PROCEEDINGS —

Twenty-third Annual Meeting

Volume XXIII • Number 1 1982

TRANSPORTATION RESEARCH FORUM

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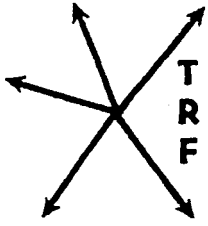
Twenty-third Annual Meeting

Theme:
"Developing Concinnity in Transportation"

October 28-30, 1982
Fairmont Hotel
New Orleans, LA

Volume XXIII • Number 1 1982



TRANSPORTATION RESEARCH FORUM

Alternative Grain Export Routes From Minnesota and the Dakotas

*by Jerry E. Fruin**

ALTHOUGH a fertile productive region and a major part of the "Great American Granary," Minnesota and the Dakotas have a major locational disadvantage for agricultural production compared with many other regions of the United States. This is due to its extreme distance from the population centers on the eastern and western seaboards and from deepwater ocean ports.

Historically, the region and the U.S. economy adjusted for this locational disadvantage in two distinct ways depending on whether the product was coarse grains (i.e., corn) or small grain (i.e., wheat). A very high percentage of the corn produced was consumed on the farm or locally and converted to less bulky meat, dairy and poultry products. The potential problems of high transportation costs and logistics capacity for bulk corn was thereby avoided until the grain export boom of the 1970's. Upper Midwest wheat and wheat flour, on the other hand, has always been shipped long distances eastward to the population centers of the U.S. industrial northeast, and even farther to the historic Old World markets of Europe where the region's durum and hard, red spring wheats were preferred for bread and baking.

This movement developed very early in the history of the country. Its initial development was due to the favorable transportation costs at the time. Over the years, a favorable rate structure was developed, and this encouraged the continuation and growth of the long distance movement of wheat and flour.

Specifically, U.S. wheat has been moving eastward to U.S. and European markets since 1825 when the Erie Canal was opened. Use of the Erie Canal lowered the cost of transportation from Buffalo, New York, to Albany almost immediately from $100 per ton to $10 per ton and eventually to $3 per ton. This opened a way for the Old Northwest (the current Midwest) to get its produce to market. Although that area is considered part of the Corn Belt today, the primary cash grain there in the 1820's and 30's was wheat. In the years following the opening of the Erie Canal, New England agriculture declined rapidly. Grain prices in England fell 40 to 60 percent as U.S. Midwestern agriculture expanded. Wheat production moved westward. Traffic grew from inland ports on the Great Lakes to Buffalo and the Erie Canal, and then up and down the sea coast or to England and Europe.

After the Civil War, agriculture continued to expand westward. Great Lakes traffic grew and the trunk line railroads became important competitors with the Lakes for grain traffic from the Midwest. By the 1870's, railroad rate wars from the Midwest to the East were common. The various accommodations and the establishment of the ICC in 1887 institutionalized the railroad east-west rate structure with export rates, port-equalization rates, transit privileges, and proportional rates designed to compete with Great Lakes water transportation.

Eventually, the pattern of the Corn Belt, the dairy region of the Lakes states, and the Wheat Belt evolved. The high quality milling wheat of the Upper Midwest was served by water transportation from Duluth-Superior to Buffalo, and in recent years, by the Seaway connection to Europe and by a stable established rail-rate structure. This rail-rate structure was designed to compete with wheat shipments over the lakes, and was equalized at a number of rail-basing points so that changes in the level of rail rates, i.e., ex parte increases, would not change the Upper Midwest's advantage over wheat coming through Omaha and Kansas City. Specifically, although frequently challenged, the rail rate for wheat from Duluth and Minneapolis to East Coast ports was generally 3 cents less per hundredweight than from Omaha and Kansas City. This rate structure lasted virtually right up until the passage of the Staggers Act.

Since the late 1960s, however, two long-term trends in U.S. agricultural exports have developed which impact the Upper Midwest agricultural commodity flows, and consequently, its agricultural transportation requirements. First, is the increasing proportion of exports of feed grains such as corn and soybeans as opposed to food grains, i.e.,

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wheat and flour. Wheat and wheat products accounted for almost 50 percent of the U.S. export tonnage of grain and oilseeds and their products in 1960, one-third in 1970, and only one-fourth in 1980 (Table 1). In addition, an increasing amount of U.S. export wheat is used as feed or is tied to feed grain sales. This is basically because of the increase in consumer demand for meat, and hence, livestock feed around the world.

