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Economic Effect of Barge Transportation On Farmers in Nez Perce, Lewis and Idaho Counties, Idaho

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INTRODUCTION

When Lower Granite Dam is completed the City of Lewiston, Idaho will become an inland port capable of handling barge shipping. Lower Granite Dam, located 30 miles down river from Lewiston, is the last in a series of four dams which will create slack water pools making that section of the Snake River from Pasco, Washington to Lewiston suitable for barge movement. At Pasco, the Snake River flows into the Columbia River. From Pasco to Portland, Oregon, the Columbia like the Snake has a series of dams which make the Columbia River fit for navigation by today's large barges. These large barges will introduce a new competitive mode of transportation to Lewiston and surrounding communities.

In agriculture, transportation is as important as the planting of the crop. Most agricultural crops require processing before they reach the ultimate consumer. In some cases an agricultural commodity may be transported by many different modes of transportation before it reaches the final consumer.

A farmer pays the initial cost of transportation on his commodities from the producing area to the central market in the form of lower prices for his production. Therefore, the closer a farmer lives to the market the more he will receive for his commodities. This central market may be either the first processing center for the commodity or a port in which the commodity is changed from one mode of transportation to another for further shipment.

The Problem

Improvement of waterways will introduce barge transportation to the Lewiston area. This has the effect of increasing competition with existing transportation modes. This increased competition has resulted in a decrease in the shipping charge for many agricultural resource inputs and commodities.

Barge shipping is well adapted to moving large quantities of bulky, raw agricultural commodities grown in the area around Lewiston. Barges are also well adapted for shipping some of the inputs used to produce agricultural crops.

The problem stated specifically is: What effect will a decrease in transportation costs have on the income of farmers in the Lewiston area? Since the farmers are dependent on transportation, they will rely on the mode which will give them the most favorable rates and still provide the necessary shipping services.

The Lewiston port will primarily serve the Clearwater Region. This study investigates a section of the Clearwater Region in which the principal towns are Lewiston, Lapwai, Culdesac, Reubens, Craigmont, Nezperce, Cottonwood, and Grangeville, Idaho. The map on page 4 illustrates the actual boundaries of the study area. Located in these towns are retail outlets for fertilizer, petroleum products, and the many other resource inputs used in production. These towns are the sites of elevators which receive the commodities grown in the study area.

The farming practices and crops grown throughout the study area are very similar. The major crops include soft white winter wheat, spring and winter barley, and Austrian and Alaskan peas. Many other specialty crops are grown in one or more locations in this area.

At present the primary modes of transportation serving the area are large commercial trucks and the Camas Prairie Railroad. The railroad connects with other major lines to provide rail service between the area and all other parts of the continental United States. Both the railroad and trucks supply the study area with resource inputs needed to produce its major crops and move the raw commodities produced in the area to marketing centers.

Objectives

The main objectives of this study are:

a. To determine which inputs and commodities will benefit from river barge shipping, and to estimate truck-barge shipping costs for those inputs and commodities which can benefit from barge shipping.

b. To determine the economic impact that introduction of barge transportation to Lewiston will have on the marginal value productivity of each input which is associated with income earning capacity for farmers operating in the study area.

Any increase in returns to production as a result of decreased shipping costs represents an increase in the farmer's income without any additional increase in investment in inputs on the part of the farmer.

Definition of Terms Used in the Procedure:

1. Commodities grown in the study are shipped from the production region to locations outside the area. These commodities have

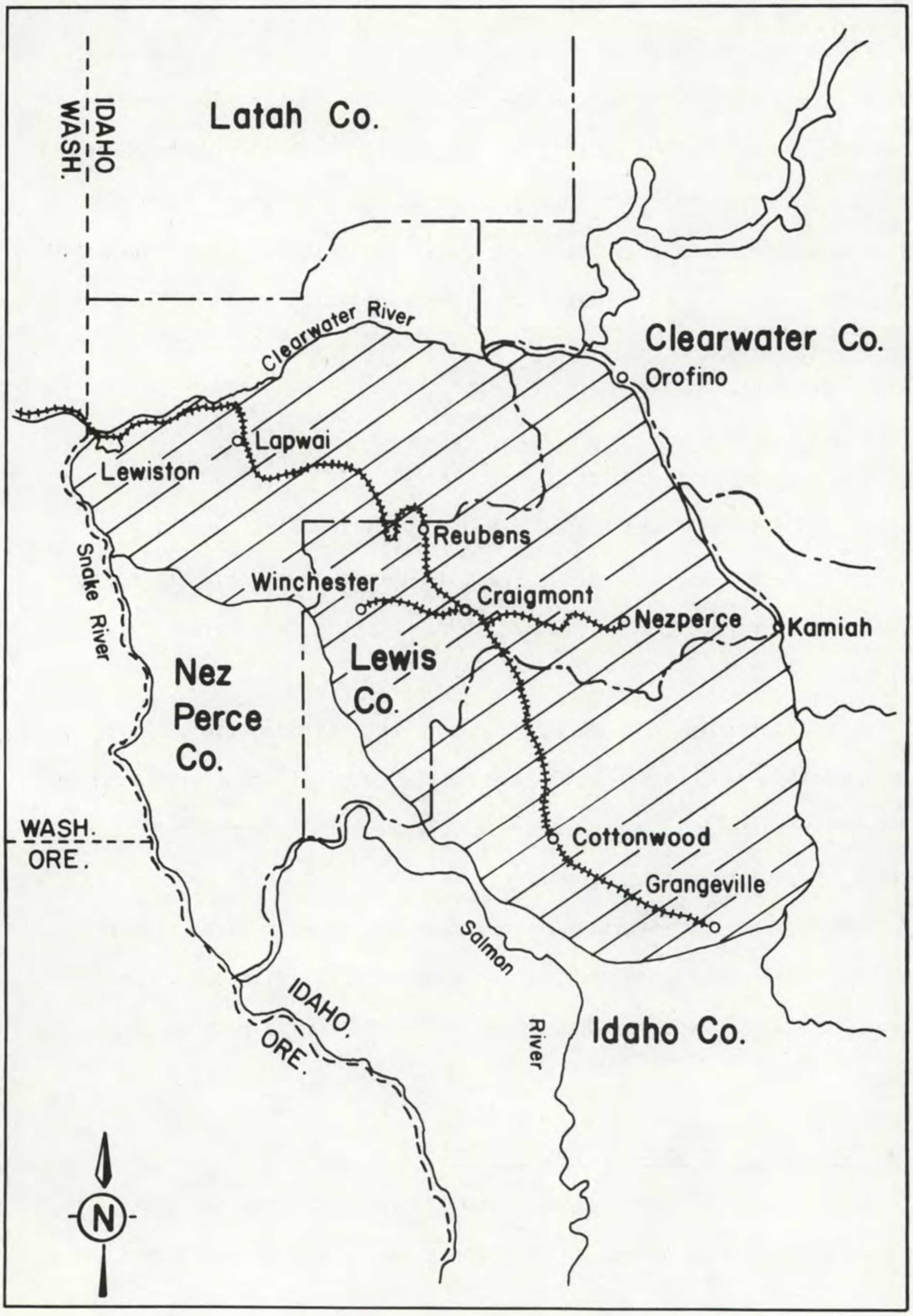

Figure 1. Location of Study Area

a shipping destination.

2. Those inputs not produced in the study area are shipped in from producers outside the study area. These inputs will have a shipping origin.

3. The inputs and commodities are shipped in many different kinds of packaging, or loose without any packing. All the products will have a shipping form whether they are packaged or loose.

4. The shipping origin and destination are classed as marketing centers for the inputs and commodities. A large share of the products being shipped to or from the study area have one primary marketing center. Other products have a wide variety of marketing centers. To determine if the products could be moved by barge requires an understanding of the market center's geographic location.

Shipping form was determined for products which could benefit from barge movement. Economies of barge shipping are realized on movement of large quantities of bulky, raw products, whereas products packaged in small lots of individual containers do not lend themselves to the economies available with barge movement.

Last, the present mode of shipment was determined for products which could be shipped by barge. This provided data for comparing present shipping costs with estimated shipping costs of these products by barge.

