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AN ECONOMIC ANALYSIS OF ALTERNATIVE GRAIN TRANSPORTATION SYSTEMS: A CASE STUDY

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16. Abstract
This report summarizes the results of research conducted to determine which grain transportation system would yield the highest net income in a 6½-county area around Fort Dodge, Iowa. Transportation alternatives considered include the traditional single-car rail system, multiple rail car shipments of 3, 50, 80, and 115 cars, truck, truck-barge and rail-barge. It was assumed that sub-terminals would be required to load the shipments of 50 cars or more. Also, rail line options were considered: these included maintaining the 1971 rail system, maintaining and upgrading 100 percent, 46 percent and 27 percent of the 1971 rail lines to permit trains with jumbo hoppers to travel at least 35 miles per hour. The evaluated alternatives were ranked in terms of total joint net revenue, investment requirements and capacity to move grain with minimum congestion within the entire grain distribution system. Institutional problems related to moving to higher income alternatives are identified and policy implications are discussed. This study is an in-depth analysis of one intensive grain production area. A second analysis at the aggregate level encompassing the United States was conducted cooperatively with this study. The results of the aggregate study are reported in Interrelationships of Grain Transportation, Production, and Demand: A Cost Analysis and Projection of Grain Shipments within the United States for 1980 by Jerry A. Fedeler, Earl O. Heady, and Won W. Koo (Phase II).

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SYNOPSIS

The transportation of America's food and feedgrains has long been associated with the railroad industry and has been a major factor in shaping the structure of today's rail network. Since the era of rail expansion during the 19th century, problems of car shortage and transportation adequacy have continually plagued shippers and carriers alike. The tremendous growth in grain production and harvest technology in the past decade, however, has been confronted with the legacy of a rail network increasingly incapable of responding efficiently to this growth. Basic problems of low traffic density in grain gathering areas, the presence of light rail lines unable to handle heavier cars and uneconomic operations are symptomatic of difficulties that increasingly threaten the financial integrity of many Granger railroads as well as the growth and development of the geographic areas they serve.

Each of these problems can be traced to the need for improved logistics coordination -- the type of coordination that employs suitable combinations of storage and transportation to minimize random fluctuations in transportation demand. Accordingly the study examined several alternative intermodal configurations, comparing the total operating and investment costs of each against a basic single-car system. The objective was to find the least costly logistics system that would yield the maximum net system revenue to the study area -- a 6-1/2 county area around Fort Dodge, Iowa.

The study found that maximum system revenue would be obtained by using regularly scheduled 115 car trains operating from six subterminals, with some shipments utilizing 3 to 10 car units or a rail-barge movement. Under this system, only 27 percent of the existing rail mileage in the study region would be required, but all existing storage facilities and receiving elevators would be needed to handle the continued area grain production, expected to reach 118 million bushels by 1980.

AGRICULTURE AND TRANSPORTATION -- A HISTORICAL SUMMARY

Since the extension of the railroad network to the midwestern and farwestern sections of the United States during the 19th century, agriculture has been associated with and involved in the formation of national transportation policies and legislation. During the 20th century, agriculture had a vital influence on the development of the highway and inland waterways systems and legislation affecting the operations of their users. In turn, the development of each surface program expanded market outlets for agricultural products and the close relationships between the two major industries over the past century could be characterized as a period when agriculture and transportation grew together, each dependent upon the other for a substantial portion of its prosperity.

Historic railroad grain rate structures were keyed on terminal markets. When first conceived, the predominant movement was from western producing regions to eastern consumption points. The traditional function of the terminal market was to absorb the excess grain at harvest time which could not be stored on the farm or in country elevators, condition it to buyer specifications, and release it into consumption channels throughout the year.

The structure consisted of rates from producing points to consuming areas which were applied equally over several markets. Through rates were a combination of individual segments -- one factor rates -- and became known as the rate-break system of rate making. Through rates consisted of gathering rates, intermarket proportionals, and proportionals from terminal markets to final destinations.

Equalization of rates coupled with the transit privilege -- the fiction of "suspended transportation" -- made possible grain processing practically anywhere along the many routes between origins and destinations, giving maximum marketing flexibility.

