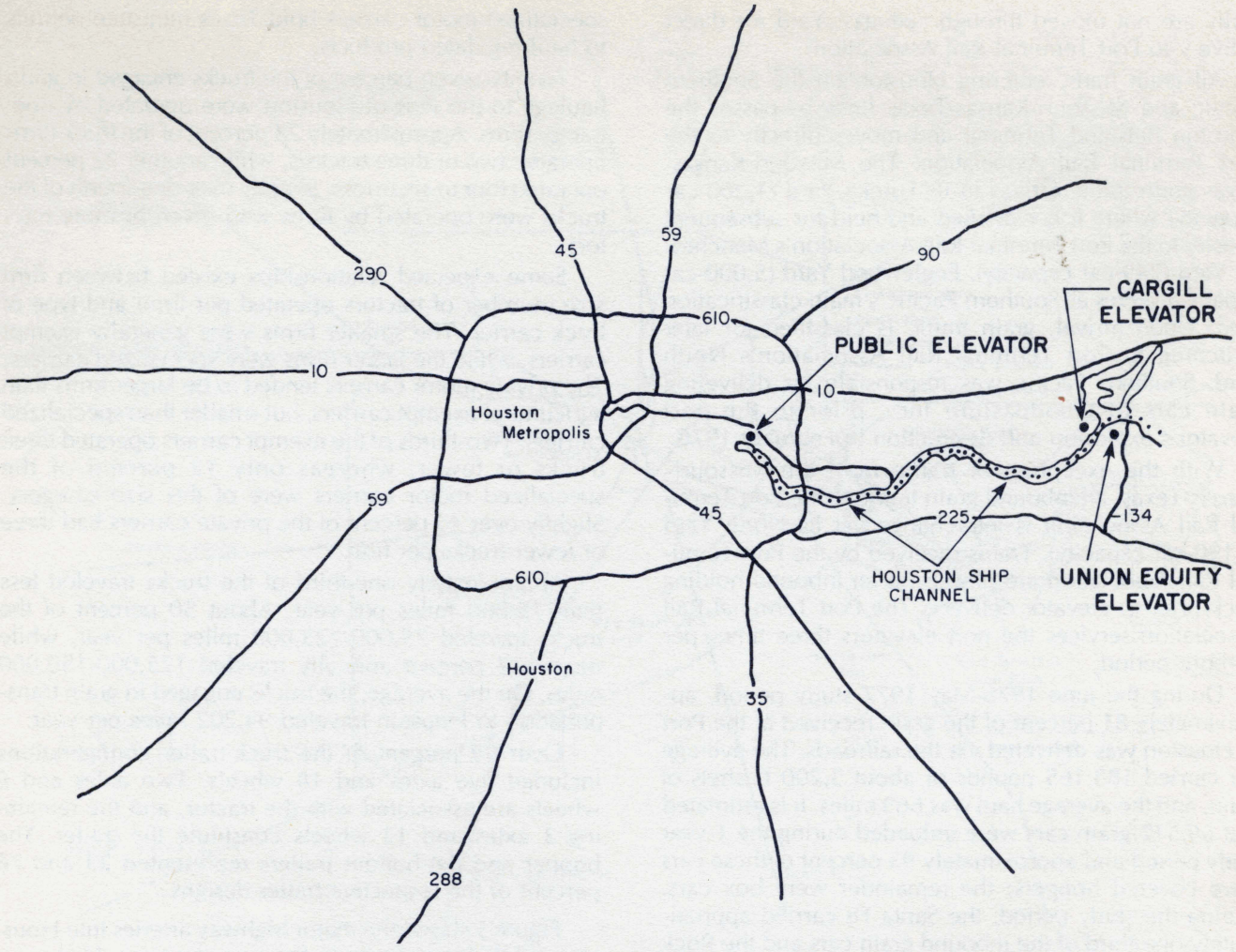

Figure 5: Major highway arteries leading to Port elevators.

cent, ore carriers 1.9 percent, and container ships 0.4 percent of the grain hauling ship population.[6]

Bulk carriers are relatively large single-deck vessels designed for carrying dry cargo. The largest bulk carrier loaded during the study period was a 80,013-dead-weight-ton (d.w.t.) vessel[7] (Table 2). The average dead-weight tonnage of bulk carriers was 31,238 d.w.t. Ore carriers are a type of bulk carrier designed for the transportation of metallic ores. These vessels ranged in size from 64,336 to 83,518 dead-weight tons, the largest of the grain-hauling ship types. One of every four vessels taking on grain at the Port of Houston was a general cargo ship and, in general, was the smallest ship type. The average size of the general cargo ship was 10,268 d.w.t. Tankers are designed for carrying liquid cargoes; however, they can be converted into grain carrying vessels by thoroughly cleaning the oil tanks, encasing the tank suctions in wood, and closing off oil pipes. Tankers ranged in size from 19,073 to 82,069 d.w.t. and averaged 43,230 d.w.t. The basic idea of the container ship has been to combine the cargo (i.e. mostly finished goods) into larger units in containers which are then stacked in the ship's hold, thus improving the accessibility of holds. Only one container ship received grain during the study period.

The quantities of grain loaded on the various ship types ranged from 9,940 bushels on a general cargo ship to 2,137,333 bushels on a bulk carrier (Table 3). Ore carriers and tankers, on the average, carried 1,608,324 and 1,241,994 bushels of grain, respectively. Bulk carriers averaged 811,362 bushels per vessel, while the respective general cargo and container ships carried an average of 267,980 and 113,407 bushels. A total of 365 vessels loaded during the study period carried an average of 730,685 bushels per vessel.

The draft of a ship is the vertical distance between the waterline and keel. In general, the larger the vessel,

[6]Ship information was obtained from Lloyd's Registry of Shipping, *Annual Report for the Year 1976*.

[7]The dead-weight capacity (d.w.t.), or the carrying capacity of a vessel is the total weight of cargo, bunkers, water and extra weights expressed in tons of 2,240 lbs. which it can lift when loaded in salt water to maximum draft. The draft of a ship is the vertical distance between the waterline and keel.

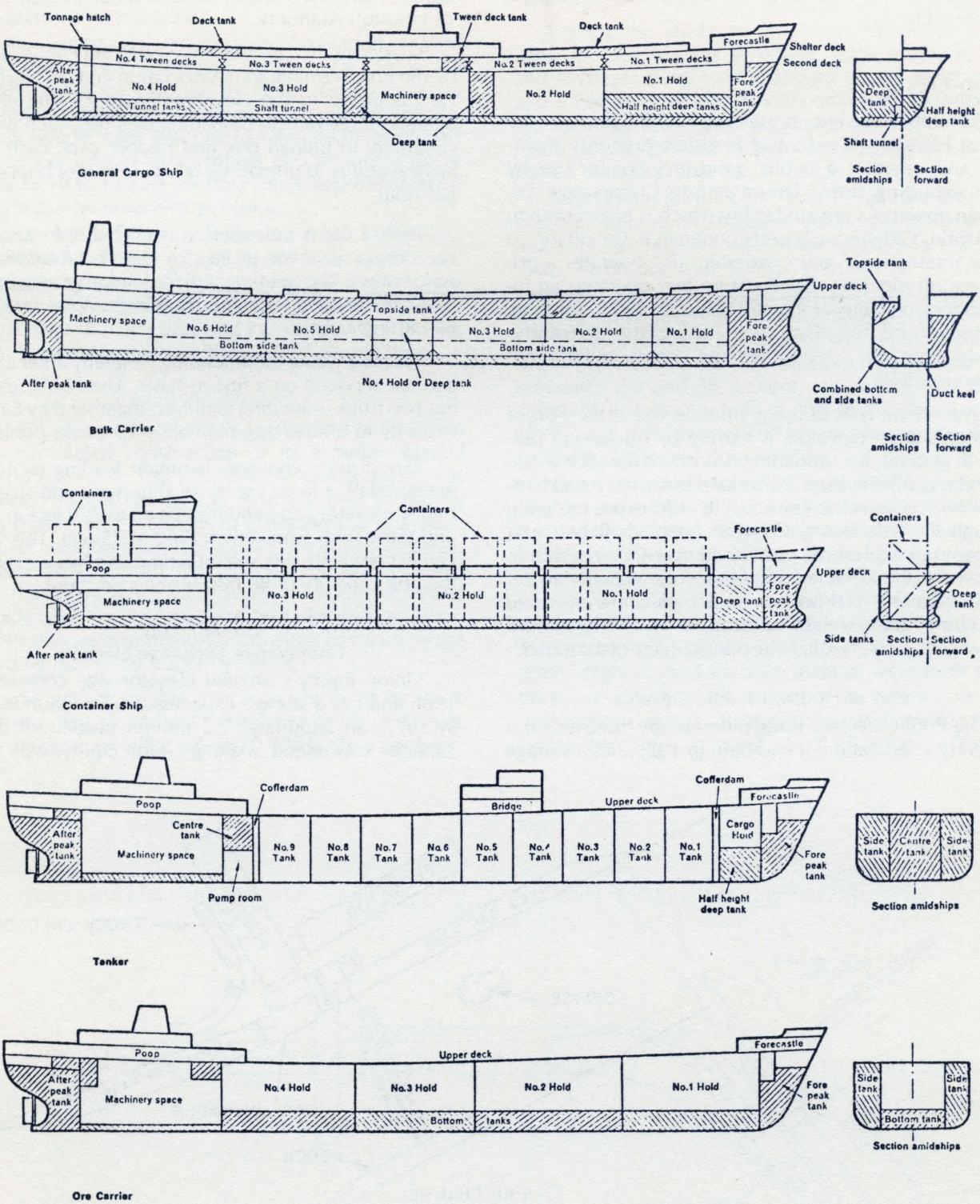

Figure 6: Principal ship types used in grain transportation.