Data Source

Data were obtained by inteviews with farmers, county agents, warehouse managers, machinery, fertilizer and chemical dealers, and other agri-business operating in the area.

Those products which are transported between the study area and Portland have the potential to benefit from barge shipping. The benefit of barge shipping is reduced if products are shipped to and from the Central, Eastern, and Southern United States. In determining which goods can benefit from barge shipping, the general procedure was to examine the initial handling of the product, the mode of transportation being used at present to move the product, and the shipping destination or origin of the product.

Methodology of Estimating Barge Transportation Rates

Estimating barge transportation rates involved computing truck rates in addition to barge rates. To complete shipments made by barge it will be necessary for trucks to ship the various products to and from the Lewiston port and towns located in the study area. The greater the mileage between Lewiston and final destination, the greater will be the trucking costs.

Barge rates were figured between Lewiston and the shipping origin or destination. Thus, the rates for selected locations within the study area will vary only in the trucking costs.

Trucking costs were obtained from the Idaho Motor Tariff Bureau. These rates are published on a mileage basis and not on a point-to-point schedule.

The rates published by the Idaho Motor Tariff Bureau for all products are primarily for use by local independent truckers operating in the State of Idaho. Extensive legal procedures are required for a trucker to charge a rate different from those published by the Tariff Bureau. Most of the small truckers cannot afford this legal cost;

therefore, they generally follow the rates established by the Idaho Motor Tariff Bureau.

The legal procedures are used to establish fair competition between all operators and to prevent any operators from being forced out of business. The larger trucking firms may go through the legal procedures and offer a lower rate than that established by the Idaho Motor Tariff Bureau. However, the study assumed that the shipping charges offered by large trucking firms between Lewiston and towns in the study area will not be substantially lower than those of the Idaho Motor Tariff Bureau. If the rate spread were too great, it would force the smaller truckers out of business.

Regulations dealing with the shipping of grain differ from those covering other products.

Trucks hauling grain interstate come under the regulation of the federally controlled Interstate Commerce Commission (ICC), but a trucker is not required to follow the tariff or publish any rates on the shipment of grain. The trucker is free to bargain on charges he will offer for hauling grain.

When the trucker hauls grain intrastate, the trucker is no longer under ICC regulation. The Idaho law requires truckers to abide by the rates published by the Idaho Motor Tariff Bureau.

An exception to this regulation on intrastate grain shipments by truckers occurs when grain being hauled is marketed for export. The grain marketed for export must not lose its identity by being mixed with grain from other sales. This identity must be maintained during shipment between the warehouse in the producing center and the ultimate marketing center of the commodity. When grain is sold and shipped under these restrictions, the trucker then follows the regulations set forth by the Interstate Commerce Commission.

This study assumed that most of the grain shipped from locations in the study area to a Lewiston terminal will be sold for export and will not lose its identity at the terminal or during shipment. The grain is stored at local warehouses until it is sold. Once a sale is completed, the grain is shipped from the local warehouse to the marketing center. There is little reason to believe that individual sales of grain will be retained in storage at a Lewiston terminal, thus reducing the possibility of the grain losing its identity.

Because of the difference in regulation on grain shipments, trucking costs for grain were derived from ICC evidence.

The truck-barge combination will be the major competitor to the now-existing railroads and trucks. A rail-barge combination will not be economical for the study area. Once a commodity is loaded on a rail car, the charges are designed for direct shipment to the marketing center, and unloading the product after a short distance of transport is too expensive. A truck-barge combination will be cheaper than a rail-barge combination for the study area.

The cost of shipping products by barge was obtained from published tariffs and interviews with barge operators. Since barge shipping is not operating at present between Lewiston and coastal ports, some of the rates used are estimates determined from the study data.

As reported by Sampson and Farris (1) barges are exempt from publishing their tariffs on the shipping of various products. Commodities are exempt from rate regulation if no more than three commodities make up the cargo. Liquid cargoes shipped as bulk in tank vessels are free of rate regulations. The majority of products that will be shipped in and out of the Lewiston port by barges will come under these exemptions.

Despite the freedom to bargain for rates, some barge companies operating on the Columbia-Snake Rivers have published shipping rates with the Pacific Inland Tariff Bureau. The barges are not required to charge these rates, but rather these rates are generally considered as a starting point in bargaining for lower rates. Such factors as having a cargo for the round trip and not having to haul one-way empty will lower the cost of shipping. The quantity shipped will also affect the cost of shipping. However, the barge rates published with the Pacific Inland Tariff Bureau were used in establishing the estimated cost for barge shipping to and from Lewiston.

At present barges operate on the inland waterways service free, in contrast with railroads which are forced to build and maintain their rail network. There is increasing pressure to pass federal legislation to levy a "user fee" on barges for use of the inland slack water. At present navigation on the inland waterways is improved and maintained through public expenditures. This study does not include consideration of this "user fee" controversy.

Included in analysis of shipping rates were the loading and unloading costs involved in the shipment of inputs and commodities. Inputs coming into the study area have a loading cost at the shipping origin and an unloading cost at the local dealers. Those commodities leaving the study area have a loading cost at the warehouse and an unloading cost at the marketing center.

The truck-barge combination will also require an unloading and loading charge at the Lewiston port terminals. The truck-barge cost estimate was adjusted to include the unloading and loading charge where the ports were not already included in the tariff.

Once the truck-barge estimates were computed, they were compared to present shipping rates. Present shipping costs were obtained from both published freight tariffs and interviews with individuals operating transportation services in the study area.

EVALUATING BARGE SHIPPING OF FARM INPUTS

This section discusses the shipping form and shipping origin for the various inputs utilized on the farms.

Seed

The majority of the seed used for planting in the study area is grown in the area itself. One exception is grass seed which is shipped into the study region. Grass production is unique in the region around the town of Nezperce. The grass seed is planted and will remain as an established crop for several years before being plowed under. In some cases grass fields are left from 10 to 20 years. Therefore, the yearly quantity of grass seed shipped into the study area is very small and not significant to the study.

Machinery

A large quantity of machinery is used in the study area for farm production. This equipment is manufactured through the United States in a wide diversity of locations. It is highly unlikely that the majority of the machinery used in the study area will ever benefit from barge shipping because of the geographic locations of the production center.

Pesticides

The majority of liquid herbicide and insecticide sprays utilized by farmers are handled in 5, 10, and 30 gallon containers. A farmer may use one or a combination of several of these containers to meet his spraying needs. Seldom does an individual farmer use large bulk quantities of spray. Some of the sprays come in a powder form in small packages to be mixed with water when needed.

The increased cost of handling products shipped in small containers generally reduces the economies of barge transportation. Favorable rates for barge shipping are generally realized for shipments of large quantities of raw, bulky products. The total quantity of spray used in the study area would not be large enough to meet the quantity demands necessary for savings in barge movement.

For these two reasons this study did not attempt to analyze further the transportation cost of sprays.

Commercial Fertilizer

Large quantities of dry and liquid forms of commercial fertilizer are used in the study area. The choice between dry and liquid fertilizer is generally a management decision based on the individual farmer's preference or the type of crop to be fertilized.

The following information on the major shipping origin of fertilizers was obtained from the major fertilizer suppliers. The information on shipping origins reflects a general yearly pattern of fertilizer supply to the local dealers and is not taken from any one particular year.

Anhydrous Ammonia

Anhydrous ammonia in liquid form handled under pressure is one of the primary sources of nitrogen fertilizer utilized by farmers. Anhydrous ammonia contains more actual nitrogen per gallon than any other nitrogen fertilizer. The primary drawback of anhydrous ammonia is that it has to be applied under pressure at the field. This involves the use of specialized equipment not required in application of other nitrogen fertilizers. Despite this drawback, anhydrous ammonia is used in large quantities.

Anhydrous ammonia used in the study area comes from Pasco, Washington. About 96 percent of the anhydrous ammonia is shipped by rail, the rest by truck. The truck shipments are made during peak use periods to maintain a supply at local plants.