These structures resulted in relatively stable rate relationships between origins and commodities shipped into common markets, in well defined grain origin areas to supply these markets, and the use of the so called "standard" box car to haul the grain. Exports were secondary to domestic grain utilization. The system worked quite well as long as the railroads were the only carriers of grain and products. But during the post World War II period, the growth of motor and water carriers through federally supported programs for highway and inland waterway development brought serious competitive forces into the grain marketing system and was a factor in the disintegration of the railroad grain rate structure.

These factors, when considered in conjunction with changes in traditional market patterns and the rise in export demand, stimulated the use of other modes, particularly inland water carriers operating through the Gulf ports. In addition, changing market needs and grain flows gave further impetus to the carriage of grain by motor vehicle over distances formerly thought to be advantageous only to rail.

Thus, by the 1970's, motor, rail and water carriers were heavily engaged in short and long distance movements of grain. Where once the railroads had been the sole carrier under rate structures which tended to stabilize the movements, now highly complex and often confusing arrangements are operative.

PROBLEM STATEMENT

These changes in the supply of and demand for corn and soybeans and innovations in grain harvesting and transportation have compounded the historical problems of grain distribution. In the past decade, U.S. corn and soybean production have increased more than 50 percent. Corn and soybean exports have almost tripled requiring more grain to be transported longer distances. Shifts and advances in harvesting techniques have enabled farmers to quickly move huge quantities of grain to market -- forcing elevator operators to either ship large quantities of grain in short periods of time or store hundreds of thousands of bushels out on the streets.

In an attempt to provide more transportation capacity, railroads have established direct, specialized train service to capture the efficiencies of faster turnaround times and to reduce delays in loading, switching and unloading cars.

In addition to direct train service, railroads are also encouraging the use of larger size rail cars for the transport of grain. The jumbo covered hopper car capable of hauling up to 3,300-3,500 bushels of grain is a specialized piece of equipment and is rapidly replacing the 2,000 bushel capacity box car due to the covered hopper car's greater capacity, more efficient loading and unloading and its far greater product protection. The number of 40-foot box cars in the United States has declined from 563,470 in 1960 to 212,000 cars in 1973. On the other hand, during the same period of time, covered hopper cars increased from 64,255 to 186,219 cars.

However, such innovations have not solved the fundamental grain transportation problems. In fact, these innovations tend to complicate the problems of some elevator operators. Many of the rail lines in grain producing regions were designed for early 1900 technology and have not been modernized due to light usage. Some of the rail lines require upgrading and/or repair if they are to handle the heavy hopper cars and multiple-car trains. Substantial investments in loading facilities are required to load large multiple-car shipments. The decline in the number of 40-foot box cars and the encouragement of multiple-car shipments by rail carriers place the elevators located on a light branch rail line at a considerable disadvantage.

Railroad officials contend that the large number of rail lines in grain producing regions preclude an efficient rail system. Although there seems to be a general agreement among railroad officials that too many branch lines are in existence, there is considerable difference of opinion in how many and which lines should be closed.

With increasing concern regarding the competitiveness of the United States in world markets and the pervasive need to reduce transportation infrastructure costs and eliminate the effects of equipment shortage and outmoded plant, coordinated planning is essential. Part of the problem rests with the fact that there is a lack of knowledge regarding the benefits of alternative grain transportation systems. There is also uncertainty as to where investments should be made to gain the maximum benefits of these systems. Neither today's pricing systems nor regulatory policies are adequately designed to coordinate or facilitate the adjustments needed to insure an efficient physical distribution system and provide for the general transportation needs of an expanding grain industry.

SUMMARY OF THE RESEARCH

The purpose of the research was to find which grain distribution system would yield the highest net income in a 6-1/2-county area around Fort Dodge, Iowa. Net income was defined as the gross income from the sale of the projected 1980 volume of 118 million bushels of grain delivered to one or more of 11 markets, minus all transportation from farm to market, non-farm storage, variable handling and facility investment costs and rail line maintenance and upgrading costs.

