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by

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TRANSPORTATION REQUIREMENTS FOR MINNESOTA CORN EXPORTS

I. Introduction

Both 1977 and 1978 were years of record-breaking corn production in Minnesota--600 million bushels were produced in 1977 and 644 million bushels were produced the following year. Corn exports, however, were much lower in 1977 than in 1978 because a good deal of the 1977 corn crop went to replenish domestic stocks which had been depleted during the disastrously poor crop year of 1976. The 1978 production came on the heels of a good year, and considerably more corn was available for export.

Based on Minnesota Grain Exchange records, various unpublished sources, and the authors' estimates, about 107 million bushels of Minnesota corn went to export markets in 1977. Of this, 55 percent, or 59 million bushels, went by barge to the Gulf. The railroads carried 14 million bushels to the Pacific Northwest and another 28 million bushels to other destinations, mostly Gulf markets. The remaining six million bushels were exported through Duluth.

Exports rose over 80 percent to 196 million bushels in 1978. The sudden surge in exports caused severe strain on the transportation system. Even though barges increased their Gulf hauls to 83 million bushels, their percentage of total exports declined to 42 percent because of capacity problems at Lock and Dam 26. The railroads, too, were unable to increase their out-of-state hauls much above 1977 levels because of car shortages and related problems. The result was a huge increase in shipments through Duluth, generally considered a poor market for corn. The 58 million bushels

Table 1. Estimated Barge, Rail and Lake Vessel Corn Export Traffic,
Minnesota, 1977 and 1978

	<u>1977</u>	<u>1978</u>
	---(million bushels)---	
Total Production	600	644

Barge to Gulf	59	83
Rail from Minneapolis	5	18
Vessel from Duluth	6	58
Rail to Pacific Northwest	14	14
Other rail, mostly to Gulf	23	23

Total Exports	197	196
Export/Production Ratio	18%	30%

leaving Duluth in 1978 were more corn than was shipped from that port in the previous three years combined.

The change in marketing patterns between 1977 and 1978 is an excellent example of the interaction between transportation capacity and market prices that ultimately determines levels of barge and rail shipments. On the one hand, the multiple car rail rates offered during the 1970's have made it profitable to ship by rail to new markets. The best example of this is the increase in shipments to Pacific Northwest markets from practically nothing in 1975 to 14 million bushels in 1977. At the same time, transportation capacity restrictions led to large shipments to Duluth in 1978 in spite of relatively low barge and multiple car rail rates to markets with high corn prices. Lower rates may make shippers look for more profitable markets, but capacity problems will cause a scramble to reach any available market.

The rail and barge requirements for Minnesota's 1985 export corn production will be the subjects of this paper. In the next section, a method will be developed to determine the most profitable export market for each of 46 corn producing counties under the assumption that the capacity problems so evident in 1978 are solved by 1985. Then, in Section III, the 1985 corn exports of each county will be estimated. The rail and barge requirements if capacity problems are not solved will be compared with the requirements if shippers can base decisions more on prices and less on availability of transportation. Some important policy implications are discussed in Section IV.

II. Transportation Rate Comparison

If transportation capacity was not a problem, would a particular southern Minnesota corn producing county be better off exporting by rail through the Pacific Northwest or by barge through a Gulf market? Or would it be better to ship by truck or rail through Duluth? To answer questions such as these, several things must be considered:

- (1) If multiple car or barge shipments are to be used, what are the rates? What will it cost to truck grain to a terminal or sub-terminal for transshipping?
- (2) Are shipments directly from country elevators to final markets less expensive than the combined cost of shipping to a terminal by truck and then transferring to another transportation mode for the remainder of the haul?
- (3) Is the market to which transportation costs are the lowest necessarily the best in terms of profits? What are the prices paid for corn in each market?

Transportation rates, market prices, and methods of cost comparisons necessary to address these issues will be the subject of this section. The overall objective is to determine the most profitable export market for each of 46 corn producing counties in Minnesota. These results will help determine in which direction market forces will push rail and barge requirements in the coming years.