The second long-term trend is the shift in our export customers away from our historical markets of Europe. Table 2 shows the change in customer mix by area between 1971 and 1980. Although the total tonnage of farm exports increased by 172 percent during the decade, the export tonnage to the Common Market countries of Europe, which used to be our primary market for wheat, has increased only 56 percent. Agricultural sales to the centrally planned economies of Russia and eastern Europe in 1979 were greater than the total agricultural sales to western Europe in the early 1970's. The Russian grain embargo reduced this in 1980. Future sales to this area obviously will depend on world politics and events over the next several years.

Mexico is now taking twice the quantities of our agricultural products as all of Latin America did 10 years ago. This trade should continue and grow because of U.S. demand for Mexican oil and Mexico's increase in food demand as a result of its very rapid population growth.

TABLE 2

U.S. AGRICULTURAL EXPORTS BY DESTINATION AREA

(million metric tons)

	1971	1980	% Increase
Western Europe	26.4	41.2	56
Eastern Europe	2.0	11.4	470
U.S.S.R.	....	6.2[1]	....
Mexico	5.3	10.1	355
Other Latin America		14.0	
Japan	9.3	24.9	167
Mainland China	....	9.0	....
Asia—Less Japan & Mainland China	11.4	20.7	82
Africa	2.3	8.8	283
Others	3.3	16.7	406
TOTAL	60	163.0	172

1 19.5 in 1979.

Source: Compiled from *U.S. Foreign Agricultural Trade Statistics Report*. ERS/USDA, calendar years 1971 and 1980.

TABLE 1

EXPORTS OF UNITED STATES AGRICULTURAL COMMODITIES

(million metric tons)

Year	All Ag Commodities	Total Grain Oilseed and Products	Wheat and Products	Percent[1] of Grain Oilseed and Products	Corn	Percent[1] of Grain Oilseed and Products	Soybeans and Products	Percent[1] of Grain Oilseed and Products
1960	N.A.	33.6	16.4	48.8	5.6	16.7	4.6	13.7
1965	57.1	52.2	19.8	37.9	15.1	28.9	8.2	15.7
1970	63.5	57.9	19.4	33.5	14.4	27.5	15.6	29.9
1975	101.7	92.5	32.1	34.7	33.4	36.1	16.3	17.6
1980	163.0	146.4	37.2	25.4	63.0	43.0	28.8	19.7

1 Percentages will not total 100 because of other grains, e.g., rice, barley, oats, etc.

Source: Compiled from *U.S. Foreign Agricultural Trade Statistics Report*. ERS/USDA various years.

Japan is a growth market and is now importing at about the same level as western Europe was 10 years ago. However, its rate of growth is less than that of several other areas. China is, of course, a huge market with whom we did not trade in 1971. The Pacific Rim nations of Japan and China are two of the three nations that are now the world's largest importers of food. The third large importer is Russia.

The exports to Asia have shifted over the decade away from western and southern Asia, i.e., India and Pakistan, to southeast Asian countries bordering the Pacific. Growth in Pacific Asia has been much greater than the 82 percent indicated in the table.

What does this mean? Well, the U.S. is exporting to many more locations, but the Upper Midwest is not well located for exporting to many of these locations. Countries that are in a good location for exports from the Upper Midwest is not well located for exporting to many of these locations. Countries that are in a good location for exports from the Upper Midwest, such as Russia and the centrally planned economies, are primarily interested in feed grains to produce meat for their consumers—and not in wheat for bread production—and they are politically uncertain customers. In short, the Upper Midwest grain industry is at the end of the whip driven by world food demand and political events over which it has little or no control.

The next section reviews the primary transportation routes from Minnesota and the Dakotas to export ports and the outlooks and trends for those routes.