Transportation alternatives considered include the traditional single-car rail system, multiple rail car shipments of 3-10, 50, 80, and 115 cars, truck, truck-barge and rail-barge. It was assumed that subterminals would be required to load shipments of 50 cars or more. Also, alternative rail line options were considered: these included maintaining the 1971 rail system (rail line option I), maintaining and upgrading 46 percent (rail line option II), 27 percent (rail line option III) and 100 percent (rail line option IV) of the 1971 rail lines to permit trains with jumbo hoppers to travel at least 35 miles per hour.

Computer programs were developed to determine the most efficient system of grain distribution. Data required in the programs included the 118 million bushels of grain expected to be sold outside the area in 1980, prices from the 11 markets now served by the area, plus all handling costs and transportation charges which are presently available in Iowa or Illinois, and the rail line options. The computer solutions determined what marketing and shipping system would produce the most net revenue for the 6-1/2 counties using various combinations of all these alternatives.

Generally, the highest net revenue was obtained by using a subterminal system to assemble large quantities of grain into multiple-car shipments. The optimum number of such subterminals varied, depending on the rate structure and amount of rail maintained in each analysis.

Table I, below, lists the alternatives examined in this study in terms of net system revenue gain. The table reveals that the highest total net revenue to the system would have been obtained from a subterminal system using 115-car trains operating continuously between Gulf ports and six subterminals within the 6-1/2-county area and maintaining only 27 percent of the 1971 rail lines in the study area. This system would have yielded 9.2 million dollars more per year or 7.8 cents a bushel, than the traditional single-car system. Revenue would have declined 0.4 cent per bushel when 46 percent of the 1971 rail lines were maintained and eight subterminals loaded the 115-car trains. Based on the assumptions of this study, this system would require only 858 covered hopper cars or 32 percent as many as the traditional system to move the 118 million bushels of grain because of car use efficiencies in multiple-car shipments.

Under the system with the 115-car continuous trains, nearly all of the grain out of the 6-1/2 counties would have been moved to Gulf ports. By contrast, when single-car rates were used, the most net revenue would have been obtained when only 9 percent of

TABLE I

ESTIMATED INCREASES IN NET REVENUE OF SELECTED GRAIN TRANSPORTATION SYSTEMS
OVER TRADITIONAL SINGLE-CAR SYSTEM: CENTS PER BUSHEL

SELECTED TRANSPORTATION ALTERNATIVES	PERCENT OF 1971 RAIL TRACK UTILIZED	NUMBER OF SUBTERMINALS	ADDITIONAL SYSTEM NET REVENUE (Cents per Bushel)
1) 115 Car Unit Train	27	6	8.7*
2) 80 Car Unit Train	27	8	8.3*
3) 115 Car Unit Train	46	8	8.1*
4) 80 Car Unit Train	46	9	7.8*
5) Occasional 50 Car Multiple	27	7	5.6*
6) Occasional 50 Car Multiple	46	8	5.4*
7) Occasional 50 Car Multiple	27	10	5.1**
8) Occasional 50 Car Multiple	46	13	4.9**
9) Occasional 50 Car Multiple	100	10	3.7**
10) Traditional Single Car System	100	0	0.0**

* Analysis Based on Costs of Transportation

** Analysis Based on Transportation Rates the grain would have moved to the Gulf and two-thirds of it would have gone to Chicago. This indicates that, at least on a total cost basis, multiple-car shipments open the Gulf export markets to Iowa.

Other major findings of this study were:

1. All existing elevators would have remained in business under all rail line options and rate structures, though those on abandoned lines will have had to modify their operations.
2. Under the 115-car continuous train system and rail line option II, reduced transportation rates would represent 89 percent of the increased net revenue. Reduced rail line maintenance costs would represent 11 percent of the increased net revenue. Under rail line option III, reduced transportation rates would represent 82 percent of the increased net revenue and reduced rail maintenance would represent 18 percent of the increased net revenue.
3. Storage requirements within the area would have increased 67 percent over 1971 for the traditional single-car system and for the single-car, 3- to 10-car and occasional 50-car system, but only 45 percent for the continuous train system. The difference in storage requirements is a result of shipping patterns rather than size of shipment.