The Study Area and Transportation Network

Most of the corn available for export from Minnesota is produced in the southern half of the state; therefore, a study area consisting of 46 southern counties was selected (see Figure 1). A transportation network for the study area was outlined as follows:

- (1) Shipments from each county to each of four export markets--
Duluth-Superior, Chicago, the Pacific Northwest and the Gulf--
were allowed.
- (2) Corn could be at one of the eight terminals shown in Figure 1
before reaching a final market, or it could be shipped directly
from the counties to any final market except the Pacific Northwest.
- (3) Corn could be transported by truck, rail and barge. Prevailing
rates and availability of facilities determined which trans-
portation modes would be allowed for particular shipments. The
specific mode/route combinations considered are shown in Table 2.

Estimation of Transportation Costs

The specific transportation cost for each allowable mode/route combination was, except in the case of barges, taken from recent published tariffs or orders of the Minnesota Public Service Commission (PSC). Costs incurred through loading, handling, and storage at origins, terminals and final markets were judged small in comparison to transportation costs and were not included in the cost estimates.

Minnesota grain truck rates are based on mileage. The rates used were those recommended in a Minnesota PSC Report of Hearing Examiner dated February 6, 1979. The highway mileage from the county seat of each county to each allowable destination was determined and the appropriate rate computed.

Table 2. Several different mode/route combinations connected each county with each export market.

Origin	Destination
<u>Truck</u>	
Each County	Each terminal
Each County	Duluth market
<u>Single Car Rail</u>	
Each County	Duluth, Gulf, and Chicago markets
Each County	Minneapolis terminal
<u>Multiple Car Rail</u>	
Each Terminal	Each market
<u>Barge</u>	
Red Wing, Winona, Savage, and Minneapolis terminals	Gulf market

Single car rail rates were taken from Supplement No. 2 (effective January 1979) to the Minneapolis Grain Exchange Rate Book No. 14. Again, county seats were used as points of origin in the counties wherever such rates were published; otherwise, the rate from a nearby point of comparable distance was used.

Multiple car rail rates for corn are generally published for 25-, 50-, and 75-car shipments. The least expensive published rate for each route was selected, so the particular size-of-shipment requirements will vary from route to route. The specific multiple car rail rates used are shown in Table 3.

Since tariffs for barge shipments are not required to be published, costs were estimated from industry sources. The cost for shipping corn by barge to the Gulf from Minneapolis, Savage, and Red Wing was taken to be \$.40 per cwt. The cost from Winona, which is closer to the market, was taken to be \$.35 per cwt.

Estimation of Market Prices

If the goal is to maximize returns over and above transportation costs, minimizing transportation costs is only half of the picture. The price of corn at each of the final markets must also be considered. Therefore, shipments from each county to each final market were evaluated in terms of net revenue potential by using the following prices:

<u>Market</u>	<u>Price per bushel</u>	<u>Price per cwt.</u>
Duluth	\$2.20	\$3.93
New Orleans	\$2.50	\$4.47
Chicago	\$2.26	\$4.04
Portland	\$2.77	\$4.95

TABLE 3. Multiple-Car Rail Rates Between Terminals and Final Markets

Market					
Terminal	Duluth	Minneapolis	Portland	Gulf	Chicago
	----- cents/cwt. -----				
Jackson	39.5 ^{3/}	32.0 ^{3/}	101.5	69.0 ^{1/}	46.5 ^{1/}
Welcome	35.0 ^{1/}	22.0 ^{2/}	101.5 ^{1/}	75.0 ^{1/}	51.0 ^{1/}
Pipestone	43.5 ^{1/}	26.0 ^{4/}	101.5	73.0 ^{1/}	48.5 ^{1/}
Minneapolis	19.5 ^{1/}	0.0	101.5	85.5 ^{1/}	42.0 ^{4/}
Winona	34.5 ^{2/}	18.0 ^{4/}	101.5	88.0 ^{2/}	52.0 ^{2/}
Red Wing	23.0 ^{4/}	15.0 ^{4/}	101.5	85.5 ^{4/}	42.0 ^{4/}
Savage	21.0 ^{4/}	15.0 ^{4/}	101.5	85.5 ^{4/}	48.5 ^{4/}
Wells	31.0 ^{4/}	18.5 ^{2/}	101.5	66.5 ^{1/}	43.5 ^{1/}