the greater its draft (Table 4). During the study period several bulk and ore carriers with loaded drafts of 46 feet were docked for grain loading; however, the maximum draft which can be accomodated at the grain elevators ranges from 35 to 41 feet. This implies that these vessels were not able to be fully loaded. Bulk carriers and tankers had average drafts of 36 and 38 feet, respectively. The general cargo vessels had the smallest average draft of 25 feet, while the ore carriers had an average draft of 44 feet — the largest draft of any vessel type taking on grain at the Port of Houston. Practical experience has shown that up to a point, the larger the ship employed in

the transport of bulk cargoes, the lower the cost per ton-mile (3).

Grain Elevators

Currently three export grain elevators operate at the Port of Houston. The Port of Houston Authority maintains and operates a public grain elevator for use by grain exporting firms. Union Equity Cooperative Exchange operates a private facility which is an export arm of an Enid, Oklahoma, based cooperative. Cargill Inc., a major international grain exporter, also operates a private export elevator. Goodpasture Inc. operated an independent port elevator until February 1976 when an explosion and fire destroyed its facility. Currently, Goodpasture Inc. is rebuilding and expects to be in operation in 1978.

Over 99 percent of the grain received at the Port of Houston's grain elevators is carried by trucks and railcars. In general, the unloading procedure for each mode is similar at all elevators. To unload box cars, a mechanical device grasps the car and tilts it to expel the grain through the side doors. Covered hopper rail cars and hopper truck trailers are positioned over their respective pits where the vehicles' bottom doors are opened for grain unloading. Flat-bottom truck trailers are unloaded via a combination weight scale and lift which tilts upward so that grain flows through the open tailgate of the trailer.

Port of Houston Public Elevator

The Public Elevator is the oldest of the three facilities currently in operation. It was built in 1925, has a storage capacity of 6 million bushels, and is operated by the Port of Houston Authority.

Loaded grain cars are delivered to the Public elevator by the Port Terminal Rail Association and are stored in a yard adjacent to the elevator (Figure 7). The elevator operates three rail car unloading facilities, each with the capability to unload box and hopper cars. Each dump has the ability to unload six box cars or four hopper cars per hour.

After a car is unloaded, it is pushed into the empty car storage yard for pickup by the Port Terminal Rail Association. The holding yard for loaded grain cars has a 111-car capacity, but that holding empty cars has a 67-car capacity.

Trucks arriving for unloading generally enter a queue and are serviced on a first-in basis. The Public elevator has two truck unloading facilities; together they have the capacity to unload approximately 25 trucks per hour.

Export grain elevators maintain loading facilities to accomodate a large variety of ship types and sizes. The Public elevator can handle ships up to 750 feet in length and those with a maximum draft of 35 feet. This facility can accomodate one ship at a time and has a maximum loading capacity of 80,000 bushels per hour.

Union Equity Cooperative Exchange Elevator

Union Equity's original elevator was completed in 1966 and has a storage capacity of 6.5 million bushels. In 1977, an additional 2.2 million bushels of storage capacity was added, making Union Equity, with its 8.7

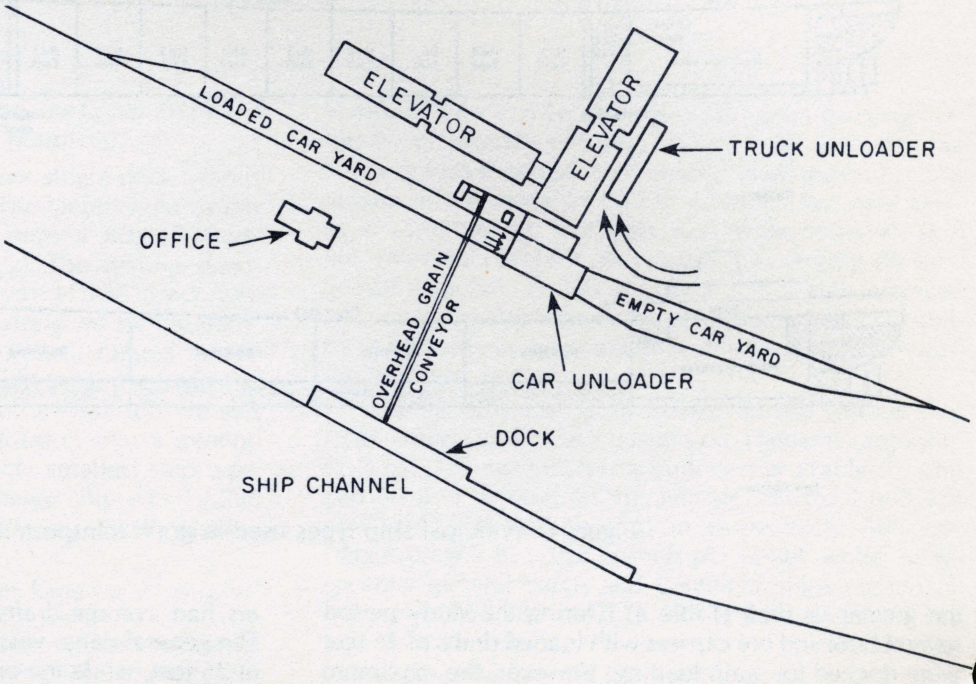

Figure 7: Layout of Port of Houston's public elevator yard.

million bushels of storage capacity, the largest of the Port's grain storage facilities.

Union Equity's rail yard consists of a loaded car yard with a capacity of 171 cars and an empty car yard with a capacity of 192 cars (Figure 8). Union Equity operates three rail car unloaders — two are designed for unloading only hopper cars, and one has the ability to unload either box or hopper cars. Hopper cars are unloaded at the rate of 10 to 12 cars per hour while approximately 8 box cars can be unloaded per hour.

Union Equity also operates two truck unloaders, each with a rated service capacity of 16 trucks per hour, and a dock that can service ships up to 900 feet in length and those with a maximum draft of 40 feet. This facility can load one ship at a time and can deliver grain to the ship at a maximum rate of 90,000 bushels per hour.

Cargill Inc. Elevator

Cargill, one of the Nation's leading grain exporting firms, completed construction of its 4-million-bushel Houston facility in 1967. Its rail car unloading area is connected to the car storage yard via two unloading tracks (Figure 9). One leads to a hopper car unloader; the other includes a box car and a hopper car unloader. After cars are unloaded, they are returned to an emptied track in the car storage yard. Ten to 12 hopper cars and approximately six box cars can be unloaded per hour. Cargill operates one truck dump which has an average unloading rate of 10 trucks per hour.

Cargill's dock facility can accomodate ships up to 900 feet in length and with maximum drafts of 41 feet. Ships are serviced at the rate of 70,000 bushels per hour.

Source of Grain and Soybean Receipts

During the study period (June 1976-May 1977), 266.7 million bushels of wheat, grain sorghum, corn, and soybeans were loaded aboard ocean-going vessels at the Port of Houston. Wheat comprised 50 percent of the loadings while grain sorghum, corn, and soybeans made up 24, 22, and 4 percent of the respective exported volume (Table 5).

Nearly one-third of the Port's exported grain and soybean volume originated in Texas; slightly over one-fourth of the receipts were from Oklahoma (Table 6). Iowa, Nebraska, and Kansas shipped 15, 11, and 10 percent of the Ports' respective grain and soybean inflow. Texas ranked first as an originator of grain sorghum (59%) and second as a source of wheat (31%) and soybeans (35%); Iowa was the principal source of corn and soybeans, (56 and 36 percent, respectively);Oklahoma supplied nearly one-half of the total wheat receipts (49%); and Nebraska ranked second as a source of grain sorghum (29%) and corn (18%).