Most of the anhydrous ammonia used in the study area is manufactured at Pasco. There is also a company shipping anhydrous ammonia by barge from Alaska to Pasco and other locations on the Columbia River. The shipping origin of anhydrous ammonia makes shipment very possible by barge from Pasco to Lewiston.

Anhydrous ammonia becomes a gas when exposed to air. Therefore, it must be shipped in special pressurized containers or containers equipped with refrigeration to maintain the ammonia in a liquid form. The company shipping anhydrous ammonia from Alaska is doing so in a specially equipped refrigerated barge, thus demonstrating that the product's shipping form is well adapted to barge movement.

No estimates were available on shipping costs of anhydrous ammonia from Pasco to Lewiston. However, the general opinion is that anhydrous ammonia will be shipped to Lewiston once the port is opened and the facilities are built to handle the fertilizer.

Aqua Ammonia

Aqua ammonia is another major source of nitrogen fertilizer. A simple converter mixes anhydrous ammonia with water to produce aqua ammonia. Aqua ammonia does not have to be handled under pressure. Fertilizer dealers generally convert the anhydrous ammonia to aqua ammonia at their plants located in the user area, because it is cheaper to ship a pound of nitrogen in the form of anhydrous ammonia than in the form of aqua ammonia.

Since aqua ammonia is not shipped directly into the area, it will not receive any direct benefit from barge shipping. Should anhydrous ammonia receive rate reductions because of barge transportation, then aqua ammonia will directly receive a similar benefit in rate reductions.

Ammonium Phosphate, Urea, and Nitro Sul

Ammonium phosphate is shipped from two primary sources--Colfax, Wasington and Burbank, Washington. All shipments are by trucks.

Another source of nitrogen fertilizer is Urea, also known as solution 32. Urea is a liquid ammonium nitrate containing 32 percent nitrogen per gallon. The entire supply of Urea is shipped by truck from Pasco.

A liquid form of sulfur is provided in a fertilizer called Nitro Sul. The complete supply of this fertilizer is also shipped by truck from Pasco.

Ammonium phosphate, Urea, and Nitro Sul are shipped in a liquid form and do not require any special handling and storage equipment. These commodities all could be shipped by barge to Lewiston.

At present these types of fertilizers are being shipped from Linnton, Oregon, near Portland, to East Pasco at a cost of $2.48 per ton (2). Using this shipping cost and the river mileage between these two towns, a cost of $1.65 per ton or 8.3¢ per hunderweight was estimated for shipping these fertilizers from Pasco to Lewiston. (See Appendix 1 for rate calculations.)

This procedure does not produce estimates of the accuracy desired for barge shipping costs between Pasco and Lewiston, but this is the most accurate estimate that can be made now. Barge operators were reluctant to make any estimates on the cost of shipping fertilizer, and this was the only available information on fertilizer rates on the Columbia-Snake Rivers. The rate for fertilizer is subject to bargaining between the shipper and barge operators and is not controlled by ICC regulations. The ultimate rate will depend on the quantity shipped and the competition that will result between barge lines.

At present there is a terminal charge of $1.50 per ton to unload fertilizer from a barge and reload to a truck for further distribution.

The trucking costs were obtained from the Idaho Motor Tariff Bureau's published tariffs (3). Table 1 lists individual and combined cost of truck-barge shipping and terminal exchange cost on a per hundredweight basis.

The comparison of present costs to estimated truck-barge rates shows substantial savings for ammonium phosphate (Table 2), and for Urea and Nitro Sul (Table 3). The present truck shipping rates were obtained from the Pacific Inland Motor Tariffs (4).

TABLE 1

AMMONIUM PHOSPHATE, UREA, AND NITRO SUL: ESTIMATED TRUCK-BARGE SHIPPING COSTS BETWEEN PASCO, WASHINGTON, AND SELECTED LOCATIONS, IN CENTS PER HUNDREDWEIGHT

	Barge Rates to Lewiston	Terminal Cost	Trucking Rate	Total Truck-Barge
Lewiston	8.3	7.5	-0-	15.8
Craigmont	8.3	7.5	12	27.8
Nezperce	8.3	7.5	16	31.8
Cottonwood	8.3	7.5	16	31.8
Grangeville	8.3	7.5	19	34.8

TABLE 2

AMMONIUM PHOSPHATE: COST COMPARISON OF TRUCK-BARGE RATES FROM BURBANK, WASHINGTON, TO SELECTED LOCATIONS, IN CENTS PER HUNDREDWEIGHT

	Truck-Barge Rate	Trucking Rate	Estimated Savings
Lewiston	15.8	34	18.2
Craigmont	27.8	43	15.2
Nezperce	31.8	46	14.2
Cottonwood	31.8	46	14.2
Grangeville	34.8	49	14.2

The ammonium phosphate produced in Colfax is the only fertilizer that will not realize a savings in transportation costs. It is now shipped by truck at a cost of 34¢ per hundredweight to Grangeville. The truck-barge cost is 34.8¢ per hundredweight. Ammonium phosphate shipped from Burbank will receive a savings in shipping costs.

The major drawback of shipping fertilizer to Lewiston by barge is the bi-yearly utilization pattern of the fertilizer. The application of fertilizer is done primarily during the two peak periods of each year. These periods exist for one and one-half months during fall planting and a month during spring planting. The rest of the year very little fertilizer is applied. This application pattern is the same for all fertilizers analyzed in this report.

TABLE 3

UREA AND NITRO SUL: COST COMPARISON OF TRUCK-BARGE RATES TO TRUCK RATES FROM PASCO, WASHINGTON, TO SELECTED LOCATIONS, IN CENTS PER HUNDREDWEIGHT

	Truck-Barge Rate	Trucking Rate	Estimated Savings
Lewiston	15.8	36	20.2
Craigmont	27.8	45	17.2
Nezperce	31.8	48	16.2
Cottonwood	31.8	48	16.2
Grangeville	34.8	50	15.2

One fertilizer supplier indicated that the quantity of fertilizer used in the study area would not justify the use of barge transportation, and the cost of building a barge terminal for fertilizer at Lewiston.

Other fertilizer suppliers indicated that there was a very good possibility that barge shipping could be used in moving fertilizer to Lewiston. The authors believe that fertilizer will be shipped to Lewiston by barge if the barge companies can offer lower shipping costs. Terminal costs will be offset not only by the quantity of fertilizer used in the study area but by that used in areas to the east, north, and immediate west of Lewiston. The study area and these other areas surrounding Lewiston are highly intensive agricultural producing regions which utilize a large total supply of fertilizer each year.

Dry Fertilizer

Farmers also use a large volume of dry fertilizer. Most is supplied from sources in Canada. The dry fertilizer is shipped by a combination of rail and trucks from Canada through points in Northern Idaho to the study area. Thus, the geographic location of the shipping origin eliminates the possibility that dry fertilizer could realize any savings from barge shipment.

Petroleum Products

Gasoline and diesel oil are the primary petroleum products used by farmers to produce agricultural crops. These come into the study area from two primary shipping origins, Pasco and Spokane, Washington. The Pasco area is supplied both by a pipeline from Salt Lake City, Utah, and by barges from southern coastal refineries. The Spokane area is supplied by a pipeline from Montana. In the past some companies shipped petroleum products into the Grangeville-to-Craigmont area from Boise, Idaho. This is not being done at present.

The choice of the shipping origin from which the local petroleum dealers are supplied is assumed to be a company preference. At present petroleum products are being shipped to the study area by both truck and rail.

Petroleum products are shipped in a bulk form by barge on many existing waterways including the Columbia River. Since a supply of petroleum is available at Pasco and can be handled conveniently and economically by barge, petroleum products exhibit an excellent ability for being shipped to Lewiston by barge.

Estimating Shipping Costs

A cost of 0.53¢ per gallon was calculated to ship petroleum by barge from Pasco to Lewiston. This is a transportation charge of 8.03¢ per hundredweight for gasoline. (See Appendix 1 for calculations.)

To complete the truck-barge cost a charge of $1.50 per ton or 7.5¢ per hundredweight to unload a barge and reload a truck at the Lewiston terminal must be added to both gasoline and diesel prices. This terminal charge is the same as that used for fertilizer. This barge cost plus the trucking charge obtained from the Idaho Motor Tariff Bureau (3) provide the cost of truck-barge shipping for gasoline (Table 4).