THE GREAT LAKES/ SEAWAY ROUTE

The Great Lakes and the Seaway, and before that the Erie Canal, have been the route to move the hard, red spring wheat and durum from the Upper Midwest to Europe. In 1979, grain shipments through Duluth-Superior totaled over 8.5 million metric tons of which about 7 million metric tons were exported. This was about 6.8 percent of U.S. grain exports even though there was a strike for 91 days. The 8.5 million metric tons included 193 million bushels of wheat, or nearly 15 percent of U.S. wheat exports, 52 million bushels of corn, 25 million bushels of barley, and 27 million hundredweight of sunflowers. Over 93 percent of the movements were by lake or ocean vessel. The rest were by rail to East Coast ports or industries primarily during the winter months. Soybean movements through Duluth-Superior have not been important since 1977.[1]

As noted previously, the movement of wheat to European Economic Community (EEC) countries is declining in importance relative to movements to developing countries served by other ports. The extreme length of the Seaway and its capacity limitations tend to place the way at a disadvantage for developing grain movements. The Seaway is an important residual route for corn exports when Gulf and East Coast ports are at capacity. In 1979, 67 percent of the corn exports from Duluth went to Russia and eastern Europe. It is a preferred route for shipments to Russia by Russian ships because of Russia's foreign exchange strategy of using their own fleet as much as possible and the lack of deep-draft "super ports" on the Baltic Sea.

One bright spot for Seaway exports is sunflower seed. There is a big demand in our traditional European markets for sunflower seed. Also, they are light in weight, and thus, do not present a draft problem on the Seaway.

The Great Lakes and the Seaway face a troubled future for both political and physical reasons. On the political side, tolls on the Seaway, which were stable for nearly 20 years, essentially doubled between 1977 and 1980 and increased another 18 percent last spring. A 10 percent increase is scheduled for 1983. The toll increases on the Seaway, of course, impact traffic and flows for all commodities including grain. There are now serious proposals for port user charges to cover dredging and maintenance. The concept of port user charges is, of course, consistent with the Reagan administration's policies of local control of expenditures. However, the concept is being pushed most vigorously by deep-draft ocean ports who want to trade off user charges for a speed up in channel and port improvements and for a looser set of environmental regulations. A major argument is that such development would help increase coal exports—which like grain exports provide needed foreign exchange to pay our OPEC oil bill. It would also give economic advantages to a few well-situated ocean ports like New York, Baltimore, and New Orleans at the expense of the Lake ports and the Upper Midwest which are already burdened with Seaway tolls.

Two types of constraints exist on the Great Lakes-Seaway system that limit its long-term potential. These are: 1) physical capacity limits due to channel depth, lock dimensions, and locking operations, and 2) seasonal limits due to the winter closing of the system. These

constraints will seriously hamper any increase in grain exports through the Seaway that would be likely to occur between 1980 and 2000.

The Welland Canal between Lake Erie and Lake Ontario is the short-term capacity constraint on the Great Lakes-St. Lawrence Seaway System. Without expansion, the limit would be reached by about 1986, but it could be reached sooner if grain exports through the Great Lakes surge. However, Canada is implementing a number of minor structural and non-structural improvements to expand the Weyland's capacity to attempt to provide adequate capacity past 1990 and possibly to the year 2000.

Extension of the nine-month Seaway season for two or three weeks is feasible and will provide needed capacity increases for moving export grain in the short run. However, an increase in the Great Lakes' shipping season to 11 or 12 months **without** a corresponding increase in the Seaway season would be beneficial mainly to ore and coal haulers and the iron and steel industry and of little utility to Midwest grain shippers. If year-round access is to assist the grain trade, it is needed to international markets through the St. Lawrence Seaway and not be limited to Buffalo, New York. It does appear that the Seaway season will be gradually extended to 10 months over the next several years, but there will be continued and severe opposition from environmentalists, eastern ports, East Coast longshoremen unions, and the overland transportation companies that compete for the Great Lakes traffic.

By the year 2000, the physical capacity constraints of the Great Lakes and the Seaway will present numerous problems. The channel depth of 27 feet is the most limiting constraint. Even now, most ocean-going vessels have drafts in excess of 30 feet. Deepening the channel just three feet to 30 feet would have serious environmental impacts on water levels, shorelines, and ecological systems throughout the Great Lakes Basin. Deepening the channel to increase capacity does not seem feasible even in the years after 2000; thus, lake navigation by typical ocean vessels will become less economical or common. The Great Lakes-Seaway system will eventually evolve into a 27-foot draft inland waterway with transfer ports for true deep-draft vessels near the Gulf of St. Lawrence.

THE MISSISSIPPI RIVER ROUTE

As mentioned previously, the Upper Midwest is geographically disadvantaged for corn producers. Prior to the agricultural export boom of the 1970's, much of the corn was fed locally to dairy animals in the form of silage, or it was sold for feed in nearby markets.