4. Total additional investment requirements to handle the projected 1980 volume of grain would have been $75,000,000 for the traditional single-car system. The total investment would be $66,000,000 for the single-car, 3- to 10-car, and 50-car system. The single-car, 3- to 10-car, and 115-car system would require only $45,000,000 of additional investment to handle the 1980 projected volume.
5. Normally, there would be a cost advantage in building additional storage at country elevators and subterminals rather than on the farm because of greater utilization of equipment at the elevator.
6. Taxes paid by trucks hauling grain from farms to elevators and subterminals, and from elevators to subterminals would have exceeded the cost of road maintenance and resurfacing resulting from the movement of the grain. This analysis, however, was only for short distance movements within the 6-1/2-county area.
7. Total fuel consumption for shipping the 118 million bushels of corn and soybeans to the Gulf for export would have increased only 5.6 percent for the 115-car continuous train system over the traditional system. The increased fuel consumption would have been the result of trucking from farms and elevators to subterminals. However, fuel consumption would be less

than the present 1973 system where large amounts of grain are being trucked 200 miles to the Mississippi River and grain is being trucked up to 80 miles to subterminals because of transportation difficulties.

This study examined the 6-1/2-county area surrounding Fort Dodge, Iowa, a heavy cash grain producing area located about 200 miles from the Mississippi River. Results are directly applicable only to that area and under the assumptions made in the study, although they may be used to provide insights into grain distribution efficiency elsewhere. In addition, the assumptions made regarding rail abandonment considers only the costs and net incomes for corn and soybeans shipped from the area. Obviously, in rail abandonment decisions consideration must be given to other shipments on these lines, although the only major product that appears to be affected in this area is fertilizer. If policy objectives are not solely economic, these non-economic variables must be considered in decision making.

POLICY IMPLICATIONS

The following discussion assumes these long-run conditions:

1. Export movements of corn and soybeans will continue at relatively high levels.
2. Transportation media involved in these movements will continue to be operated on a privately owned-publicly regulated basis in the United States.

With the introduction of the multiple-car rates in Iowa in 1971, the traditional single-car system began changing to alternative nine. Alternative nine is the system operating in the 6-1/2-county area at the present time.

The highest revenue would have been obtained from the 80-car or 115-car continuous trains operating on 27 percent of the 1971 rail line system. Thus, this study indicates the 115-car or 80-car continuous train systems are the best alternatives in terms of net revenue, reduced investment in equipment and facilities, and in capacity to move large quantities of grain with minimum congestion in the entire system. This high net revenue system is something of an "ideal" or model system. It ignores the realities of separate ownership and competition. Therefore, it should be regarded as a goal or target. Realistically, moving 50 percent to 60 percent of the grain, rather than 99 percent, in continuous trains, would be a dramatic accomplishment in the area.

The system which actually develops will depend on what rail abandonment actually occurs and the extent to which the grain industry, carriers and farmers are willing to work together to accomplish such a goal. Basically, these people must weigh the benefits of the model system against the problems of individual adjustments and cooperation, continuing transportation problems and the risk of rail abandonment and over-investing in facilities if each unit decides to go its own way in an unplanned system.

To move toward reaching the higher net revenue goals of the first or second system, two intermediate phases could be implemented. The first phase might be to improve the present operations of alternative nine. The second phase might be to maintain parts of the 1971 rail line system and upgrade other rail lines to more closely approximate rail line option II (46 percent). This latter phase could facilitate the introduction of 80- to 115-car continuous trains which result in substantial improvements in net revenue over alternative nine. Again, this analysis included only corn and soybeans. It is possible that if other commodities such as fertilizer had been included in the analysis, rail option II (46 percent) could be a better alternative than rail option III (27 percent).