Grain flows were identified as originating from country elevators (initital assemblers) or inland terminals (secondary holders). Grain originating from secondary holders implies transshipped grain; grain originating from initial assemblers indicates direct shipment (Table 6). Approximately 72 percent of the wheat destined for the Port of Houston originated from secondary holders. In contrast, only 16, 28, and 10 percent of the corn, grain sorghum, and soybean receipts were from secondary sources. About 85 percent of the wheat from Oklahoma, the principal wheat supplier, originated from secondary holders. In contrast, about 97 percent of the corn

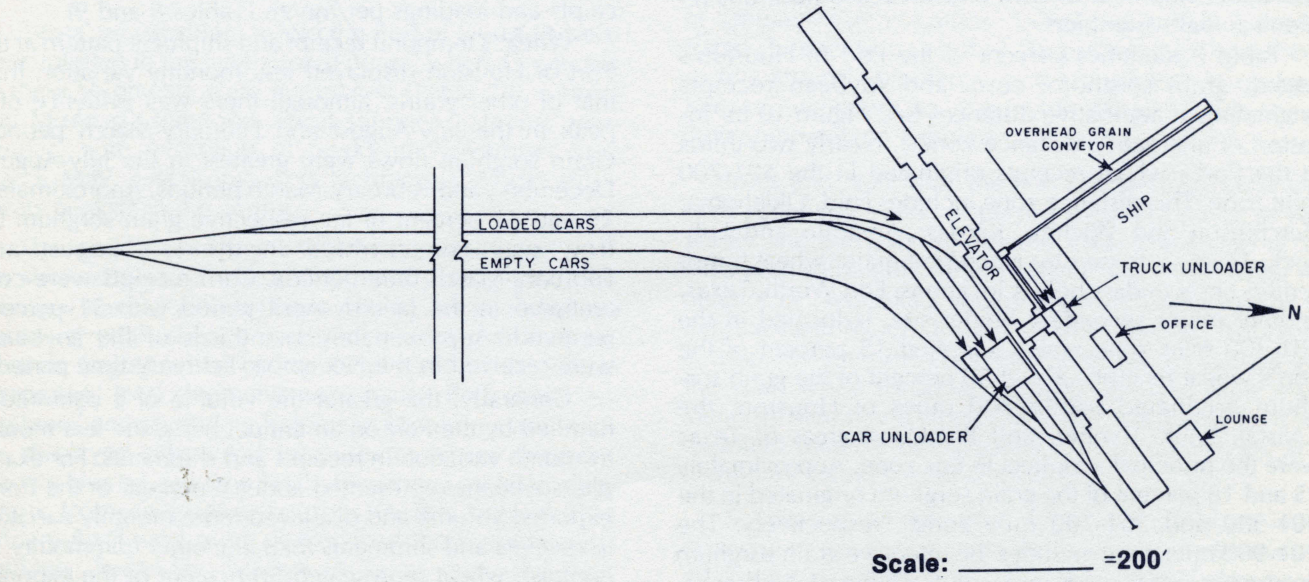

Figure 8: Layout of Union Equity Elevator yard.

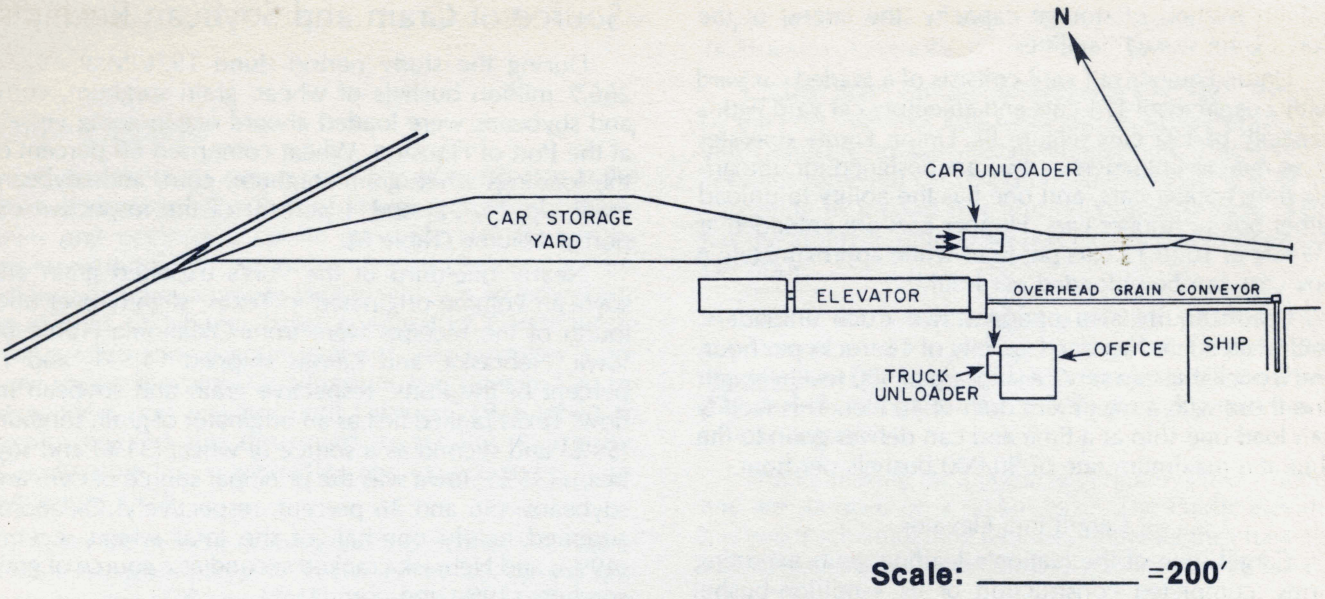

Figure 9: Layout of Cargill Elevator yard.

and soybeans were from secondary sources. About 85 percent of the wheat from Oklahoma, the principal wheat supplier, originated from secondary holders. In contrast, about 97 percent of the corn and soybeans coming from Iowa sources originated with initial assemblers. This variation in marketing patterns is due to the rail rate structure. In the wheat producing areas, rail rates are structured so that grain may transit (be stored) at inland terminal locations at no additional transportation cost to the shipper. Accordingly, substantial volumes of wheat transit through secondary holders. Unit train rates from Iowa country-elevator origins to Gulf ports facilitate direct shipment of corn and soybeans from this region's initial assemblers.

Table 7 identifies percent of the Port of Houston's wheat, grain sorghum, corn, and soybean receipts originating at alternative distances (*see* Figure 10 for location of alternative distance zones). Nearly two-thirds of the Port's wheat receipts originated in the 501-700 mile zone. This distance zone includes Enid, Oklahoma; Hutchinson and Wichita, Kansas; Amarillo and Lubbock, Texas — these sites respresent major wheat transit centers or secondary holder locations. Fort Worth, Texas, another major secondary holder site, is located in the 201-300 mile zone which supplied 15 percent of the Port's wheat receipts. About 50 percent of the grain sorghum originated within 300 miles of Houston; the Coastal, South Central, and Blackland areas of Texas were the principal suppliers in this zone. Approximately 25 and 18 percent of the grain sorghum originated in the 701-900 and 501-700 mile zones, respectively. The 701-900 mile zone includes the intensive grain sorghum producing areas of Kansas and southeast Nebraska, while the 501-700 mile zone includes a major producing area located in the Texas and Oklahoma Panhandle. Over 83 percent of the Port's corn receipts came from the 801-1,100 mile zone which includes the principal corn production areas of Iowa and Nebraska. The 0-300 and 800-1,100 mile zones were the principal sources of soybean receipts. These zones include Texas, Louisiana, and Iowa, the major suppliers of soybeans.

Temporal Receipt and Shipment Patterns

In general, the volumes of grain received and loaded per month are of similar magnitude at the Port of Houston. The primary purpose of port elevator storage capacity is coordination of grain inflow and outflow; accordingly, the similarity in percentages of annual grain receipts and loadings per month (Tables 8 and 9).

Wheat's temporal receipt and shipment pattern at the Port of Houston displayed less monthly variation than that of other grains, although there was evidence of a peak in the July-August and February-March periods. Grain sorghum flows were greatest in the July-August, December, and February-March periods. Approximately 29 and 31 percent of the respective grain sorghum inflow was concentrated in the July-August and February-March time periods. Corn receipts were concentrated in the January-April period with 51 percent received. Approximately two-thirds of the soybeans were received in the November-February time period.

Generally, the greater the volume of a commodity handled by the Port on an annual basis, the less month-to-month variation in receipts and shipments. For example, soybeans represented about 4 percent of the Ports' exported volume and displayed more monthly variation in receipts and shipments than any other commodity. In contrast, wheat represented 50 percent of the exported volume and displayed less variation in temporal patterns than other commodities.