The export boom changed that. Now, about one-half of the much larger corn crop is exported as many of the livestock and dairy farms have been converted to cash grain farms.[2]

However, farm prices for corn in the Upper Midwest are still the lowest in the nation. Why? Simply stated, through out most of the 1970's, it was the last area in the nation that the exporters would buy from because of its distance from the Gulf ports. Sixty percent of the corn exported from the U.S. is shipped by barge to the Gulf. However, the Upper Midwest has the longest barge haul, as well as the highest barge operating costs of any major grain traffic segment on the river system. However, with the exception of the drought years of the mid-70's, truck-barge shipments of corn from the area expanded rapidly. This was not primarily due to rail car shortages, branchline abandonments, or other railroad problems. It was due primarily to truck-barge rates to the Gulf declining throughout the period when compared with single-car rail rates.[3]

Mississippi River transportation has a number of problems including the Lock and Dam 26 bottleneck at Alton, Illinois, proposals to increase user charges, and restrictions on the Corps of Engineers' dredging.

Lock and Dam 26 has been operated at or near its capacity since 1976. There is no question that this lock is a bottleneck that restricts the capacity of the cheapest method for transporting grain from the Upper Midwest to the Gulf of Mexico and has silently caused expensive changes in grain flow patterns. This bottleneck will continue until about 1990.

A paradox exists in that barge shipments from the upper reaches of the Mississippi (i.e., the Twin Cities and Winona) have increased consistently since Lock and Dam 26 reached its capacity of about 63 million tons per year six years ago. For example, almost 7 million metric tons of grain and soybeans were shipped by barge from Upper Mississippi River terminals in 1979, up from a little over 3.6 million metric tons in 1970 and 4.5 million metric tons in 1976. That is because barge shipments from the Upper Mississippi have larger transportation cost savings than from locations closer to Lock and Dam 26. Consequently, these shipments have forced grain

from Iowa and Illinois off the river. That grain then goes by an alternative mode or to an alternative port at a higher cost and causes mode or port expansion, i.e., grain is diverted to the Gulf or to the East Coast by rail, or by truck to lake ports.

The new Lock and Dam 26 is under construction and is scheduled for completion about 1988. At this time, the capacity will still be constrained to about 73 million tons for 18 months until parts of the old lock and dam can be removed. The capacity of the new, single 1200-foot lock, as currently authorized, is estimated to be about 89 million tons per year (from 1990 on) or about a 40 percent increase over the present capacity.

One of the unsettled arguments regarding Lock and Dam 26 has been whether or not a second lock chamber is needed at Alton, and if so, how large should that lock chamber be, i.e., 600 or 1200 feet long? Proponents of building a second lock at the present time maintain that the new lock will be operated at capacity immediately because of the growth in demand for river transportation over the next decade. This probably will not be the case as the railroads and alternative outlets to the Gulf for Midwest barge grain (Pacific Northwest, East Coast, and lake ports) will have established capacities and handled the grain during the 1980's. The railroads and ports will attempt to keep this business through contracts, concessions, etc. In time, this grain may shift back to the river, but not immediately. When the new lock opens, capacity will be adequate.

There have also been arguments that when the capacity of Lock and Dam 26 is enlarged, other locks will become bottlenecks. This is not true as Lock and Dam 26 is located at Alton, Illinois, just below the conjunction of the Illinois River and the Upper Mississippi River. During the 1970's, each of these rivers (the Illinois and the Upper Mississippi) contributed about an equal amount of traffic to Lock and Dam 26, so that Lock and Dam 26 handled about twice as much traffic as any of the locks immediately above it. The locks on the Upper Mississippi are the same size as the current Lock and Dam 26 so they will not automatically be at capacity when the new 26 is opened. Lock and Dam 27, below 26, is a new lock and dam with two 1200-foot chambers; thus, it will not be a capacity problem. There will, however, be problems with the locks on the Upper Mississippi in the future as the entire system is reaching the end of its initial design life of 40 years.

WATER USER CHARGES

Waterway user charges will have more effect on barge volumes from the Upper Midwest in the 1990's than the capacity of the new Lock and Dam 26. The amount will depend on the outcome of current proposals for increased user fees.

The current 6 cents per gallon tax is estimated to increase the cost of barge transportation from St. Paul to Baton Rouge by 1 cent per bushel, and the future 10 cents per gallon tax by 2 cents per bushel. The current and 1985 user tax level and structure will have very little impact on grain flows.