INSTITUTIONAL PROBLEMS IN IMPLEMENTING ALTERNATIVES

A number of possible institutional problems could arise in implementing the highest income alternatives. Among these is the difficulty of expediting interline movements. At the present time, unit train movements are most successful on railroads which have direct lines to the selected markets. In this case, the originating railroad controls the train the entire route. The average unit train turnaround time to the Gulf over a 12-month period for one railroad operating direct to the Gulf from the 6-1/2-county area was 8.9 days. This included 48 hours of free unloading time. On the other hand, multiple car movements of less than trainload size which interline with other railroads may require substantially longer turnaround times. In part, this difficulty arises because the interlining railroad will sometimes take part of a multiple-car shipment to fill out a scheduled train. The remaining cars must then wait for another through train to the destination. Frequently, multiple-car shipments that arrive at the destination as a unit are broken up in a similar manner on the return trip, causing longer turnaround times because of extra days required to accumulate cars for loading at the origin. Thus, a major institutional problem in implementing the selected alternatives is coordination among the interlining railroads to keep the cars together as an economic unit. Using the same set of locomotives to power the unit is possible and desirable from the standpoint of faster turnaround times. Interline problems have been solved in moving other commodities. For example, continuous trains now moving steel from a western origin to a midwestern destination are being handled by three rail lines in route without the delays normally encountered in interline traffic. Two of the three railroads involved in this movement operate in the 6-1/2-county area.

The interline problem could also restrict the number of buyers who could receive grain from the 6-1/2-county area on a unit train basis. Typically, the originating railroad prefers to write the tariff so receiving elevators on the direct line movement can receive the grain. If the interlining problem were solved, more receivers could bid for the grain and thereby increase the willingness of shippers to guarantee annual volumes.

Another problem on unit train movements is the present condition of main line track in Iowa. While there is uncertainty of the impact of unit grain train movements on the maintenance of lines, there seems to be little doubt that some main line track in Iowa will need substantial maintenance to avoid delays from derailment and speed limitations. Recent studies of unit train operations suggest that more than proportional wear of rail lines occurs under unit train operations.

Present and planned investments in subterminal facilities could also create problems in moving to the higher income alternatives. The solutions in this study indicate that a larger number of subterminals is optimum for alternatives eight and nine than for alternatives one through four. Once the optimal number of subterminals for alternative nine are constructed, there will be resistance to changing to higher revenue alternatives because of the fixed investments. Therefore, the income potential of the other alternatives would be lowered because of the costs associated with duplicate investments. As of July 1973, there were nine subterminals with 50-car loading capacity either planned or constructed within the 6-1/2-county area. Moreover, there were at least four subterminals with 25-car loading capacity. A planning effort needs to be undertaken with railroad participation to avoid either duplicate or unneeded investments.

Problems could also arise at the port destinations. Some port elevators do not have sufficient rail siding to handle 80-car or

115-car unit trains. Thus, delays could be encountered if the units are broken up for unloading unless the amount of siding is increased.

Another problem could arise regarding the export ports. Use of 115-car continuous trains basically is a system of booking transportation in advance. Essentially, a contract is made with the railroad to supply a train for a period of time continuously between the subterminals and the Gulf ports. In addition to the concern about the ports being able to handle the grain physically, there is an equal or greater concern on the part of shippers with an available market outlet.

Accordingly, there is a probable need to make available to other markets rates of a type similar to the 115-car rates available to Gulf export from Illinois. However, such rates would need to be made available to export elevators within an area, other than those located on a given rail line. And there would be a need to have rates of a similar type to other areas so shippers have the opportunity to gain the efficiencies of these systems in moving grain to other markets. The concept of booking transportation in advance is not new. It currently is used on barge shipments and to some extent on the 50-car occasional trains which must be scheduled for a minimum of five consecutive turns. However, the expanded use of even larger continuous trains on this basis obviously would require additional flexibility.

There is concern among leaders in rural communities of the possible disastrous impact of railroad abandonment in their communities. The results of this research under the assumptions stated, suggest that none of the alternative grain distribution systems evaluated would force country elevators out of business if the size of the railroad line network were reduced. The growth of these elevators would undoubtedly be reduced but farmers would continue to be served by these facilities. On the other hand, the cost of not moving to alternative one through eight is reduced income and continuing grain transportation problems.