TABLE 4

GASOLINE: ESTIMATED TRUCK-BARGE SHIPPING COST BETWEEN PASCO, WASHINGTON, AND SELECTED POINTS, IN CENTS PER HUNDREDWEIGHT

	Barge Rate to Lewiston	Terminal Charge	Trucking Rate from Lewiston	Total Truck-Barge Rate
Lewiston	8.03	7.5	-0-	15.53
Craigmont	8.03	7.5	15	30.53
Nezperce	8.03	7.5	18	33.53
Cottonwood	8.03	7.5	18	33.53
Grangeville	8.03	7.5	20	35.53

The cost to ship diesel was calculated to be 7.2¢ per hundredweight. (See Appendix 1) The estimated barge costs for diesel are shown in Table 5. The truck rates in Table 5 were obtained from the Idaho Motor Tariff schedules. (3)

TABLE 5

DIESEL: ESTIMATED TRUCK-BARGE SHIPPING COST BETWEEN PASCO, WASHINGTON, AND SELECTED POINTS IN CENTS PER HUNDREDWEIGHT

	Barge Rate to Lewiston	Terminal Charge	Trucking Rate	Total Truck-Barge Rate
Lewiston	7.2	7.5	-0-	14.7
Craigmont	7.2	7.5	15	29.7
Nezperce	7.2	7.5	18	32.9
Cottonwood	7.2	7.5	18	32.9
Grangeville	7.2	7.5	20	34.9

The present cost of rail shipments is the same for gasoline and diesel fuel (5). Railroads offer separate rates on the two different size tank cars used in the shipment of petroleum products. Shipments made in the larger tank cars receive a lower rate per hundredweight because of the larger quantity being shipped. The shippers of petroleum operating in the study area used the larger size tank cars in order to receive the lower shipping costs. Thus, the rail rates quoted in this study are for the larger sized tank cars.

The truck-barge rates for gasoline reflect savings over the present rail rates for only Lewiston and Nezperce (Table 6). The railroad from Craigmont to Nezperce cannot carry the larger sized tank cars. This forces any dealers operating in Nezperce who may use the railroads as a shipper to use the smaller sized tank cars which increase their cost of shipping. At present the cost of rail shipments is more favorable than the estimated truck-barge rates for Craigmont, Cottonwood, and Grangeville.

A savings on the shipments of diesel is evident for only Lewiston and Nezperce (Table 7). The rail shipping cost for diesel is also high for Nezperce because of the extra costs involved in shipments made in the smaller tank cars.

The extra costs incurred in trucking petroleum products from Lewiston to locations in the study area generally reduce the savings realized in barge shipping. For example, the town of Craigmont is located approximately half the road miles between Lewiston and Grangeville. The cost of shipping petroleum products by truck between Lewiston and Craigmont is 15¢ per hundredweight, while the cost of shipping between

TABLE 6

GASOLINE: COST COMPARISON OF TRUCK-BARGE TO RAIL SHIPPING BETWEEN PASCO, WASHINGTON AND SELECTED LOCATIONS IN CENTS PER HUNDREDWEIGHT

	Truck-Barge Rate	Railroad Rate	Estimated Savings
Lewiston	15.53	19.0	3.47
Craigmont	30.53	25.0	-5.53
Nezperce	33.53	36.0*	2.47
Cottonwood	33.53	27.0	-6.53
Grangeville	35.53	30.0	-5.53

*The rate for Nezperce is on smaller size tank cars. All other rates are on shipments made in 20,000 gallon tank cars.

TABLE 7

DIESEL: COST COMPARISON OF TRUCK-BARGE TO RAIL SHIPPING BETWEEN PASCO, WASHINGTON, AND SELECTED LOCATIONS IN CENTS PER HUNDREDWEIGHT

	Truck-Barge Rate	Railroad Rate	Estimated Savings
Lewiston	14.7	19.0	4.3
Craigmont	29.7	25.0	-4.7
Nezperce	32.9	36.0*	3.1
Cottonwood	32.9	27.0	-5.9
Grangeville	34.9	30.0	-4.9

*The rate for Nezperce is for shipments of smaller tank cars. All other rates are on shipments made in 20,000 gallon tank cars.

Lewiston and Grangeville is 20¢ per hundredweight (Table 4). The total trucking cost between Lewiston and Grangeville is only 25 percent larger than trucking costs between Lewiston and Craigmont. This reduction in barge transportation savings continues to be evident for all products analyzed.

Savings become apparent for all locations when estimated truck-barge rates are compared to the present trucking costs from Pasco and Spokane (Tables 8 and 9). These present trucking costs were obtained from the Pacific Inland Motor Tariffs (6).

TABLE 8

GASOLINE: COST COMPARISON OF TRUCK-BARGE RATES TO TRUCKING RATES FROM PASCO AND SPOKANE, WASHINGTON, TO SELECTED POINTES IN CENTS PER HUNDREDWEIGHT

	Truck-Barge Rates	Trucking Rates	Estimated Savings
Lewiston	15.5	26.5 (P) 26.5 (S)	11.0 (P) 11.0 (S)
Craigmont	30.5	38.0 (P) 35.0 (S)	7.5 (P) 4.5 (S)
Nezperce	33.5	41.5 (P) 37.0 (S)	8.0 (P) 3.5 (S)
Cottonwood	33.5	41.5 (P) 37.0 (S)	8.0 (P) 3.5 (S)
Grangeville	35.5	45.0 (P) 40.5 (S)	9.5 (P) 5.0 (S)

(P) Rates between Pasco and selected locations.

(S) Rates between Spokane and selected locations.

These savings are quoted in cents per hundredweight. One hundred pounds of gasoline contain 15.15 gallons; this saving is approximately 1¢ per gallon at Lewiston. The other locations receive approximately ½¢ per gallon savings. This does not appear to be very much, but this savings will add up over a year's time for farmers because of the large quantity of petroleum products they utilize in the crop and livestock production processes.

TABLE 9

DIESEL: COST COMPARISON OF TRUCK-BARGE RATES TO TRUCKING RATES FROM PASCO AND SPOKANE, WASHINGTON, TO SELECTED POINTS IN CENTS PER HUNDREDWEIGHT

	Truck-Barge Rates	Trucking Rates	Estimated Savings
Lewiston	14.7	13.2 (P) 27.2 (S)	16.5 (P) 12.5 (S)
Craigmont	29.7	38.8 (P) 34.8 (S)	9.1 (P) 5.1 (S)
Nezperce	32.9	41.5 (P) 37.9 (S)	8.6 (P) 5.0 (S)
Cottonwood	32.9	41.5 (P) 37.9 (S)	8.6 (P) 5.0 (S)
Grangeville	34.9	44.6 (P) 40.6 (S)	9.7 (P) 5.7 (S)

(P) Rates between Pasco and selected locations.

(S) Rates between Spokane and selected locations.

EVALUATING FARM PRODUCED PRODUCTS FOR BARGE SHIPPING

The study area produces a wide range of commodities used for export, domestic consumption and animal feed. This section considers the shipping form and shipping destination of these commodities to determine which commodities are best suitable for barge transportation.

Present shipping rates and estimated truck-barge shipping rates are compared for commodities which can utilize barge transportation. The shipping rates are the total cost of transporting the commodities from selected warehouse locations to their shipping destinations.

Soft White Winter Wheat

Wheat is now shipped in bulk form by barges operating on the Columbia-Snake Rivers, and it is a commodity which benefits from barge shipping.

The major marketing centers for wheat grown in central Idaho are located at Portland and Seattle-Tacoma. The Portland market receives approximately 75 percent of the wheat traded for export in the Pacific market. With the coming of slack water to Lewiston this share of the wheat going to the Portland market will undoubtedly increase (7). Therefore, the Portland market will be used as the major marketing center for wheat.

Grain dealers in the study area report that more than 90 percent of their present wheat is shipped by rail to the Portland marketing center. At Portland the wheat is removed from the rail cars and loaded onto ocean-going ships for export.