However, the administration has proposed that a fuel tax of 36 cents per gallon be implemented, and others have proposed that all commercial navigation expenditures be recovered. Some of the proposals would change the structure of the user charges so that collections from the different river segments would correspond to the federal navigation expenditures on each segment.

The proposals to increase the tax to 36 cents per gallon would increase barge transportation costs from St. Paul to the Gulf by about 5 cents per bushel. This would be significant and would impact grain flows and exports. A full expenditure recovery charge of 70 cents per gallon would raise barge transport cost to the Gulf an estimated 10 cents per bushel based on current volumes. However, at that level of user charge, sufficient volumes of commodities would leave the river so that user charges per unit would have to be increased even higher to meet expenditures. The other proposals calling for changing the structure of the user charge to more closely match revenues and expenditures on river segments would have an even greater impact on the Upper Mississippi River route.

DIRECT RAIL ROUTES

Upper Midwest grain flows responded to the changing commodity and customer mix in the 1970's primarily by an increase in barge shipments of grain to the Gulf. However, the Lock and Dam 26 bottleneck and the success of unit grain trains in Illinois and Iowa led to the introduction of multiple-car and train load rates from the Upper Midwest. Table 3 shows the growth of multiple-car loading facilities in rural Minnesota. Note the growth in both size and number. Until recently, all of the multiple-car facilities were located in the corn and soybean area in southwestern Minnesota. Recently, unit-train facilities

TABLE 3

MULTI-CAR RAIL LOADING FACILITIES IN MINNESOTA[1]

	1974	1977	1981
25-Car	14	29	39
50-Car	5	11	9
75-Car	....	....	9
100-Car	....	....	3
TOTAL	19	40	60

1 Does not include terminal elevators in the twin Cities and Duluth.

Source: *Yearbook*: *The Farmers Elevator Association of Minnesota*—various years.

have been constructed in South Dakota and in the wheat areas of North Dakota and Minnesota.

In 1979, about 1.8 million metric tons of corn and soybeans were shipped by rail from these loading facilities to Gulf ports for export. Direct rail shipments to Gulf ports were negligible prior to the mid-70's. This direct rail movement to the Gulf will continue to increase as a consequence of waterway user fees, Lock and Dam 26 congestion, improved rail operations in the Midwest, and low unit-train grain rates.

The map of the rail system from the Upper Midwest to the Gulf is still undergoing changes. Parts of the defunct Rock Island Railroad are being absorbed into the remaining railroads and the reorganized Milwaukee II will be available as part of a larger system or as a bridge line. The merger of the Burlington-Northern and the Frisco will allow single-line service from the Upper Midwest to the Gulf ports of Mobile and Pensacola and increase the importance of these Gulf ports for corn and soybeans.

Potential exists for two international movements by direct rail which might impact the rail network of the Upper Midwest. One possibility is by unit train to locations in Mexico as U.S. grain shipments to Mexico increase. The other is a movement of Canadian grain by unit train through the Midwest directly to Gulf ports. The wheat area of the Canadian prairie is a geographical and geological extension of the U.S. Wheat Belt. Total logistics costs including ocean freight from the Canadian prairies to South America, Africa, and some other markets would be less if Canadian grain was shipped out of U.S. ports rather than Thunder Bay, Ontario, on Lake Superior, or Vancouver, British Columbia, on the Pacific coast. This has not been feasible in the past because the artificially low statutory Crow's Nest Pass grain rates subsidized Canadian grain movements. It appears that Canadian rail grain rates will be rationalized. When this occurs, the economic incentive to use the U.S. Gulf ports will increase because ocean shipping costs from Gulf of Mexico ports to Latin America are substantially less than from Lake ports. There are some institutional constraints, primarily in different quality grading systems, but these are relatively minor compared with the potential logistics cost savings. A single rail line, the Burlington-Northern, runs from Winnipeg, Manitoba, to the Gulf. In addition, a railroad affiliated with the Canadian National (the Grand Trunk) will purchase the reorganized Milwaukee II so that the Canadian National will control U.S. bridge lines as far south as the Kansas City gateway. The Canadian Pacific already controls the Soo Line which provides bridge lines to Minneapolis and Chicago.