^{1/} 75-car rate^{2/} 50-car rate^{3/} 25-car rate^{4/} Estimate

Source: Chicago, Milwaukee, St. Paul and Pacific Railroad Tariff #18710-D effective 8/4/78.

Chicago and Northwest Tariff #17194-C effective 7/78.

These prices are the averages for number two yellow corn during the 1977-78 crop year as reported by USDA.

Methodology

The methodology used to determine the most profitable export market for each county was to first determine the cheapest way to transport corn to each market, then to calculate the difference between market price and transportation cost at each market, and finally to select the market with the greatest excess of market price over transportation costs.

For example, consider the case of Big Stone county in the northwest corner of the study area. The least cost way for this county to ship corn to each of the four markets is as follows:

<u>Least Cost Shipping Methods</u>		
<u>Destination</u>	<u>Route</u>	<u>Cost per cwt.</u>
Duluth	Direct truck	\$.56
Chicago	Truck to Pipestone terminal (\$.23), then rail to Chicago (\$.485)	.715
Pacific Northwest	Truck to Pipestone terminal (\$.23), then rail to PNW (\$101.5)	1.245
Gulf	Truck to Minneapolis (\$.38), then barge to Gulf (\$.40)	.78

Thus, Duluth is the cheapest market to reach, followed by Chicago, the Gulf, and the Pacific Northwest. However, when market prices (in \$/cwt.) are considered, the following results are obtained:

Net Revenues

<u>Destination</u>	<u>Market Price</u>	<u>Trans. Cost</u> -----(\$/cwt.)-----	<u>Net</u>
Duluth	3.93	.56	3.37
Chicago	4.04	.715	3.325
Pacific Northwest	4.95	1.245	3.705
Gulf	4.47	.78	3.69