The Port of Houston's aggregate grain and soybean flow peaked in August, February, and March (Tables 8

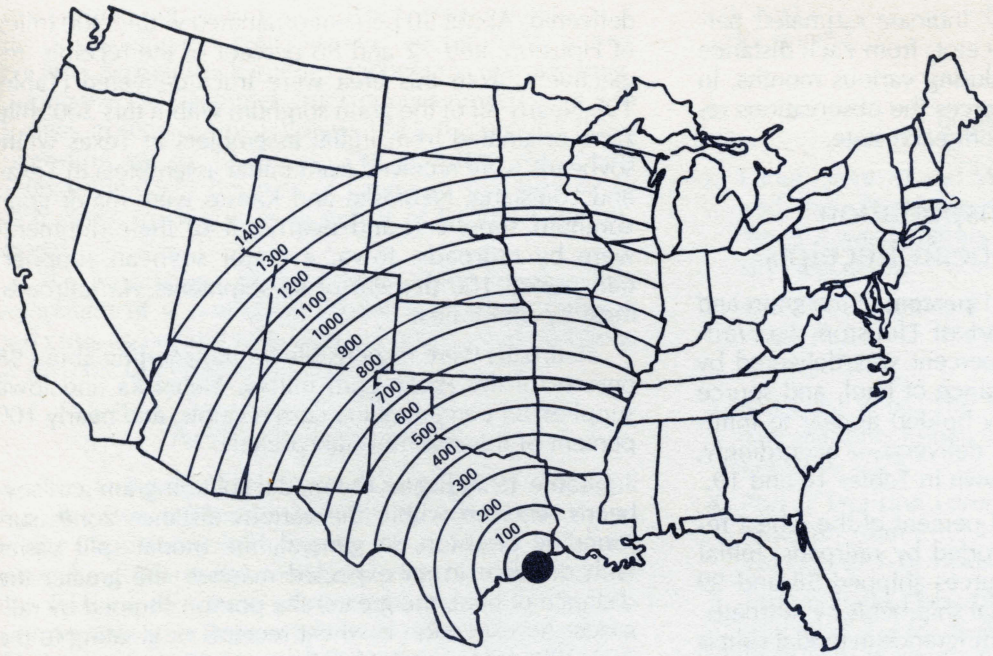

Figure 10: One-hundred mile distance zones about the Port of Houston.

and 9). During each of these months 11-14 percent of the Port's annual volume was handled. Flows peaked in August as a result of above average wheat, grain sorghum, and corn volumes; in February because of increased volumes of grain sorghum, corn, and soybeans; and in March because of above average flows for wheat, grain sorghum, and corn. In all remaining months, except September and October, 6-9 percent of the annual volume was handled. Only 4-5 percent of the Port's total volume was handled during each of the months of September and October. Tables 10, 11, 12, and 13 identify temporal shipment patterns for each state and its initial assemblers and secondary sources.

Texas' wheat shipments to the Port of Houston were concentrated in the June-August period when 47 percent of these shipments were completed (Table 10). Kansas and Missouri's temporal wheat shipment patterns were similar, with evidence of peaks in November and March-May. Oklahoma and Nebraska's wheat shipments peaked in the spring.

The initial assemblers in Oklahoma, Texas, and Kansas showed peaked wheat shipments during June, the principal harvest month (Table 10). In Texas, initial assemblers' peak shipment period extended from June through August when nearly 71 percent of the initial assemblers' total shipments were made. Both initial assemblers' and secondary holders in Oklahoma and Kansas displayed substantial increases in wheat shipment activity during January-April. In general, wheat shipments from secondary sources in this area during January-April were more peaked than those of initial assemblers. Secondary holders in Texas increased their wheat shipments in June-August, November, and May.

The principal grain sorghum producing states of Texas, Nebraska, and Kansas had significantly peaked temporal shipment patterns. Nearly one-half of Texas' grain sorghum shipments to the Port of Houston were concentrated in July and August, the harvest period for grain sorghum produced in the Southcentral and Coastal areas of Texas. Nebraska's grain sorghum shipments were concentrated in February and March when 48 percent of this area's shipments were completed. Approximately two-thirds of Kansas' shipments were in December, February, and March. In Nebraska, the initial assemblers and secondary holders displayed similar temporal shipment patterns. Texas' initial assemblers shipped approximately 54 percent of their Houston-destined grain sorghum in July and August, while the secondary sources shipped two-thirds of their shipments in January-March. Kansas' initial assemblers concentrated shipments in October-December when two-thirds of this groups' shipments were completed. In contrast, Kansas' secondary sources made about 55 percent of their shipments in February and March.

Iowa and Nebraska, the Port of Houston's principal corn supplying states, displayed shipment peaks in late winter and early spring months. Over one-fourth of Iowa's corn shipments were in March and April, while 47 percent of Nebraska's shipments were concentrated in February and March. Iowa's initial assemblers displayed a relatively uniform corn shipment pattern throughout the year, while secondary sources grouped their shipments in March and April. Generally, the temporal corn shipment patterns of Nebraska's initial assemblers and secondary sources were similar.

Soybean shipments from Texas and Louisiana were concentrated in their harvest period or shortly thereafter. About 72 percent of the Texas-originated shipments were in November-January while 77 percent of Louisiana's shipments were in September and October. About 50 percent of Iowa's soybean shipments to the Port of Houston occurred in April and May.

Tables 14, 15, 16, and 17 indicate estimated percentage of grain or soybean receipts from each distance zone to the Port of Houston during various months. In general, this information reinforces the observations regarding temporal shipments from each state.

Modes of Transportation of Grain and Soybean Receipts

During the study period, 81 percent of the grain and soybeans received at the Port of Houston was rail-delivered; the remaining 19 percent was delivered by trucks. Time of shipment, distance of haul, and source (initial assembler or secondary holder) appear to influence modal split (rail or truck delivery) — accordingly, the variation in modal split shown in Tables 18 and 19.

On the average, nearly 88 percent of the wheat received at the Port was transported by railroads. Initial assemblers and secondary sources shipped 58 and 99 percent of their respective wheat shipments by railroads. One reason for the substantial difference in modal split is the rail rate structure. The rail rate, in the wheat producing areas, permits wheat to be shipped from initial assembler to Gulf ports on a single through rate with intermediate stops for wheat storage (transit). That is, the rail rate on the direct shipment from initial assembler to Gulf port is equal to the sum of the rates from initial assembler to secondary holder and from secondary holder to Gulf port. Accordingly, the transportation costs to the shipper are the same for direct and transited shipments. In general, the sum of the trucking rates from initial assembler to secondary holder and from secondary holder to Gulf ports is substantially higher than the rail rate. However, in many areas the direct trucking rate from initial assembler to Gulf ports is lower than the rail rate. Because of initial assemblers' storage limitations, much of their wheat is transported via railroads to secondary holders for storage; thus railroads are able to capture a significant portion of the wheat transportation market, even though their rate is greater than the truck rate. Wheat which remains in storage with initial assemblers is more likely to be direct-shipped to the Port later via trucks because the direct trucking rate from initial assembler to Gulf port may be lower than the rail rate — accordingly, the difference in modal split between initial assembler and secondary holder.

Initial assemblers in the principal wheat supplying states of Oklahoma, Texas, and Kansas shipped 27, 60, and 43 percent of their Houston-destined wheat shipments via railroads. This variation is partially due to a time of shipment and the extent that shipments are concentrated in a time period. During peak shipment periods, initial assemblers appear to rely on railroads to a greater extent than during non-peak periods. Texas' initial assemblers grouped 71 percent of their wheat shipments in June, July, and August — accordingly, the higher portion of annual wheat shipments by rail than in other areas.

Approximately 45 percent of the grain sorghum and soybeans received at the Port of Houston was truck-delivered. About 50 percent originated within 300 miles of Houston, and 72 and 86 percent of the receipts, respectively, from this area were truck-delivered (Table 19). Nearly all of the grain sorghum within this 300-mile zone originated from initial assemblers in Texas while soybeans were received from initial assemblers in Texas and Louisiana. Nebraska and Kansas were major grain sorghum suppliers, and nearly all of their shipments were by railroads. Iowa, a major soybean supplier, transported 100 percent of its shipments via railroads, most by unit trains.

Railroads were responsible for transporting about 98 percent of the Port's corn inflow. Nebraska and Iowa supplied 85 percent of the corn receipts, and nearly 100 percent of this was rail-transported.

Table 19 indicates the modal split on grain and soybeans received within the various distance zones surrounding Houston. In general, the modal split varies with distance in an expected manner; the greater the distance of haul, the greater the portion shipped by railroads. An exception is wheat receipts originating in the 201-300 mile zone. Slightly over 90 percent of the wheat from this zone was rail transported, a larger percentage than might be expected. Fort Worth, Texas, a major wheat transit location, is located in this zone and receives and ships most of its annual volume via the railroads — accordingly, the unexpected proportion carried by this mode.

Foreign Destinations

Japan and the United Soviet Socialist Republic (USSR) received 23.1 and 19.8 percent, respectively, of the Port of Houston's exported grain and soybean volume (Table 20). The USSR was the leading wheat (27%) and corn (29%) importer; Japan received 47.4 percent of the exported grain sorghum volume. Approximately 50 percent of the soybeans were destined for Europe.

Cargo Sizes by Destination and Commodity

Table 21 indicates distribution of cargo sizes; Table 22 shows the average number of bushels loaded on vessels destined for alternative foreign destinations. In general, the average cargo sizes for grain sorghum and corn were greater than for wheat or soybeans (Table 21). On the average, cargo sizes of grain shipments to the USSR were substantially larger than those destined for other countries (Table 22).

Observation

Because of limited port elevator storage capacity and large volumes of grain and soybeans moving into export, coordination of domestic grain carriage and ship transportation is essential. If inbound modes and ship arrival are not coordinated, delays and waiting costs are incurred. Additional complications are created by seasonal surges in grain arrival, inclement weather which stops ship loading, and labor-management problems. As

an example, during July and August, nearly one-third of the truck-delivered grain arrives; accordingly, during this time period, truck queues become excessively long. During the 1976 summer, truck queues ranged from 2 to 3 miles in length; this involved truck turnaround times extending up to 30 hours. The problem was compounded in 1977 because of delays in ship arrival; in such cases, truck queues in excess of 5 miles were observed.