The barge companies have made a firm offer to ship wheat from Lewiston to Portland at a cost of $2.16 per ton or 10.8¢ per hundredweight. This charge has been confirmed by the manager of the Lewiston Port District.

The cost for trucking wheat from selected locations to a Lewiston port was calculated at 0.105¢ per mile. This cost was derived from Interstate Commerce evidence (7).

Warehouses being served at present by barges on the Snake River are charging 2¢ per bushel or 3.33¢ per hundredweight to unload trucks and reload barges at port terminals. The same "put through" charge is assumed for a Lewiston terminal. This charge must be added to the truck-barge cost to obtain a total shipping cost.

TABLE 10

WHEAT AND BARLEY: ESTIMATED TRUCK-BARGE SHIPPING RATE BETWEEN PORTLAND, OREGON, AND SELECTED POINTS IN CENTS PER HUNDREDWEIGHT

	Trucking Rate	Terminal Cost	Barge Rate to Portland	Total Truck-Barge Rate
Lewiston	-0-	3.33	10.8	14.13
Culdesac	1.4	3.33	10.8	15.53
Craigmont	4.2	3.33	10.8	18.33
Reubens	4.6	3.33	10.8	18.73
Nezperce	5.9	3.33	10.8	20.03
Cottonwood	6.0	3.33	10.8	20.13
Grangeville	7.6	3.33	10.8	21.73

A schedule of the estimated costs for shipping wheat from warehouses to Portland by truck-barge combination is shown in Table 10.

The cost of shipping wheat by a truck-barge combination is a substantial decrease when compared to present rail rates (Table 11). The rail rates were obtained from published tariffs (8). There is an additional surcharge at present of 2½ percent added to the basic rail rate on shipments of grain. This surcharge adds approximately \$0.0065 to the basic rate at Lewiston and \$0.0074 on shipments from the Craigmont to Grangeville region.

The savings range from a maximum of 12.52¢ per hundredweight to 8.51¢ per hundredweight on the shipments of wheat by barge. This savings for the entire study area averages 10.81¢ per hundredweight or 6.49¢ per bushel.

Barley

In the study area both the winter and spring varieties of barley are raised. The two barley varieties are sold for export, domestic use and animal feed.

Barley is shipped in a loose form, making it well adapted to movement by barge shipping.

Barley has a very diverse geographic pattern of marketing centers. The barley is sold for brewing if it can pass the rigid standards of quality demanded by the brewers. These breweries are located throughout the United States. The primary use for barley is livestock feed. The study area itself uses 15-20 percent of the barley production as livestock feed. Some of the barley is sold to other regions of the United States for feed. The Pacific markets buy 40-60 percent of the barley production for export. The quantity of barley sold to these markets will vary among years depending on the different market demands.

The total cost to ship barley by truck-barge will be the same as for wheat. These estimated truck-barge rates are shown in Table 10.

The major shipper of barley to coastal ports is the railroad. The rail rate per hundredweight (cwt) is the same for wheat and barley and savings in transportation per cwt will be the same (Table 11). Because weight per bushel is less for barley than wheat, barley will receive a 5.41¢ savings per bushel.

TABLE 11

WHEAT AND BARLEY: COST COMPARISON OF TRUCK-BARGE AND RAIL SHIPPING BETWEEN PORTLAND, OREGON AND SELECTED LOCATIONS IN CENTS PER HUNDREDWEIGHT

	Truck-Barge Rate	Railroad Rate	Estimated Savings
Lewiston	14.13	26.65*	12.52
Culdesac	15.53	26.65	11.12
Craigmont	18.33	30.24**	11.91
Reubens	18.73	30.24	11.51
Nezperce	20.03	30.24	10.21
Cottonwood	20.13	30.24	10.11
Grangeville	21.73	30.24	8.51

*Rail rate at Lewiston: 26¢/cwt. + o.65¢ surcharge.
**Rail rate Craigmont to Grangeville: 29.5¢ + 0.74¢ surcharge.

Austrian Peas

Austrian peas, generally called "black peas" because of their darker color, are harvested dry. These peas are shipped in a bulk, loose form in Jumbo rail cars. The primary market is in the Asian countries with some of the production delivered to the southern United States. Shipments to the southern United States represent only a small percentage of the total crop and will not be discussed here.

Austrian peas require slower-moving unloading and loading equipment than that used for wheat and barley. If not handled properly, the peas will split, which reduces their desirability to the buyer. One company located in Tacoma now handles a major share of the Austrian peas in bulk form. The peas are shipped by rail to Tacoma, unloaded from rail cars, and reloaded onto ocean-going vessels for shipment overseas.

The introduction of ocean-going barges affords the possibility for shipment of Austrian peas. These large barges are capable of traveling across oceans for direct delivery. Trucks could ship peas in a loose bulk form from locations in the study area to a Lewiston terminal. From the terminal the peas could be loaded into the ocean-going barges. The barge would be shipped down the Snake-Columbia Rivers and directly across the ocean to the overseas markets. The use of ocean-going barges would eliminate unloading and loading at coastal ports.

It was impossible to obtain accurate information for estimating barge rates on shipping peas. This lack of information made further analysis impossible.

Dry Alaskan Peas

Alaskan peas are harvested both green and dry. This section will analyze the Alaskan peas harvested and marketed in the dry form.

Alaskan peas are cleaned and bagged at local warehouses, then loaded into containers for shipment to Portland. The peas are bagged and shipped in containers to avoid splitting. These peas have a major market in England and other European countries. The peas are reconstituted in Europe and sold as canned peas.

The containers of bagged peas are shipped primarily to Portland by railroad, at a cost of 52¢ per hundredweight (9). The most commonly used container is 8' x 8' x 20' and holds approximately 40,000 pounds of peas. This size is best fitted for shipments by rail. At Portland the containers are unloaded from the rail cars to ocean-going ships at a cost of 12.5¢ per hundredweight.

Barges can handle containers. The Alaskan peas could be shipped by truck to Lewiston and loaded onto barges by large cranes. The barges could ship the containers to Portland and the containers could then be loaded onto ocean-going ships. Truck-barge shipping will involve two unloading and loading charges for the containers. If the charge for unloading and loading containers at Lewiston is the same as the 12.5¢ per hundredweight charged at Portland, truck-barge combination will involve a total 25¢ per hundredweight unloading and loading charge.

The empty containers will have to be unloaded from the barges at Lewiston and loaded onto trucks for shipment to local warehouses where they will be loaded with peas. The study assumed that this charge will be covered in the 12.5¢ charge made for unloading and loading the filled out-going containers.

The present rail rate of 52¢ per hundredweight includes the cost of bringing the empty containers to the local warehouse and, from there, delivering the filled containers to Portland.

The barge tariff at present for containers 8' x 8' x 20', not mounted on wheeled chassis, is $38 per empty container one way and $70 per loaded container one way (10). This is $108 per container or a total charge of 27¢ per hundredweight of peas round trip from Portland to Lewiston and back to Portland. Add to this the 25¢ for unloading and loading the container and the total is 52¢ per hundredweight, the same as the rail rate.

The cost of shipping by barge and the cost of unloading and loading containers is equal to the present rail rate. The additional cost of trucking the containers between locations in the study area and Lewiston will make the truck-barge shipping rate less favorable than the present rail rate.

There is some speculation about transporting the Alaskan peas in bulk form. Bulk shipping will depend on the ability of the terminals to develop methods of handling the peas and on the desire of overseas ports to handle peas in the bulk form.

Canning Peas

Farmers in the Lewiston, Culdesac, and Reubens area produce Alaskan peas for canning and freezing. Processing centers for green Alaskan peas are located in the city of Lewiston. The harvested peas are shipped directly from the harvest fields to the processing plants by truck.

The production of canning peas has not reached farther from Lewiston because of the distance from the plant. The peas are harvested green and if the distance of hauling is too great, the quality of the peas is affected. Also, the cost of hauling determines the areas which can raise the Alaskan peas green for processing.

The green peas are processed and boxed for shipping. Small boxes are used to facilitate the marketing and handling of the peas at individual retail outlets. A commodity does not lend itself favorably to barge shipping when it is packaged in small boxes.