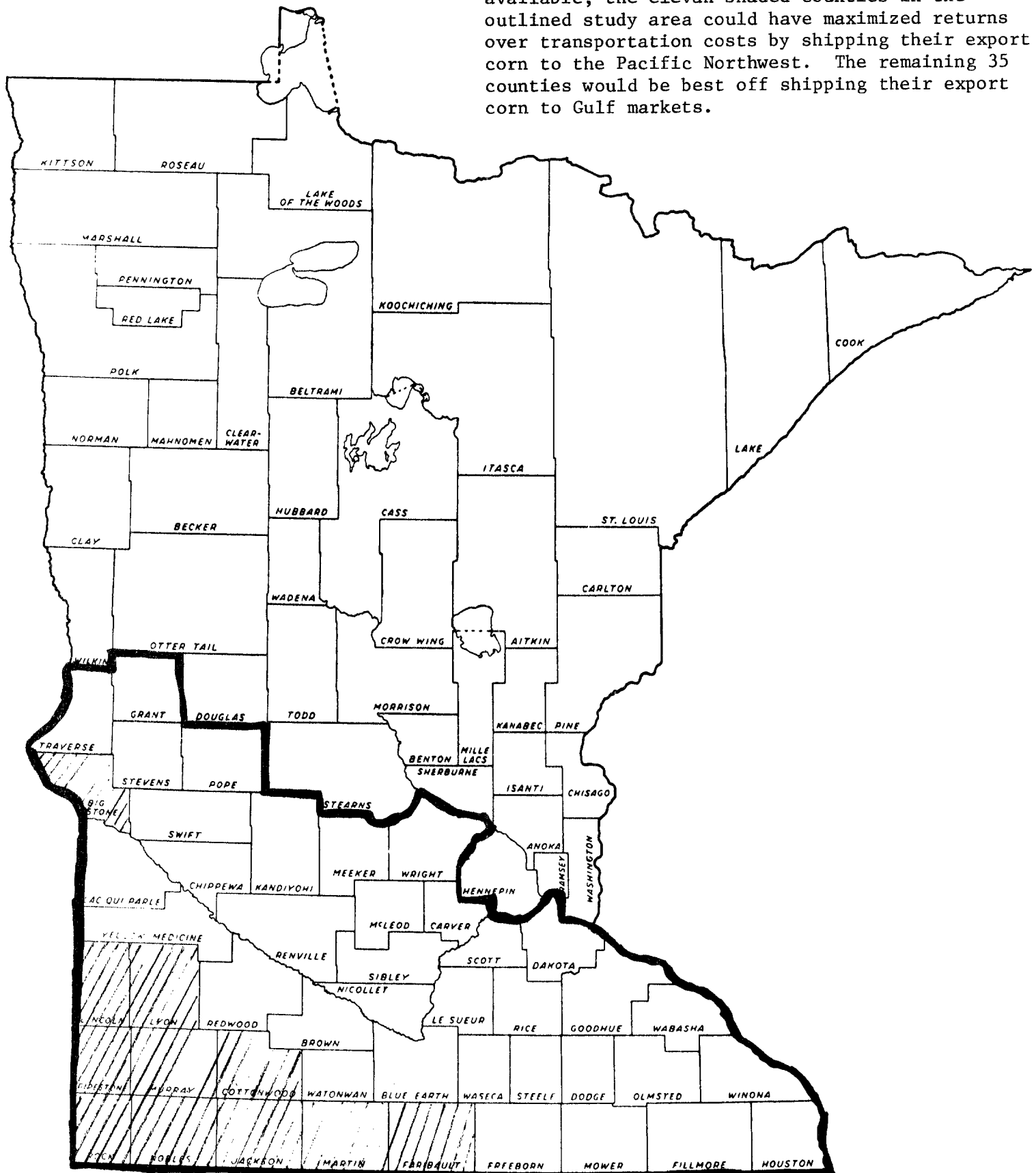
These results show that for Big Stone county, the Pacific Northwest market, which has the highest transportation cost in this example, also has the highest net revenue potential.

The maximum net revenue evaluation just shown for Big Stone county was repeated for each county in the study area. Although the procedure used is not complicated, the volume of calculations required for the many combinations of counties, terminals, markets, and transportation modes necessitated the use of computers. The specific computer technique employed was a variation of linear programming, a widely-used method in operations research and agricultural applications.

Results

As is shown in Figure 2, corn growers in eleven western counties would maximize returns over transportation costs by marketing through the Pacific Northwest. The remaining 35 counties would be best off shipping to the Gulf by barge. Even though the transportation costs to Duluth and Chicago were generally lower than those to the Pacific Northwest and Gulf, the relatively low market prices ruled out shipments from any of the counties in the study area to the Lake ports.

FIGURE 2. Had sufficient transportation capacity been available, the eleven shaded counties in the outlined study area could have maximized returns over transportation costs by shipping their export corn to the Pacific Northwest. The remaining 35 counties would be best off shipping their export corn to Gulf markets.



III. Projected Barge and Rail Shipments for 1985

The transportation rate analysis of the previous section showed which counties would ship corn by rail and barge if transportation capacity was not a problem. In this section, the task will be to estimate how much corn these counties will ship by each mode in 1985 under different assumptions concerning capacity.

Implications of Rate Analysis

In Table 4, the 35 counties that would be best off shipping by barge are listed along with their projected 1978 corn production. Together, these counties produced 417 million bushels. Figuring 30 percent (the 1978 state average) going to export, these counties would export 125 million bushels. Table 5 is similar and shows the production and exports for the eleven counties which would be best off shipping to the Pacific Northwest. These counties produced 158 million bushels, 47 million of which would be exported.