The next phase of the current study involves development of a simulation model to evaluate benefits and costs associated with removal of logistical problems at the Port of Houston.

Acknowledgments

The authors acknowledge the assistance of Cargill Inc., the Port of Houston's Public Elevator, and Union Equity Cooperative Exchange for the assistance provided throughout this study. Monies to carry out research on the Port of Houston were made available by the Cooperative State Research Service (616-15-89) and The Texas Agricultural Experiment Station. The authors are indebted to Clive Harston and Michael Cook for manuscript review.

References

1. Fuller, Stephen and Mechel Paggi, "Texas Gulf Ports and Their Port Terminal Complex," *Technical Note,* Texas Transportation Institute, Texas A&M University, December 1976.
2. Kneafsey, James T., *Transportation Economic Analysis,* D. C. Heath and Company, Lexington, Mass., 1975.
3. Metaxas, B. N., *The Economics of Tramp Shipping,* The Athlone Press, University of London, London, England, 1971.
4. *Port of Houston Foreign Trade,* published by Port of Houston Authority, 1519 Capitol Avenue, Houston, Texas, 1973-75 issues.
5. United States Department of Agriculture, *Foreign Agricultural Trade of the U.S.,* U.S. Trade Statistics, Economic Research Service, various issues.

Tables

TABLE 1: Estimated Quantity of Grain and Soybeans Exported Through the Port of Houston, 1968-1976 a/

YEAR	GRAIN WHEAT	GRAIN SORGHUM	GRAIN CORN	SOYBEANS
	(000) bushels			
1968	144,778.9	61,640.6	2,407.9	692.5
1969	85,604.2	25,383.3	876.6	1,382.8
1970	172,945.3	52,154.0	4,332.6	14,347.9
1971	214,964.4	32,971.3	8,879.2	25,308.5
1972	185,764.3	45,462.7	19,671.2	19,033.2
1973	387,539.5	59,828.1	51,132.4	22,821.1
1974	187,275.6	73,619.6	71,074.2	17,377.6
1975	215,446.4	68,276.4	80,260.2	8,885.8
1976	162,979.9	59,173.5	69,232.6	9,566.9

a/ Port of Houston's Foreign Trade, Data originally compiled by the Bureau of the Census, and processed by Viana & Associates. Published in final form by port staff at 1519 Capitol Avenue, Houston, Texas.

TABLE 2: Grain Ship Type and Dead-Weight Tons, Port of Houston, 1976-1977 a/

Ship Type	Average Dead-Weight Tonnage	Minimum Dead-Weight Tonnage	Maximum Dead-Weight Tonnage
Bulk Carrier	31,238	12,851	80,013
Container	12,726	12,726	12,726
General Cargo	10,268	1,072	21,337
Ore Carriers	77,124	64,336	83,518
Tankers	43,230	19,073	82,069

a/ The dead-weight capacity (d.w.t.), or the carrying capacity of a vessel is the total weight of cargo, bunkers, water and extra weights expressed in tons of 2,240 lbs. which it can lift when loaded in salt water to maximum draft. The draft of a ship is the vertical distance between the waterline and keel.

TABLE 3: Grain Ship Type and Grain Cargo Sizes, Port of Houston, 1976-1977

Ship Type	Average Bushels Loaded Per Ship	Minimum Bushels Loaded Per Ship	Maximum Bushels Loaded Per Ship
Bulk Carrier	811,362	29,866	2,137,333
Container	113,407	113,407	113,407
General Cargo	267,980	9,940	793,600
Ore Carrier	1,608,324	746,666	1,953,827
Tanker	1,241,994	160,000	1,837,086

TABLE 4: Grain Ship Type and Draft, Port of Houston, 1976-1977 a/

Ship Type	Average Draft (ft.)	Minimum Draft (ft.)	Maximum Draft (ft.)
Bulk Carrier	35.6	26.4	46.2
Container	29.7	29.7	29.7
General Cargo	25.4	13.2	33.0
Ore Carrier	44.2	42.9	46.2
Tanker	37.9	29.7	42.9

a/ Draft is vertical distance between ships waterline and keel.

TABLE 5: Bushels of Grain and Soybeans Loaded on Ocean Going Vessels, Port of Houston, 1976-1977 a/

Grain			
Wheat Bushels	Sorghum Bushels	Corn Bushels	Soybeans Bushels
132,625,508.0	64,351,196.0	57,580,003.0	10,976,577.0

a/ An additional 1,150,433 bushels were loaded during this time period; however, the commodity type was not identified.

TABLE 6: Estimated Percent of Grain and Soybean Receipts from Alternative States, Port of Houston, 1976-1977

	Wheat	Grain Sorghum	Corn	Soybeans	All Grain and Soybeans
ARIZONA	3.6	0.0	0.0	0.0	1.8
Initial Assemblers	3.6	0.0	0.0	0.0	1.8
Secondary Sources	0.0	0.0	0.0	0.0	0.0
IOWA	0.0	1.2	55.5	35.9	14.4
Initial Assemblers	0.0	0.3	54.1	34.8	13.8
Secondary Sources	0.0	0.9	1.4	1.1	0.6
KANSAS	11.2	14.9	4.8	0.2	10.1
Initial Assemblers	2.9	5.1	1.5	0.1	3.0
Secondary Sources	8.3	9.8	3.3	0.1	7.1
LOUISIANA	0.1	0.1	0.0	16.9	0.8
Initial Assemblers	0.1	0.1	0.0	16.9	0.8
Secondary Sources	0.0	0.0	0.0	0.0	0.0
MISSOURI	2.5	3.0	4.3	4.9	3.1
Initial Assemblers	1.8	2.9	2.3	0.5	2.1
Secondary Sources	0.7	0.1	2.0	4.4	1.0
NEBRASKA	1.1	18.0	29.0	4.4	11.2
Initial Assemblers	0.5	9.6	21.0	3.1	7.2
Secondary Sources	0.6	8.4	8.0	1.3	4.0
OKLAHOMA	48.7	3.9	0.3	1.2	25.7
Initial Assemblers	7.1	3.1	0.2	1.2	4.4
Secondary Sources	41.6	0.8	0.1	0.0	21.3
TEXAS	31.3	58.8	5.5	34.9	31.9
Initial Assemblers	10.4	50.8	4.3	32.3	19.1
Secondary Sources	20.9	8.0	1.2	2.6	12.8
AVERAGE					
Initial Assemblers	26.3	71.8	83.4	88.9	52.7
Secondary Sources	72.1	28.0	16.0	9.5	47.3

TABLE 7: Estimated Percent of Grain and Soybean Receipts From Alternative Distance Zones, Port of Houston, 1976-1977

Distance Zones (Miles)	Wheat	Grain Sorghum	Corn	Soybeans
≤100	.5	24.5	2.4	28.1
101- 200	1.3	16.2	.6	11.0
201- 300	15.0	9.4	.7	8.1
301- 400	1.7	1.5	.2	1.1
401- 500	5.3	1.9	.1	.3
501- 600	53.1	8.9	2.0	4.2
601- 700	11.4	8.7	4.4	.3
701- 800	5.5	10.3	3.9	.6
801- 900	1.1	16.2	23.3	3.4
901-1,000	.5	1.9	31.3	9.4
1,001-1,100	.4	.4	28.8	32.5
1,101-1,200	2.4	.1	2.2	1.0
1,201-1,300	.6	a/	.1	a/
1,301-1,400	1.2	a/	a/	a/
≥1,400	a/	a/	a/	a/
TOTAL	100.0	100.0	100.0	100.0

a/ Less than .1%

TABLE 8: Estimated Percent of Grain and Soybeans Loaded on Ocean-Going Vessels per Month, Port of Houston, 1976-1977

	----------% of each grain loaded per month----------											
Commodity	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total
Wheat	7.5	10.7	14.3	6.1	7.3	7.2	7.1	8.3	8.3	9.2	7.9	6.1	100.0
Grain Sorghum	3.4	6.4	15.4	4.8	1.9	7.6	11.0	8.2	15.0	16.3	5.2	4.8	100.0
Corn	11.5	7.3	9.5	.2	3.9	5.8	6.0	10.2	10.3	20.2	10.3	4.8	100.0
Soybeans	0.0	7.9	0.0	7.7	0.0	23.8	14.3	10.6	17.8	6.7	4.5	6.7	100.0
All Grain and Soybeans	7.1	8.8	12.9	4.6	4.9	7.7	8.1	8.8	10.7	13.2	7.7	5.5	100.0

TABLE 9: Estimated Percent of Grain and Soybeans Received per Month, Port of Houston, 1976-1977