Other Crops

Wheat, barley and peas are the primary crops produced throughout the study area. Farmers also produce many other crops on a smaller scale and in more limited locations.

The region around the town of Nezperce has developed a substantial grass seed production. The area is well suited to production of several grass seed varieties and many of the farmers have discovered its production to be very beneficial in their rotations. Once the grass crop is established, it will produce year after year with no further tillage costs. The grass crop requires heavy yearly fertilizer applications and harvesting costs.

Grass seed is generally cleaned and bagged for shipment by the elevators. Large trucks are then used to ship the seed to many different regions of the United States. A pattern may develop for shipping grass seed by barge in the future. No attempt was made at further analysis of this future shipment of grass seed.

Rape, oats and clover are also produced in the area. All of these commodities are suitable to be shipped by barge, but insufficient data from farm interviews prevented development of a meaningful analysis.

In all probability barge movement of the minor crops will develop once slack-water reaches Lewiston. New markets may also open for these minor crops. Barge transportation may even make it possible for some of these minor crops to develop a competitive advantage over the present major crops.

THE EFFECT OF TRANSPORTATION RATE CHANGES ON AN AVERAGE FARMER

The estimated decreases in shipping costs will result in increases in the returns to production. Direct accounting will determine the total change in income. Marginal analysis has been used to determine the respective shares each input resource contributes to the increase in income.

Preparation of Operating Budgets

Production practices and cost data used in compiling the crop budgets were collected from interviews with individual farmers in the study area. Computation of production costs included seed, fertilizer, spray, labor, machinery, and interest on operating capital. To these production costs were added hauling, handling, farm supplies, and land tax.

Total cost in this study is the sum of these individual production costs. The cost of management and return on investment in land were assumed to be paid from the net income remaining after total cost was subtracted from total income. Storage and crop insurance costs were assumed to be a cost to management. Total income was computed by multiplying production by a 6 year average price per bushel obtained by adding weekly prices found in the Portland Grain and Marketing News for the years 1966-1971 (11).

Increase in Income Determined by Accounting Method

The data for computing the savings of barge transport are based on the cost and returns for an average farm of 915 acres growing 314 acres of wheat. Only the 314 acres of wheat and charges in fertilizer price are included in the analysis. (See Appendix 2, Table 12)

The equation for determining a change in income is as follows:

$$\Delta\P = (\bar{Y}' - \bar{Y}) - (\bar{X}_1' - \bar{X}_1)$$

where:

$\Delta\P$ = benefit

$\bar{Y}'$ = adjusted income after a rate change

$\bar{Y}$ = adjusted income before a rate change

$\bar{X}_1'$ = cost of (15.7 tons) fertilizer after a rate change

$\bar{X}_1$ = cost of (15.7 tons) fertilizer before a rate change

In this equation it is assumed that the total physical inputs and output will remain constant; only prices per unit will vary.

The adjusted income is the result of subtracting the total fixed costs, interest on operating capital, and seed costs from total income. Total income was estimated by regression analysis from the data collected from the farmers. This adjusted income is the income remaining to pay for the variable inputs, fertilizer, spray, labor, machinery variable costs, and returns to management and investment in land.

The adjusted income for the average farm (Appendix 2) was estimated to be $24,090 which is equal to 16,729 bushels of wheat at a price of $1.44 per bushel. The savings from barge transportation was 6.5 cents per bushel (see page 27) increasing the price to farmer to $1.505 per bushel. Multiplying 16,729 bushels by $1.44 per bushel, the price before a rate change, yields the value of $\bar{Y}$, and 16,729 times $1.505 yields the value of $\bar{Y}'$.

The savings on transportation costs of some fertilizers, as determined on pages 15, 16, and 17, will represent lower fertilizer costs. The lower costs for fertilizer were applied to each budget for wheat.

The new individual totals for fertilizer on each budget were then summed and a new average of \$1,787 ($\bar{X}'$) was obtained. The mean cost for fertilizer before a rate change was \$1,953 ($\bar{X}$).

Substituting these values into the direct accounting equation resulted in an increase in income of \$1,253.40 for an average farmer operating 314 acres of wheat or approximately \$4.00 per acre.

Marginal Value Products Analysis

A farmer invests in seed, fertilizer, spray, machinery and other inputs in the hopes of realizing production which will generate returns above his actual investment. Thus, a farmer's income is his return on investment in the factors of production. If the price of the commodity increases or the price of the inputs decreases, this is reflected as an increase in returns on investment.

The study has shown that the increased competition exerted by a truck-barge combination of transportation will indirectly increase the price of wheat and barley. Savings were also indicated for the shipments of some fertilizers and petroleum products.

Estimating interfarm value production functions for wheat and barley provided regression equations that yielded coefficients used to estimate marginal value products. The marginal value products provided a measure of the return on investment for various inputs at various price levels. If the commodity price increases or the input price decreases due to savings in transportation costs, then the marginal value products of the inputs should increase.

Regression Analysis for Wheat

A Cobb-Douglas Production Function was used as an estimating equation. This equation incorporated fertilizer cost, spray cost, and the combination of labor and machinery variable costs as the three independent variables. Adjusted income was the dependent variable.

The three independent variables were found to explain about 79 percent of the variation in total income.

Estimated Cobb-Douglas function is as follows:

$$Y = 33.68\ X_1^{0.19672}\ X_2^{0.14895}\ X_3^{0.52576}$$

t -ratio	2.3635	1.7865	3.8599
Level of significance	(0.05)	(0.1)	(0.001)

$R = 0.89$

where: Y is adjusted total income

X_1 is total fertilizer cost

X_2 is total spray cost

X_3 is total labor and machinery variable costs.

Comparing the marginal value products before a price change with the marginal value products after a price change will provide a procedure to estimate the effect these price changes will have on the returns to production inputs. (See Appendix 3 for the procedure used in computing the price indexes.)

Calculating Marginal Value Products for Wheat

Using the regression coefficients from the estimating equation, the marginal value products were calculated from the formula:

$$MVP_{x_i} = b_i \frac{\overline{Y}}{\overline{X}_i} .$$

The mean levels for the variables were: ($\overline{Y}$) adjusted income, \$24,090; ($\overline{X}_1$) fertilizer, \$1,953; ($\overline{X}_2$) spray, \$765; ($\overline{X}_3$) labor and machinery, \$2,403. The marginal value products represent what an average farmer is receiving at present on the last dollar invested in various resource inputs. The marginal value products before rate changes can be seen in Table 13.

TABLE 13

MARGINAL VALUE PRODUCTS: BEFORE AND AFTER A CHANGE IN THE PRICE OF WHEAT AND FERTILIZER IN DOLLARS

	MVP before a price change	Price Index relationships	MVP after a change in prices	Increases in MVP
Fertilizer	$2.43	$1.14	$2.77	$0.35
Spray	$4.69	$1.05	$4.90	$0.21
Labor and Machinery	$5.27	$1.05	$5.51	$0.24

In order to calculate the marginal value products for each of the inputs after a price change, price indexes were used to compare commodity group prices from one time period to another. The first section of this chapter established that as a result of truck-barge shipping the price of fertilizer should decrease and the price of wheat should increase. (See Appendix 3)

Comparing Marginal Value Products

The benefits received by the individual input were analyzed by comparing the marginal value products before and after a change in prices. The values in Table 13 were used for these comparisons.

The marginal value product of fertilizer increased 34.5¢. This 34.5¢ increase on fertilizer input represents a 14.2 percent additional income over returns before a rate change. Income will increase $345 on every $1,000 invested in fertilizer after shipping rates change.

The marginal value product for spray increased 21.2¢. The rate change increased the marginal value product of spray 4.5 percent. Every $1,000 invested in spray will realize an additional increase in income of $212 after a rate change.

The marginal value product for labor and machinery increased 23.8¢. The result of a rate change increased the marginal value product of labor and machinery 4.5 percent. The income for labor and machinery will increase $238 for every $1,000 invested in the input.