The 47 million bushels being shipped to the Pacific Northwest would, of course, move by rail. The situation for the 125 million Gulf-bound bushels is not so simple, however, because the river is frozen in the winter and barges are not available year round. Even though rail shipments to the Gulf cost 2 to 3 times as much as barge shipments, some corn is shipped by rail to the Gulf, primarily during the winter when the Upper Mississippi Waterway is closed.

During 1976 and again in 1977, both years in which capacity problems were less severe than in 1978, about 92 percent of the corn shipped out of Minneapolis moved by barge and the remaining eight percent moved by rail. Assuming these percentages hold, about 115 million bushels of the 125 million

Table 4. 1978 Corn Production and Estimated Exports for Unshaded
Counties in Figure 1

County	Production	Exports ^{a/}
	-----bushels-----	
Blue Earth	21,468,000	6,440,400
Brown	13,241,000	3,972,300
Carver	6,763,000	2,028,900
Chippewa	9,568,000	2,870,400
Dakota	10,316,000	3,094,800
Dodge	12,253,000	3,675,900
Fillmore	19,176,000	5,752,800
Freeborn	20,838,000	6,251,400
Goodhue	14,382,000	4,314,600
Grant	2,544,000	763,200
Houston	6,463,000	1,938,900
Kandiyohi	14,420,000	4,326,000
Lac Qui Parle	9,948,000	2,984,400
LeSeuer	9,662,000	2,898,600
McLeod	10,055,000	3,016,500
Meeker	11,233,000	3,369,900
Mower	19,176,000	5,752,800
Nicollet	10,827,000	3,248,100
Olmsted	13,270,000	3,981,000
Pope	5,992,000	1,797,600
Redwood	20,436,000	6,130,800
Renville	19,767,000	5,930,100
Rice	13,043,000	3,912,900
Scott	5,914,000	1,774,200
Sibley	14,881,000	4,464,300
Steele	12,029,000	3,608,700
Stevens	7,742,000	2,322,600
Swift	12,553,000	3,765,900
Traverse	1,580,000	474,000
Wabasha	8,073,000	2,421,900
Waseca	14,674,000	4,402,200
Watonwan	12,695,000	3,808,500
Winona	9,425,000	2,827,500
Wright	8,657,000	2,597,100
Yellow Medicine	13,451,000	4,037,700
TOTAL	416,523,000	124,956,900

^{a/} 30 percent of production

Table 5. 1978 Corn Production and Estimated Exports for Shaded Counties in Figure 1

County	Production	Exports ^{a/}
	-----bushels-----	-----
Big Stone	4,723,000	1,416,900
Cottonwood	15,736,000	4,720,800
Faribault	20,233,000	6,069,900
Jackson	20,458,000	6,137,400
Lincoln	7,864,000	2,359,200
Lyon	13,429,000	4,028,700
Martin	23,000,000	6,900,000
Murray	14,629,000	4,388,700
Nobles	17,383,000	5,214,900
Pipestone	7,958,000	2,387,400
Rock	12,640,000	3,792,000
TOTAL	158,053,000	47,415,900

^{a/} 30 percent of production

bushel total Gulf shipments would travel by barge. The other 10 million bushels would go by rail.

In total, there would be 57 million bushels leaving the state by rail, 10 million to the Gulf and 47 million to the Pacific Northwest. Barge shipments would be 115 million bushels, all to the Gulf. No corn would be shipped through Duluth.

For purposes of comparison, barge shipments of corn from all sources through Twin Cities ports were 83 million bushels in 1978. Shipments of corn leaving the state by rail in 1978 have been estimated at 55 million bushels--14 million to the Pacific Northwest and 41 million to other destinations, mostly Gulf markets. Duluth shipped 58 million bushels.

Projections for 1985

If relative transportation rates and market prices remain unchanged in coming years, the most important determinants of rail and barge requirements will be transportation capacity and export levels.