Commodity	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	TOTAL
Wheat	9.3	10.0	11.2	5.8	4.7	8.2	5.0	8.6	9.3	12.1	10.2	5.6	100.0
Grain Sorghum	2.0	9.6	19.2	3.3	5.1	5.8	9.8	8.6	15.0	16.1	3.8	1.7	100.0
Corn	9.4	7.2	8.4	0.3	4.8	6.6	6.1	8.7	13.0	17.7	11.7	6.1	100.0
Soybeans	1.1	0.8	0.2	6.1	11.5	14.7	11.2	14.2	9.6	5.5	8.3	16.8	100.0
All Grain and Soybeans	7.3	8.8	11.8	4.0	5.2	7.7	6.6	8.9	11.4	13.9	9.0	5.4	100.0

TABLE 10: Estimated Percent of Wheat Receipts per Month, Port of Houston, 1976-1977

	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	TOTAL
Arizona	29.0	47.0	10.8	12.7	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Initial Assemblers	29.0	47.0	10.8	12.7	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Secondary Sources	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kansas	4.5	1.5	2.4	0.8	4.3	17.4	5.1	7.2	9.8	14.3	17.6	15.1	100.0
Initial Assemblers	13.2	2.3	2.6	2.4	5.8	12.8	13.2	9.8	7.4	7.8	12.6	10.2	100.0
Secondary Sources	1.8	1.4	2.5	0.3	4.1	19.8	2.4	6.9	11.4	15.9	19.4	14.3	100.0
Missouri	2.7	2.6	1.9	0.0	5.8	23.5	7.0	0.0	1.6	17.1	26.6	11.2	100.0
Initial Assemblers	3.7	3.6	2.6	0.0	8.0	28.4	8.3	0.0	1.1	14.3	29.1	0.0	100.0
Secondary Sources	0.0	0.0	0.0	0.0	0.0	10.5	3.5	0.0	2.8	24.5	20.0	38.7	100.0
Nebraska	4.1	4.4	7.1	0.6	5.5	9.4	0.8	1.6	9.0	33.9	5.1	18.5	100.0
Initial Assemblers	6.9	9.4	0.7	1.2	2.8	0.0	1.6	3.5	6.7	27.1	6.8	33.3	100.0
Secondary Sources	1.7	0.0	12.9	0.0	8.0	17.8	0.0	0.0	11.1	40.3	3.5	4.8	100.0
Oklahoma	3.4	5.5	12.3	7.7	5.4	6.4	4.4	12.0	11.9	15.3	10.5	5.2	100.0
Initial Assemblers	20.6	7.3	4.7	7.0	5.7	7.0	5.6	7.4	11.0	13.7	5.8	4.5	100.0
Secondary Sources	0.5	5.2	13.7	7.8	5.3	6.3	4.2	12.8	12.1	15.6	11.2	5.3	100.0
Texas	18.6	15.3	12.8	4.7	4.4	7.6	6.7	5.2	6.2	7.4	7.6	3.5	100.0
Initial Assemblers	28.2	28.5	14.1	3.7	1.7	1.7	2.5	3.3	3.9	4.9	3.8	3.8	100.0
Secondary Sources	13.8	8.7	12.1	5.3	5.7	10.4	8.8	6.2	7.3	8.7	9.5	3.5	100.0

TABLE 11: Estimated Percent of Grain Sorghum Receipts per Month, Port of Houston, 1976-1977

	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	TOTAL
Iowa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	31.3	60.8	5.9	0.0	100.0
Initial Assemblers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	91.8	0.0	0.0	0.0	100.0
Secondary Sources	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.8	80.4	7.8	0.0	100.0
Kansas	2.5	0.0	0.2	0.0	5.9	12.5	22.1	5.6	21.3	23.3	4.1	2.5	100.0
Initial Assemblers	0.8	0.0	0.0	0.0	16.0	13.6	35.6	5.3	10.9	13.5	2.7	1.6	100.0
Secondary Sources	3.4	0.0	0.3	0.0	0.7	12.1	15.3	5.5	26.6	28.5	4.9	2.8	100.0
Missouri	3.5	0.0	0.6	0.0	21.9	14.5	18.7	5.0	18.6	7.1	9.5	0.6	100.0
Initial Assemblers	3.7	0.0	0.0	0.0	23.0	15.2	18.5	4.3	17.8	7.5	10.0	0.0	100.0
Secondary Sources	0.0	0.0	13.5	0.0	0.0	0.0	21.3	19.1	33.4	0.0	0.0	12.7	100.0
Nebraska	7.2	0.0	0.8	0.0	2.8	6.5	17.6	9.4	18.2	30.2	5.1	2.2	100.0
Initial Assemblers	11.1	0.0	1.5	0.0	4.9	10.4	12.8	6.3	16.1	29.6	5.2	2.2	100.0
Secondary Sources	2.7	0.0	0.0	0.0	0.3	2.1	22.6	13.0	20.8	31.2	4.9	2.2	100.0
Oklahoma	0.5	0.6	5.2	6.1	13.1	16.9	11.8	14.0	13.5	13.4	3.0	1.9	100.0
Initial Assemblers	0.7	0.6	4.6	7.7	16.5	21.2	8.5	5.3	15.7	13.9	3.1	2.4	100.0
Secondary Sources	0.0	0.7	7.5	0.0	0.0	0.0	24.8	48.0	5.1	11.2	2.7	0.0	100.0
Texas	0.4	16.3	32.1	5.2	4.3	2.8	4.0	9.0	12.0	9.5	3.0	1.4	100.0
Initial Assemblers	0.5	18.5	35.5	5.1	4.0	2.6	4.1	8.5	9.5	7.0	3.1	1.7	100.0
Secondary Sources	0.0	2.1	9.7	5.9	6.4	4.7	3.4	12.5	27.5	25.6	2.4	0.0	100.0

TABLE 12: Estimated Percent of Corn Receipts per Month, Port of Houston, 1976-1977

	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	TOTAL
Iowa	5.5	11.4	10.9	0.0	6.4	9.4	6.4	8.2	9.2	14.6	11.8	6.2	100.0
Initial Assemblers	5.7	11.2	11.0	0.0	6.5	9.9	6.8	8.3	8.5	14.9	11.8	5.4	100.0
Secondary Sources	6.5	15.1	0.0	0.0	5.6	0.0	0.0	11.7	16.7	21.5	23.0	0.0	100.0
Kansas	9.2	0.0	3.3	0.0	0.8	5.6	17.6	11.1	10.2	11.8	19.9	10.5	100.0
Initial Assemblers	3.8	0.0	11.0	0.0	2.8	0.0	15.9	10.2	7.3	21.8	13.0	14.3	100.0
Secondary Sources	12.5	0.0	0.0	0.0	0.0	8.7	19.9	10.8	12.5	8.1	20.8	6.8	100.0
Missouri	1.1	6.8	6.1	0.0	3.6	3.5	10.4	16.7	18.9	6.6	10.0	16.3	100.0
Initial Assemblers	2.0	0.0	0.2	0.0	3.2	6.5	19.2	27.3	16.7	12.2	12.8	0.0	100.0
Secondary Sources	0.0	14.9	13.1	0.0	4.0	0.0	0.0	4.2	21.5	0.0	6.8	35.6	100.0
Nebraska	19.3	2.1	0.0	0.0	1.8	2.4	3.1	9.3	20.1	26.7	9.3	5.9	100.0
Initial Assemblers	22.7	2.9	0.0	0.0	1.9	2.6	3.2	9.3	19.6	24.4	9.0	4.5	100.0
Secondary Sources	10.4	0.0	0.0	0.0	1.6	2.1	2.6	9.2	21.8	32.5	10.0	9.8	100.0
Oklahoma	10.5	0.0	0.0	0.0	0.0	38.8	0.0	0.0	0.0	15.2	35.5	0.0	100.0
Initial Assemblers	14.2	0.0	0.0	0.0	0.0	17.2	0.0	0.0	0.0	20.5	48.1	0.0	100.0
Secondary Sources	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Texas	0.3	a/	36.7	4.5	8.5	1.0	0.6	3.1	17.3	11.2	11.6	5.2	100.0
Initial Assemblers	0.0	0.1	45.7	5.7	9.3	1.3	0.7	3.2	14.8	6.2	10.2	2.8	100.0
Secondary Sources	1.2	0.0	4.0	0.0	5.4	0.0	0.0	2.5	26.6	29.8	16.6	13.9	100.0

a/ Less than .1%

TABLE 13: Estimated Percent of Soybean Receipts per Month, Port of Houston, 1976-1977