Shares of Total Income Contributed by Various Imports

The Euler Theorem makes it possible to analyze the effect changes in prices of the commodity and inputs would have on the returns to production of the inputs. This divides the total adjusted income into shares represented by each input. (Appendix 4 presents the procedure using the Euler Theorem.)

The marginal value products, adjusted marginal value products, mean level of inputs, and shares attributed to each input derived from the Cobb-Douglas production function can be seen in Table 14.

Total adjusted income before a change in the prices is $24,087 and total adjusted income after a change in prices of wheat and fertilizer

TABLE 14

INPUTS SHARES OF TOTAL ADJUSTED INCOME: BEFORE AND AFTER CHANGES IN PRICES

Resource Input	MVP's (1)	Adjusted MVP's (2)	Mean Level of Input (3)	Share Attributed to Input (2x3)
Fertilizer				
Before	$2.43	$2.78	$1,953	$ 5,437
After	$2.77	$3.18	$1,787	$ 5,683
Direct Savings				$ 166
Spray				
Before	$4.69	$5.38	$ 765	$ 4,116
After	$4.90	$5.62	$ 765	$ 4,302
Labor and Machinery				
Before	$5.27	$6.05	$2,403	$14,533
After	$5.51	$6.32	$2,403	$15,189

is $25,340.38. This is an increase in adjusted income of $1,253.42 at mean levels of inputs for an average size farm of 915 acres. The share attributed to fertilizer increased $411.51, spray increased $185.89 and labor and machinery increased $656.02. These increases in inputs are a result of a change in prices and does not require any change in the mix of the quantity of physical inputs.

The difference between the respective shares before and after changes in the price can be seen in Table 15.

A producer may change his resource and commodity mix to obtain further benefits. The benefits found in this study are minimum benefits and under the assumptions of this study will accrue to the farmer with no action required on his part.

TABLE 15

INCREASE IN SHARE OF INPUTS: DETERMINE FROM TOTAL SHARES OF INPUTS BEFORE AND AFTER A PRICE CHANGE

Resource Input	Total Share before a Price Change	Total Share after a Price Change	Increase in Share Attributed to Input
Fertilizer	$ 5,437 (Direct savings)	$ 5,683 166 $ 5,849	$ 412
Spray	$ 4,116	$ 4,302	$ 186
Labor and Machinery	$14,533	$15,189	$ 656
Total Income	$24,087	$25,340	
		Total Increase in Adjusted Income	$1,253

SUMMARY AND CONCLUSIONS

The study estimated the truck-barge shipping cost for the inputs used in the production of major crops in the study area. Comparing the present shipping costs to the estimated truck-barge rates reflected savings on ammonium phosphate, Urea, and Nitro Sul fertilizers. A truck-barge shipping rate was not determined for anhydrous ammonia because of a lack of information. The data collected on anhydrous ammonia gave every indication that a savings will be realized in the use of truck-barge shipping. The estimated truck-barge shipping rates reflect savings on shipments of gasoline and diesel fuel when compared with present rates.

Several commodities possess the necessary qualitities to be shipped by barge. Estimated savings of 6.5¢ per bushel on wheat and 5.4¢ per bushel on barley were obtained when truck-barge estimates of rates were compared to present rail rates. The shipping requirements for Austrian and Alaskan peas would prevent them from being shipped by barge at present. Savings in shipping rates will become evident once technology advances so both pea crops can be handled by barges. Lack of sufficient data prevented rate analysis on many other minor crops.

Using a Cobb-Douglas function, an inter-farm area value production function was computed for wheat. The calculated marginal value products before and after rate changes showed that yearly income for wheat on the average farm size of 915 acres, using mean values of inputs, would increase income from $24,087 to $25,340 a total of $1,253.

The increase in income is an average of all farm sizes included in the sample taken from the study area. Producers closer to the Lewiston port can expect to realize a greater income increase than producers located farther from Lewiston. The income increases will vary with the size of the farm. The extent of the increase in income does not include the effect of management.

The estimated reductions in shipping costs will occur only if all modes of transportation can compete effectively. The railroad rates are restricted by the Interstate Commerce Commission on shipments of all products. This restriction on rail rates indirectly establishes the rates offered by the less restricted trucks and barges. When barge shipping is introduced to Lewiston, the rail will reduce its rates to remain competitive. The ICC will not allow the railroad rates to drop so low that competition would be destroyed. The truck-barge will then adjust their rates low enough, below the rail rates, to maintain a share of the shipping market.

The truck-barge rate data used in this study were obtained from other areas where rail is competing with barges. The rates estimated in this study will, therefore, by very close to what should occur once barge shipping reaches Lewiston. Still it is important to remember that the actual reductions in rail rates will determine the savings that will occur in shipping at Lewiston.

Transportation costs have been reduced in agricultural areas along the Columbia-Snake Rivers where barge shipping has been introduced. The same is expected to happen in the Lewiston area.

APPENDIX 1

A. Calculations of barge shipping costs for fertilizer

1. Barge shipping costs Linnton, Oregon to East Pasco - \$2.48 per ton. River mileage between Linnton and East Pasco - 240 miles

   \$2.48/ton ÷ 210 miles = 1.18¢ per ton per mile

2. River mileage between Pasco and Lewiston - 140 miles

   140 miles x 1.18¢ per ton per mile = \$1.65 per ton

   \$1.65 per ton ÷ 20 hundredweight/ton = 8.3¢ per hundredweight from Pasco to Lewiston.

B. Calculations of barge shipping cost for petroleum

1. Barge shipping cost:

   Portland, Oregon to Umatilla, Oregon - 0.70¢ per gallon

   Vancouver, Washington to Pasco, Wash.- 0.80¢ per gallon

   Average shipping cost:

   0.70¢/gallon + 0.80¢/gal. = 1.50¢/gal. ÷ 2 = 0.75¢ per gallon

2. River mileage:

   Portland, Oregon to Umatilla, Oregon - 180 miles

   Vancouver, Washington to Pasco, Wash. - 214 miles

   Average mileage:

   180 miles + 214 miles = 394 miles ÷ 2 = 197 miles

3. Shipping cost per gallon per mile:

   0.75¢/gallon ÷ 197 miles = 0.0038¢ per gallon per mile

4. River mileage between Pasco and Lewiston - 140 miles

   0.0038¢/gallon/mile x 140 miles = 0.53¢ per gallon Pasco to Lewiston

C. Barge shipping cost for gasoline and diesel

1. Gasoline weighs 6.6 pounds per gallon or 15.15 gallons per hundredweight.

   15.15 gal./100# x 0.53¢/gal. = 8.03¢/hundredweight

2. Diesel weighs 7.4 pounds per gallon or 13.51 gallons per hundredweight.

   13.51 gal./100# x 0.53¢/gal. = 7.2¢ per hundredweight

APPENDIX 2

TABLE 12

CROP BUDGET FOR WHEAT: AVERAGE PRODUCTION COSTS AND RETURNS PER ACRE* FOR A 915 ACRE FARM RAISING 314 ACRES OF WHEAT

	Unit (1)	Quantity Per Acre (2)	Price Per Unit (3)	Price Per Acre (2x3)
Production:				
Wheat	bu.	67	$1.44	$96.48
Inputs:				
Variable Costs				
Seed	lbs.	71	$0.025	1.78
Fertilizer	lbs.	100	variable	6.22
Spray	acre	1	variable	2.44
Labor	hrs.	1.07	$1.88	2.02
Machinery		variable	variable	7.66
Interest on operating capital	acre	1	8% of variable costs	1.61
Fixed Costs				
Machinery	acre	1	variable	12.64
Hauling	bu.	67	$0.02	1.34
Handling	bu.	67	$0.0725	4.86
Farm Supplies	acre	1	$2.13**	2.13
Land Tax	acre	1	$4.28**	4.28
Total Cost				$46.98
Net Return to Management and Investment in Land				$49.50

*These prices per acre are only averages taken from the farm interviews and do not reflect any particular farmer.