In order to forecast export levels, a relatively modest increase in corn exports of two percent per year (compounded) was assumed for 1978-1985. This increase will come about both from increased corn production and from an increasing percentage of that production being exported. At the assumed rate of increase, the state will export 14.8 percent more corn in 1985 than in 1978. Total exports from counties in the study area will increase from 172 million bushels to 197 million bushels.

If capacity problems were solved by 1985, the transportation rate analysis of Section II implies a proportional increase in rail and barge shipments of 14.8 percent above the "optimal" 1978 levels. Barge

shipments would increase from 115 to 132 million bushels; Pacific Northwest rail shipments would increase from 47 to 54 million bushels; and Gulf-bound rail shipments would increase from 10 million bushels to 11 million bushels.

The rail and barge situation for 1985 would be quite different if capacity problems are not solved. The relevant question would no longer be one of which marketing patterns would maximize profits; the overriding concern would be finding ways to transport the export crop to any market.

Although the study area was projected to export 197 million bushels in 1985, not all of Minnesota's exports come from the study area. Neighboring states also depend on Minnesota's terminals and ports to varying degrees. Thus, the total 1978 Minnesota exports were 196 million bushels, 24 million bushels higher than the estimated study area exports.

The 1978 actual shipments from all sources and the projected 1985 "optimal" (unconstrained) shipments from the study area are as follows:

	<u>1978 (all sources)</u>	<u>1985 (study area)</u>
	-----(million bushels)-----	
Barge to Gulf	83	132
Rail to Pacific Northwest	14	54
Rail from Minneapolis	18	11
Rail from other origins	23	0
Vessel from Duluth	<u>58</u>	<u>0</u>
TOTAL	196	197

The implications of this comparison are the subject of the following section. In short, the numbers above say one thing clearly: if transportation capacity is not expanded, the transportation requirement for Minnesota 1985 export corn crop cannot be met, no matter which markets are chosen.

IV. Policy Implications

A line-by-line comparison of the "1978 actual" and "1985 optimal" shipments presented at the end of the last section paints a dismal picture of Minnesota's export corn transportation outlook.

Barge shipments in 1985 from the study area alone would be 49 million bushels higher than 1978 actual levels from all origins if transportation capacity problems were resolved. More likely, barge shipments will not increase much until the new Lock and Dam 26 is completed. The "extra" 49 million bushels will have to go through Duluth, with probable loss of income to producers.

The rail situation is no more encouraging. Railroads hauled 55 million bushels out of Minnesota during 1978. The 1985 projection is for the study area alone to add 11 million more bushels to the severely strained rail system.

There is also a significant change in the direction, as well as volume, of 1985 optimal rail shipments from Minnesota. The 1977-1978 pattern of most rail-hauled export corn going to the Gulf with a lesser amount going to the Pacific Northwest would be reversed. Projected 1985 optimal rail shipments to the Gulf are 11 million bushels, barely one-fourth of their 1978 level. In fact, the rate analysis of Section II suggests that these 1978 shipments result more from barge shortages than from the profitability of rail shipments from inland terminals. On the other hand, shipments to the Pacific Northwest increase by 386 percent. This would require expansion of western Minnesota's terminal capacity as well as a satisfactory reorganization of the Milwaukee Road.

In total, barge capacity is presently 49 million bushels short of 1985 optimal projections. Rail capacity is short 11 million bushels. On top of this, shipment from other states would add another 29 million bushels to the overloaded system. The total shortfall is 89 million bushels.

Clearly, Duluth will have to continue its important role in corn exports during high production years. But even then, the shortfall is 31 million bushels over Duluth's 1978 shipments. Two options remain for meeting this demand -- expanded capacity of Lock and Dam 26 or expanded capacity for westward rail shipments.

In the author's opinion, Minnesota should not stake its corn export future solely on Lock and Dam 26. The Pacific Northwest at its best is a highly profitable market; at its worst, it is a "safety valve" for corn that might otherwise not be transported to any market because of capacity restrictions.

The State of Minnesota should investigate and pursue ways to expand both its waterway and railroad options if the next decade's export crops are to be marketed smoothly and profitably.

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