	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	TOTAL
Iowa	2.7	0.0	0.0	0.0	4.1	4.0	7.1	14.3	9.9	7.1	17.1	33.7	100.0
Initial Assemblers	0.0	0.0	0.0	0.0	4.7	4.6	8.2	16.5	11.5	8.2	19.8	26.5	100.0
Secondary Sources	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Kansas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.6	0.0	0.0	52.4	100.0
Initial Assemblers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
Secondary Sources	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0
Louisiana	0.0	0.0	0.0	28.4	49.3	1.6	8.9	8.9	3.0	0.0	0.0	0.0	100.0
Initial Assemblers	0.0	0.0	0.0	28.4	49.3	1.6	8.9	8.9	3.0	0.0	0.0	0.0	100.0
Secondary Sources	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Missouri	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.1	89.9	100.0
Initial Assemblers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	100.0
Secondary Sources	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0
Nebraska	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.6	21.7	36.2	7.3	30.2	100.0
Initial Assemblers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.6	10.3	40.2	0.0	43.0	100.0
Secondary Sources	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.5	26.9	24.6	0.0	100.0
Oklahoma	0.0	7.5	0.0	3.0	0.0	56.5	11.2	0.0	9.4	2.4	0.0	10.0	100.0
Initial Assemblers	0.0	7.5	0.0	3.0	0.0	56.5	11.2	0.0	9.4	2.4	0.0	10.0	100.0
Secondary Sources	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Texas	0.0	1.9	0.6	3.6	4.5	34.0	19.1	19.4	7.9	3.0	1.6	4.4	100.0
Initial Assemblers	0.0	1.3	0.3	2.1	4.8	35.9	19.7	20.0	7.2	2.6	1.4	4.6	100.0
Secondary Sources	0.0	9.4	3.3	22.4	0.0	9.5	12.3	12.9	15.6	7.7	4.2	2.8	100.0

TABLE 14: Estimated Percent of Wheat Receipts From Each Distance Zone per Month, Port of Houston, 1976-1977

Distance Zones (Miles)	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	TOTAL
≤100	19.8	21.2	32.6	3.6	3.0	2.6	0.0	3.6	2.5	4.7	0.7	5.8	100.0
101- 200	57.0	23.0	8.5	2.3	1.4	0.5	0.2	0.7	1.7	1.0	2.1	1.6	100.0
201- 300	24.4	10.5	14.6	5.1	4.3	4.0	1.3	1.7	7.3	9.7	12.9	4.1	100.0
301- 400	43.6	34.2	5.0	3.9	0.9	0.9	0.1	2.2	1.1	2.9	1.5	3.6	100.0
401- 500	39.1	5.4	3.0	6.2	4.7	4.8	4.2	4.4	9.2	8.8	3.5	6.7	100.0
501- 600	0.8	6.1	12.3	7.2	5.6	8.5	7.1	12.6	11.2	14.1	9.7	4.7	100.0
601- 700	3.7	7.8	5.3	2.2	3.9	14.0	4.9	8.9	9.2	13.5	15.0	11.7	100.0
701- 800	4.6	15.4	10.9	0.7	4.6	17.9	3.4	0.1	4.4	11.5	18.1	8.7	100.0
801- 900	1.6	16.1	19.9	1.4	4.6	10.8	0.7	0.0	9.8	25.0	1.8	8.3	100.0
901-1,000	7.7	14.8	2.9	5.2	1.5	0.0	1.0	4.1	7.4	15.6	13.8	26.1	100.0
1,001-1,100	14.7	19.8	13.3	19.7	0.0	0.0	0.4	4.4	26.3	0.0	0.7	0.7	100.0
1,101-1,200	37.5	41.3	9.6	7.9	0.5	0.0	0.0	0.0	2.4	0.8	0.0	0.0	100.0
1,201-1,300	18.9	73.6	3.6	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1,301-1,400	9.4	46.9	14.7	11.8	0.0	0.0	0.0	16.1	1.2	0.0	0.0	0.0	100.0
≥1,400	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0

TABLE 15: Estimated Percent of Grain Sorghum Receipts from each Distance Zone per Month, Port of Houston, 1976-1977

Distance Zones (Miles)	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	TOTAL
≤100	0.6	35.0	39.9	2.0	1.2	1.2	2.5	5.0	3.9	3.2	3.4	2.1	100.0
101- 200	0.8	6.2	36.5	6.6	4.9	2.9	5.3	13.7	10.4	7.2	3.8	1.8	100.0
201- 300	0.0	0.2	30.1	12.0	9.1	7.0	4.2	6.1	15.6	13.4	2.1	0.2	100.0
301- 400	0.0	0.0	19.7	18.1	28.4	11.6	7.7	1.1	5.0	1.6	2.7	4.2	100.0
401- 500	0.0	1.3	1.5	11.1	28.0	24.1	9.6	8.0	6.3	6.8	2.7	0.7	100.0
501- 600	0.1	1.9	3.8	1.6	5.6	2.8	7.3	17.3	30.5	27.5	1.3	0.4	100.0
601- 700	1.9	1.4	1.1	0.1	7.3	16.3	18.3	4.0	20.4	21.6	5.7	1.8	100.0
701- 800	3.8	0.0	0.0	0.0	6.4	9.3	21.5	6.9	23.7	21.4	4.5	2.5	100.0
801- 900	6.4	0.0	1.0	0.0	1.6	5.7	17.3	8.8	19.2	33.1	4.8	2.2	100.0
901-1,000	8.0	0.0	0.0	0.0	6.9	9.2	9.4	14.7	16.5	25.6	9.1	0.6	100.0
1,001-1,100	4.0	0.0	0.0	0.0	4.6	9.9	45.4	0.0	24.4	11.7	0.0	0.0	100.0
1,101-1,200	0.0	0.0	0.0	0.0	64.1	35.9	0.0	0.0	0.0	0.0	0.0	0.0	100.0
1,201-1,300	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	100.0
1,301-1,400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
≥1,400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 16: Estimated Percent of Corn Receipts from each Distance Zone per Month, Port of Houston, 1976-1977

Distance Zones (Miles)	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	TOTAL
≤100	0.0	0.2	65.9	5.4	5.9	0.2	0.0	0.7	9.6	7.4	4.6	0.0	100.0
101- 200	0.0	0.0	52.4	13.9	4.6	0.0	0.0	0.0	24.0	1.6	0.0	3.7	100.0
201- 300	2.0	0.0	35.9	5.6	0.0	0.0	0.0	8.3	6.9	5.0	22.0	14.3	100.0
301- 400	25.0	0.0	0.0	0.0	0.0	15.4	0.0	0.0	0.0	13.7	46.0	0.0	100.0
401- 500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.4	78.6	0.0	100.0
501- 600	0.0	0.0	2.3	0.0	14.0	5.2	0.0	4.6	42.2	19.7	4.0	8.0	100.0
601- 700	9.3	0.0	5.2	0.0	1.0	6.4	18.2	12.8	10.7	11.7	21.3	3.5	100.0
701- 800	5.6	0.0	0.7	0.0	4.3	3.8	12.7	16.7	17.9	13.4	19.3	5.7	100.0
801- 900	15.8	3.2	1.2	0.0	3.5	2.4	6.1	10.7	16.9	25.0	8.5	6.8	100.0
901-1,000	7.3	9.9	8.3	0.0	3.7	6.6	7.8	9.0	8.4	18.1	12.7	8.4	100.0
1,001-1,100	7.8	10.2	10.4	0.0	7.4	12.1	3.0	6.9	13.5	14.3	10.4	4.0	100.0
1,101-1,200	23.4	18.8	8.4	0.0	2.6	0.0	2.9	2.0	4.2	20.3	15.9	1.5	100.0
1,201-1,300	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	100.0
1,301-1,400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
≥1,400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 17: Estimated Percent of Soybeans from each Distance Zone per Month, Port of Houston, 1976-1977

Distance Zones (Miles)	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	TOTAL
≤100	0.0	1.5	0.2	0.5	5.7	39.2	20.8	22.3	6.8	1.8	1.2	0.0	100.0
101- 200	0.0	0.0	0.0	25.0	42.5	5.3	11.8	10.1	4.4	0.0	0.8	0.0	100.0
201- 300	0.0	2.9	0.0	24.0	40.0	2.3	4.9	5.9	0.0	2.4	0.4	17.2	100.0
301- 400	0.0	8.5	0.0	9.0	0.0	70.7	1.2	0.0	10.6	0.0	0.0	0.0	100.0
401- 500	0.0	0.0	0.0	11.3	0.0	16.3	44.1	0.0	0.0	9.2	0.0	19.2	100.0
501- 600	0.0	0.0	3.3	20.3	0.0	14.5	14.9	10.1	23.2	8.2	2.5	3.1	100.0
601- 700	0.0	0.0	0.0	0.0	0.0	0.0	5.6	0.0	44.9	0.0	0.0	49.5	100.0
701- 800	0.0	0.0	0.0	0.0	0.0	8.4	8.8	6.6	0.0	0.0	76.1	0.0	100.0
801- 900	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	25.7	41.8	8.5	21.9	100.0
901-1,000	0.0	0.0	0.0	0.0	2.4	0.0	11.7	11.8	0.0	8.8	19.9	45.4	100.0
1,001-1,100	3.5	0.0	0.0	0.0	4.5	5.2	5.4	15.1	13.2	6.4	15.8	31.0	100.0
1,101-1,200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
1,201-1,300	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1,301-1,400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
≥1,400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 18: Estimated Modal Split on Grain and Soybean Receipts from Alternative States, Port of Houston, 1976-1977