**These values are average costs for wheat following both summer-fallow and recrop.

APPENDIX 3

The price index used was the Laspeyre's formula:

$$I = \frac{P_{(n)}\ Q_{(o)}}{P_{(o)}\ Q_{(o)}}$$

where I is a price index, P is price and Q is quantity and (o) is the time period before a rate change and (n) is the time period after a rate change. Since the quantity (Q) in both time periods remains a constant, the price index becomes a simple price ratio

$$I = \frac{P_{(n)}}{P_{(o)}}.$$

The price index for income after a rate change is expressed as $I_{Y_{(n)}}$ and the index for a resource input is $I_{X_{i_{(n)}}}$, such that $I = \frac{P_{(n)}}{P_{(o)}}$. The equation for calculating the marginal value products for input X_i after a rate change then becomes

$$MVP\ \overline{X}_{i_{(n)}}{}' = I_{Y_{(n)}} \cdot b_i \frac{E\ (Y)_{(o)}}{\overline{X}_{i_{(o)}} \cdot I_{X_{i_{(n)}}}}$$

where $E\ (Y)_{(o)} = a\ \overline{X}_{1_{(o)}}^{b_1} \overline{X}_{2_{(o)}}^{b_2} \ldots \overline{X}n_{(o)}^{b_n}$, or $E(Y)_{(o)}$ is the mean level of observed incomes and $\overline{X}_{i_{(o)}}$ is the mean level of observed input usage before a rate change. (15)

As the price of commodity increases, because of a decrease in shipping costs, the index $I_{Y_{(n)}}$ will have a value greater than one. Multiplying the marginal value products by a price index greater than one results in the new marginal value products becoming larger. These increased marginal value products represent the returns to the respective resource inputs after an increase in the price of the commodity.

When a price of a resource input decreases, the index price will have a value less than one. Multiplying the price index of the resource input ($I_{X_{i(n)}}$) by the mean value $\overline{X}_i$ forces the denominator in the marginal value product equation to become smaller (see above equation). The quotient of the mean of $\overline{Y}$ divided by a smaller denominator will increase the value of the marginal value product. The additional return to the resource input is reflected in the larger marginal value product because of lower resource input prices.

This equation allows for changes in both the prices of the commodity and the resource inputs. If only the price of the commodity varies, then the price index ($I_{X_{i(n)}}$) multiplied by the mean value of $\overline{X}_i$ can be omitted from the equation.

The price index for wheat was calculated by dividing \$1.505 by \$1.44. The prices were established in section 4.1 on direct accounting. This division yielded a price index or price ratio for wheat of 1.04514. Dividing the new mean for fertilizer of \$1,787 by the means of \$1,953, established a price index of 0.91500 for fertilizer. The means for fertilizer were also established in the section on direct accounting.

The marginal value products after a rate change were computed by multiplying the marginal value products before a rate change by the appropriate price indexes. Since the price of wheat and fertilizer changed, the price index relationship ($I_{Y_{(n)}} \div I_{X1_{(n)}}$) was multiplied by the marginal value product for fertilizer. The price index ($I_{Y_{(n)}}$)

was multiplied by the marginal value products of spray and labor and machinery. The price of spray and labor and machinery did not change, so the index ($I_{X_{i(n)}}$) was omitted in computing the new marginal value products for these two variables. The new marginal value products, price indexes, and increase in the marginal value products are in Table 13.

APPENDIX 4

Shares of the Total Product Contributed by Various Inputs

A part of the second objective of the study was to analyze the effect changes in prices of the commodity and resource inputs would have on the returns to production of the resource inputs. The Euler theorem, sometimes called the adding-up theorem, establishes a special relationship for homogeneous functions. The theorem states that the total product will be exhausted if the inputs are multiplied by their marginal value products and summed. The Euler theorem can be seen in equation form as follows:

$$\overline{Y} = \overline{X}_1\ MVP_{x_1} + \overline{X}_2\ MVP_{x_2} + \overline{X}_3\ MVP_{x_3} \quad .$$

This relationship holds if the elasticity of production is equal to one (1). With an elasticity of production equal to one the marginal value products are equal to the average value products. The quantity of input $\overline{X}_1$ multiplied by its marginal value product (MVP_{x_1}) represents the share of the total product contributed by input $\overline{X}_1$. The same holds for the inputs X_2 and X_3.

The elasticity of production is the sum of the regression coefficients in the regression equation. For wheat this value is 0.87143. When the elasticity of production deviates from one, the marginal value products are no longer equal to the average value products. If the marginal value products of a function having elasticity differing from one are applied to the Euler theorem, the computer total product will be either overestimated or underestimated. The total product will not be exhausted if the elasticity is less than one. The total product will be overestimated if the elasticity is greater than one. (16) This relationship of under-estimating or overestimating the total product can be seen by the equation:

$$\bar{Y} E_p = \left(\bar{X}_1 \, MVP_{x_1}\right) + \left(\bar{X}_2 \, MVP_{x_2}\right) + \left(\bar{X}_3 \, MVP_{x_3}\right)$$

where elasticity of production is expressed as (E_p).

Since the wheat regression equation had an elasticity less than one the total product was not exhausted when the marginal value products found in Table 13 were applied to the Euler theorem. The residual total product not exhausted by the shares of the inputs cannot be allocated to any respective input defined or not defined in the regression equation. It was necessary to adjust the Euler equation so that the inputs defined in the equation would exhaust the total product.

Dividing the marginal value products by the elasticity of production for wheat:

$$\bar{Y} = \left[\bar{X}_1 \frac{MVP_{x_1}}{E_p}\right] + \left[\bar{X}_2 \frac{MVP_{x_2}}{E_p}\right] + \left[\bar{X}_3 \frac{MVP_{x_3}}{E_p}\right]$$

adjusted the Euler theorem so that the total product was exhausted by the three inputs defined in the regression equation.

This relationship was illustrated by computing the total product before a rate change. The marginal value products were computed using the mean values for the inputs and output. The marginal value products were then adjusted. Since the means were used in computing the marginal value products the computed adjusted income and the mean adjusted income should be equal if the total product is exhausted. The sum of the adjusted marginal value products multiplied by their respective input means is \$24,089.64, which is approximately equal to the mean adjusted income of \$24,090.

Allocating the change in adjusted income resulting from the rate change, to the shares of the inputs responsible for that change, required that the basic form of the accounting equation

$$\Delta\pi = (\bar{Y}' - \bar{Y}) - (\bar{X}_{1'} - \bar{X}_1)$$

be used. The previous Euler equation defined $\bar{Y}$. Therefore a similar Euler equation will define $\bar{Y}'$ after a rate change:

$$\bar{Y}' = \left[\bar{X}_{1'} \quad \frac{MVP_{x_{1'}}}{E_p}\right] + \left[\bar{X}_2 \quad \frac{MVP_{x_{2'}}}{E_p}\right] + \left[\bar{X}_{3'} \quad \frac{MVP_{x_{3'}}}{E_p}\right].$$

This equation computes the shares each input contributed to the total adjusted income after a change in the prices of fertilizer and wheat.

Substituting the two Euler equations which yield $(\bar{Y}')$ and $(\bar{Y})$ into the accounting equation gives:

$$\Delta\pi = \left[\left(\bar{X}_{1'} \quad \frac{MVP_{x_{1'}}}{E_p}\right) - \left(\bar{X}_1 \quad \frac{MVP_{x_1}}{E_p}\right) - \left((\bar{X}_{1'} - \bar{X}_1)\right)\right]$$

$$+ \left[\left(\bar{X}_2 \quad \frac{MVP_{x_{2'}}}{E_p}\right) - \left(\bar{X}_2 \quad \frac{MVP_{x_2}}{E_p}\right)\right]$$

$$+ \left[\left(\bar{X}_3 \quad \frac{MVP_{x_{3'}}}{E_p}\right) - \left(\bar{X}_3 \quad \frac{MVP_{x_3}}{E_p}\right)\right]$$

This equation shows how the benefit $(\Delta\pi)$ can be divided into three components, one attributed to each input. Since the mean cost of fertilizer decreased from \$1,953 $(\bar{X}_1)$ to \$1,787 $(\bar{X}_{1'})$, this direct savings on fertilizer purchase $(\bar{X}_{1'} - \bar{X}_1)$ can be included with the share of adjusted total income contributed by fertilizer.

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