THE PACIFIC NORTHWEST RAIL ROUTE

Some wheat farmers from western North Dakota has always gone west. In the last decade, the quantities have been increasing and some westward movements now originate as far east as the Red River Valley. However, the real growth in shipments to the Pacific Northwest in recent years has been in corn for export. There was no corn exported from the Pacific Northwest ports as recently as 1977. Sixty-eight million bushels were exported in 1978, 171 million bushels in 1979, and 270 million bushels (6.8 million metric tons) in 1980. This corn came by unit train from South Dakota, Minnesota, Nebraska, and Iowa. The latest development is unit train shipments of soybeans direct to the Pacific Northwest for export.

What is responsible for this rapid growth of corn exports through the Pacific Northwest? Contributing factors include continued growth in demand in the Pacific Rim markets, the bottleneck at Lock and Dam 26, a capacity problem and increased tolls at the Panama Canal, and increased ocean fuel costs.

However, the most important factor has been the development of low unit-train rates. Table 4 analyzes the net price per bushel of corn obtainable from four major markets at locations in

TABLE 4

NOVEMBER 1981 CHARTERS

Origin	Destination	Tons	Rate U.S. $
Great Lakes	Venezuela	11,000	37.00
Duluth	Venezuela	11,000	37.25
Duluth	Maracaibo	13,500	36.00
Gulf	Venezuela	12,000	15.75
Gulf	Venezuela	20,000	16.00
Gulf	Venezuela	10,500	17.00
Gulf	Venezuela	18,000	14.75

Source: H. P. Drewry, Ltd., *Shipping Statistics and Economics*, December 1981.

southwestern Minnesota in the fall of 1981. This was calculated by taking the bid price for corn in each of the four potential markets and subtracting the appropriate transportation cost to the market. The highest net price could be obtained by shipping 75-car trains to the Pacific Northwest export market. This was 20 cents per bushel more than could be obtained by shipping 75-car train to the Twin Cities. In general, direct rail shipment to the Pacific Northwest provided considerably higher net prices than any of the alternatives throughout the summer and fall of 1981. This is a very recent development. Throughout the 70's, the highest net would have been obtained by truck shipment to the Twin Cities (whenever barge rates to the Gulf were favorable). Note in Table 4 that trucking to the Twin Cities would provide a more favorable net than any single-car rail alternative. This demonstrates the rate advantage causing the switch to trucks throughout the 1970's. Table 4 also indicates that the truck market in the Twin Cities would provide a higher net than 26- or 52-car trains directly to the Gulf ports.

Using Table 4, it can be computed that an increase in trainload rates of 21 cents per bushel (37 cents per hundredweight) and the same market prices would "price the Pacific Northwest out of the market." These rates to the Pacific Northwest are now very competitive due to the rail car surplus. They are compensatory, that is, they cover variable costs, but probably do not cover fully allocated costs. It is quite possible that rate increases could occur and that other markets would provide higher net prices as they did as recently as 1980.

EFFECT ON THE RURAL ROAD NETWORK

Development of unit-train loading facilities and their use has had a mixed effect on the road and highway system. Like the old rail-rate structure, the primary highways of the area are generally east-west oriented. Usage and wear on these primary roads increased substantially throughout the '70's as an increasing number of heavy grain trucks hauled grain longer and longer distances to the lake and river terminals each year.

Increased direct-rail shipments of grain from country elevators has reduced the use of the primary highways. But now heavy vehicles used in grain assembly are going much longer distances over rural and secondary roads and are increasing the wear on these roads. These secondary roads are frequently not as well constructed as the primary roads which were previously used.

The net effect of whether total road wear will increase or decrease has not yet been determined. However, there will be a transfer of the financial responsibility from the states to local units of government because financing the collector roads is generally a function of local government. This shift is only now being recognized, but will become of increasing concern to the local officials who are responsible for highways.

FOOTNOTES

1 Poon, Hing and Jerry Fruin, **Historical Flows of Corn, Wheat, and Soybeans from Minnesota, North Dakota and South Dakota,** University of Minnesota, Department of Agricultural and Applied Economics, Staff Paper P79-6, February 1979.

2 Alley, J. Mike, Jerry Fruin and Chuck Eldridge, **Minnesota Grain Movements—1979,** University of Minnesota, Department of Agricultural and Applied Economics, Economic Report ER 82-1, February 1982.

3 Michaels, Gregory H., Richard Levins and Jerry Fruin, **Rail and Truck Rates Under Public Regulation: Corn and Soybean Transportation in Minnesota, 1970-79,** University of Minnesota, Department of Agricultural and Applied Economics, Staff Paper P81-6, February 1981.