	Wheat		Grain Sorghum		Corn		Soybeans		All Grain & Soybeans	
	% Truck	% Rail	% Truck	% Rail	% Truck	% Rail	% Truck	% Rail	% Truck	% Rail
Arizona	1.3	98.7	0.0	0.0	0.0	0.0	0.0	0.0	1.3	98.7
Initial Assemblers	1.3	98.7	0.0	0.0	0.0	0.0	0.0	0.0	1.3	98.7
Secondary Sources	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Iowa	0.0	0.0	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0
Initial Assemblers	0.0	0.0	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0
Secondary Sources	0.0	0.0	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0
Kansas	15.0	85.0	2.6	97.4	0.0	100.0	0.0	100.0	9.6	90.4
Initial Assemblers	56.8	43.2	6.7	93.3	0.0	100.0	0.0	100.0	31.2	68.8
Secondary Sources	0.6	99.4	0.4	99.6	0.0	100.0	0.0	100.0	0.5	99.5
Louisiana	100.0	0.0	100.0	0.0	0.0	0.0	100.0	0.0	100.0	0.0
Initial Assemblers	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	100.0	0.0
Secondary Sources	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Missouri	0.2	99.8	0.6	99.4	0.1	99.9	0.0	100.0	0.3	99.7
Initial Assemblers	0.3	99.7	0.0	100.0	0.2	99.8	0.0	100.0	0.2	99.8
Secondary Sources	0.0	100.0	13.5	86.5	0.0	100.0	0.0	100.0	0.4	99.6
Nebraska	1.5	98.5	0.5	99.5	0.1	99.9	0.0	100.0	0.3	99.7
Initial Assemblers	2.6	97.4	0.9	99.1	0.2	99.8	0.0	100.0	0.5	99.5
Secondary Sources	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0.
Oklahoma	12.4	87.6	48.5	51.5	4.3	95.7	32.7	67.3	13.7	86.3
Initial Assemblers	72.6	27.4	59.1	40.9	5.8	94.2	32.7	67.3	69.4	30.6
Secondary Sources	2.2	97.8	7.7	92.3	0.0	100.0	0.0	0.0	2.2	97.8
Texas	13.4	86.6	71.7	28.3	43.5	56.5	80.8	19.2	43.6	56.4
Initial Assemblers	40.1	59.9	80.2	19.8	53.4	46.6	80.9	19.1	67.8	32.2
Secondary Sources	0.4	99.6	18.1	81.9	6.8	93.2	80.1	19.9	3.8	96.2
Average	12.4	87.6	44.6	55.5	2.4	97.6	45.7	54.3	19.0	81.0
Initial Assemblers	42.0	58.0	59.9	40.1	2.8	97.2	48.8	51.2	46.1	53.9
Secondary Sources	1.4	98.6	5.6	94.4	0.5	99.5	21.9	78.1	2.1	97.9

TABLE 19: Estimated Modal Split on Grain and Soybean Receipts from Each Distance Zone, Port of Houston, 1976-1977

Distance Zones (Miles)	Wheat		Grain Sorghum		Corn		Soybeans		All Grains and Soybeans	
	% Truck	% Rail	% Truck	% Rail	% Truck	% Rail	% Truck	% Rail	% Truck	% Rail
≤100	40.2	59.8	89.1	10.9	60.7	39.3	83.5	16.5	84.8	15.2
101- 200	79.2	20.8	74.4	25.6	69.0	31.0	98.8	1.2	79.5	20.5
201- 300	9.7	90.3	49.7	50.3	19.1	80.9	75.7	24.3	21.7	78.3
301- 400	28.9	71.1	37.4	62.6	0.0	100.0	25.3	74.7	33.3	66.7
401- 500	55.0	45.0	78.8	21.2	7.0	93.0	100.0	0.0	62.3	37.7
501- 600	6.3	93.7	33.9	66.1	21.1	78.9	86.3	13.7	8.9	91.1
601- 700	21.9	78.1	8.6	91.4	0.5	99.5	6.3	93.7	15.8	84.2
701- 800	3.2	96.8	2.6	97.4	0.0	100.0	30.2	69.8	1.8	98.2
801- 900	0.5	99.5	a/	100.0	0.0	100.0	0.0	100.0	0.1	99.9
901-1,000	38.8	61.2	4.0	96.0	0.1	99.9	0.0	100.0	1.4	98.6
1,001-1,100	8.3	91.7	0.0	100.0	0.0	100.0	0.0	100.0	0.3	99.7
1,101-1,200	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0
1,201-1,300	0.0	100.0	0.0	100.0	0.0	100.0	0.0	0.0	0.0	100.0
1,301-1,400	0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
≥1,400	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	100.0
AVERAGE	12.4	87.6	44.6	55.5	2.4	97.6	45.7	54.3	19.0	81.0

TABLE 20: Estimated Percent of Grain and Soybean Shipments to Alternative Destinations, Port of Houston, 1976-1977

Country	Grain Type			
	Wheat	Grain Sorghum	Corn	Soybeans
Africa a/	8.5	0.0	1.3	0.0
Northern Africa b/	5.3	0.0	4.8	0.0
East Asia c/	0.0	1.3	10.9	6.3
India	2.3	0.0	0.0	0.0
Singapore	0.0	0.0	0.8	3.7
Eastern Europe d/	4.2	8.4	6.6	26.3
Western Europe e/	6.2	20.6	8.3	23.1
Middle East f/	8.7	15.5	3.9	0.0
Japan	10.5	47.4	28.2	11.4
Central America g/	0.4	2.1	2.3	9.9
South America h/	26.2	2.8	1.8	0.0
USSR	27.0	0.0	28.9	0.0
West Indies i/	0.3	0.0	0.7	0.0
Scandinavia j/	0.0	2.0	1.5	11.2
Other	0.4	0.0	0.0	8.1
Total	100.0	100.0	100.0	100.0

a/ Includes Ethiopia, Nigeria, Tanzania and Zaire

b/ Includes Algeria, Egypt and Moracco

c/ Includes Korea and Taiwan

d/ Includes Czechoslovakia, Greece, Poland, Yugoslavia and East Germany

e/ Includes Belgium, Germany, Great Britain, Holland, Italy, Portugal and Spain

f/ Includes Israel, Iran and Jordan

g/ Includes Belize, El Salvador, Guatemala, Honduras and Mexico

h/ Includes Bolivia, Brazil, Chile, Columbia, Ecuador, Guyana, Peru and Venezuela

i/ Includes Bahamas, Dominican Republic and Jamica

j/ Includes Denmark and Norway

TABLE 21: Estimated Percent of Grain and Soybeans Exported Via Each Cargo Size, Port of Houston, 1976-1977

Bushels Loaded Per Ship	Wheat	Grain Sorghum	Corn	Soybeans	All Grains and Soybeans
≤50,000	.2	0.0	0.0	0.0	.1
50,001-100,000	.8	.2	.2	0.0	.5
100,001-250,000	2.9	.5	3.4	0.0	2.5
250,001-500,000	11.6	1.9	6.4	14.0	8.2
500,001-750,000	26.2	3.7	5.6	40.8	16.9
750,001-1,000,000	28.0	23.8	23.6	45.2	26.7
1,000,001-1,250,000	7.8	32.9	23.6	0.0	17.0
1,250,001-1,500,000	6.2	20.4	18.5	0.0	12.0
1,500,001-1,750,000	6.2	4.9	5.6	0.0	5.5
1,750,001-2,000,000	6.9	8.5	9.6	0.0	7.6
≥2,000,000	3.1	3.2	3.5	0.0	3.1
Average Bushels	662,655	1,021,447	846,765	645,681	730,685

TABLE 22: Average Cargo Sizes of Grain and Soybeans by Destination, Port of Houston, 1976-1977

Country	Grain Type			
	Wheat	Grain Sorghum	Corn	Soybeans
Africa a/	331,381	0	256,860	0
Northern Africa b/	644,870	0	922,044	0
East Asia c/	0	834,133	1,042,624	695,000
India	776,046	0	0	0
Singapore	0	0	485,816	404,199
Eastern Europe d/	1,118,126	1,354,593	632,013	722,042
Western Europe e/	683,404	1,102,968	957,076	634,576
Middle East f/	827,260	1,106,494	1,107,296	0
Japan	666,395	952,821	856,043	627,843
Central America g/	73,673	541,065	665,306	541,065
South America h/	502,874	896,800	205,363	0
USSR	1,191,457	0	1,384,597	0
West Indies i/	87,472	0	206,682	0
Scandinavia j/	0	1,290,139	880,024	613,097

a/ Includes Ethiopia, Nigeria, Tanzania and Zaire

b/ Includes Algeria, Egypt and Moracco

c/ Includes Korea and Taiwan

d/ Includes Czechoslovakia, Greece, Poland, Yugoslavia and East Germany

e/ Includes Belgium, Germany, Great Britain, Holland, Italy, Portugal and Spain

f/ Includes Israel, Iran and Jordan

g/ Includes Belize, El Salvador, Guatemala, Honduras and Mexico

h/ Includes Bolivia, Brazil, Chile, Ecuador, Guyana, Peru and Venezuela

i/ Includes Bahamas, Dominican Republic and Jamica

j/ Includes Denmark and Norway

The Texas Agricultural Experiment Station, Neville P. Clarke, Director, College Station, Texas.
2M — 10-78