REGULATION

The welfare of agricultural shippers, as well as others, is the responsibility of government through laws and policies designed to make the transportation system function in a manner which is beneficial to society. Clearly, this is the function of the federal government because transportation is national in character and defies rational handling in a broad policy sense at lower government levels.

Railroads, trucks and barges are involved at one stage or another in the physical distribution of grain from farm to markets. The high income alternatives in this study suggest railroads would be the major carrier from the 6-1/2-county area. Such observations assume that certain percentages of the lines available for the traffic could be maintained but to do so would not require major changes in regulatory policy. Procedures proposed by the Interstate Commerce Commission in Ex Parte 271, Sub 1, establish the basis for abandonment of light density lines. These rulings would allow railroads to abandon when volume averages less than 34 carloads per mile per year on the lines at issue. Whether this ruling will result in the higher income alternatives suggested in this study is unknown at this time.

One possible change in regulations, or perhaps in the interpretation of regulations, might be suggested. Motor and water carriers are legally permitted to quote rates, subsequently filed with the Commission, on a "contract" basis. These rates may cover a single haul only, or a number of hauls from a single shipper, or over a period of time. Railroads, classified as common carriers, must submit rate adjustments for Commission approval before publishing them, a time consuming process which often negates any advantage the original rate proposal may have had. Contract rates might be a possibility for overcoming objections, delays and other procedural matters in implementing continuous trains for grain movements.

PUBLIC INVESTMENT

The poor earnings record of the nation's railroads and particularly some of those serving Iowa has been a well publicized fact. Poor earnings of railroads may be a result of management inertia, national policies, public investment in competing modes, or a combination of each. Railroad officials allege that these national policies have been partially responsible for the earnings record which in turn has resulted in a lack of capital for new equipment and improvements in physical plant. In any event, equipment shortages and deterioration of roadbed have created serious problems for grain shippers. So serious is the railroad-owned hopper car shortage that Iowa grain shippers during the summer of 1973 were forced to pay penalties up to 15 cents or more per bushel to grain companies for making privately owned or leased cars available for shipments from the elevators.

Financial assistance for railroad owned equipment and for upgrading selected lines could be justified for two important reasons. One relates to the new importance of agricultural production in domestic and export markets in terms of national and international trade and currency balances. If railroad revenues cannot provide the facilities necessary to meet the anticipated future demands for agricultural commodities, it could be in the national or state interest to assist them to do so. The second reason is supported by the "equal treatment" philosophy of federal regulation and policy. Both state and federal governments could share in this responsibility through assistance by loans, grants in aid, or direct subsidies if and when needed.

COORDINATION AND COOPERATION

From time to time, coordination of carrier services has been suggested as a means of easing grain transportation problems. Coordination between carriers may be voluntary or compelled. Railroads by law must establish through routes and joint rates with other railroads, but cannot be compelled to short haul themselves on interline traffic. Voluntary coordination may be established by motor carriers themselves and with railroads and water carriers but they cannot be compelled to do so by the Commission. The same thesis applies to water carriers. Examples of voluntary coordination in grain transportation are truck-rail, truck-barge, and rail-barge combinations.

A major justification for coordination lies in the possibility of increased efficiency in equipment utilization. Given the critical transportation conditions existing in the grain producing areas today, one way to improve car handling techniques is for railroads to allow unit trains to move intact under interchange arrangements. It is difficult to achieve the efficiencies of multiple-car units when the units are broken at major switching terminals and cars are held for inclusion on trains of the terminating line or when unit trains are stopped for changes in power units or other equipment. Coordination between railroads involved in long distance grain movements should be expressed in expedited service from origin to destination regardless of the number of lines in the routes.

Current railroad operating procedures need to be evaluated to determine their impact on the efficiency of the total grain distribution system.

Improvements in transportation services and facilities will be easier to achieve when the interests of all concerned parties are harmonized. Grain producers, merchandisers, carriers, and government agencies need to coordinate their efforts and to develop a spirit of cooperation. Interline and intermodal coordination should stress the continuation of competition for improvement of service but such competition should be controlled. It is not an easy task to reconcile the diverse interests of these groups into a common purpose.