TRANSSHIPMENT OF CONTAINERIZED AGRICULTURAL EXPORTS VIA THE COLUMBIA SNAKE RIVER SYSTEM

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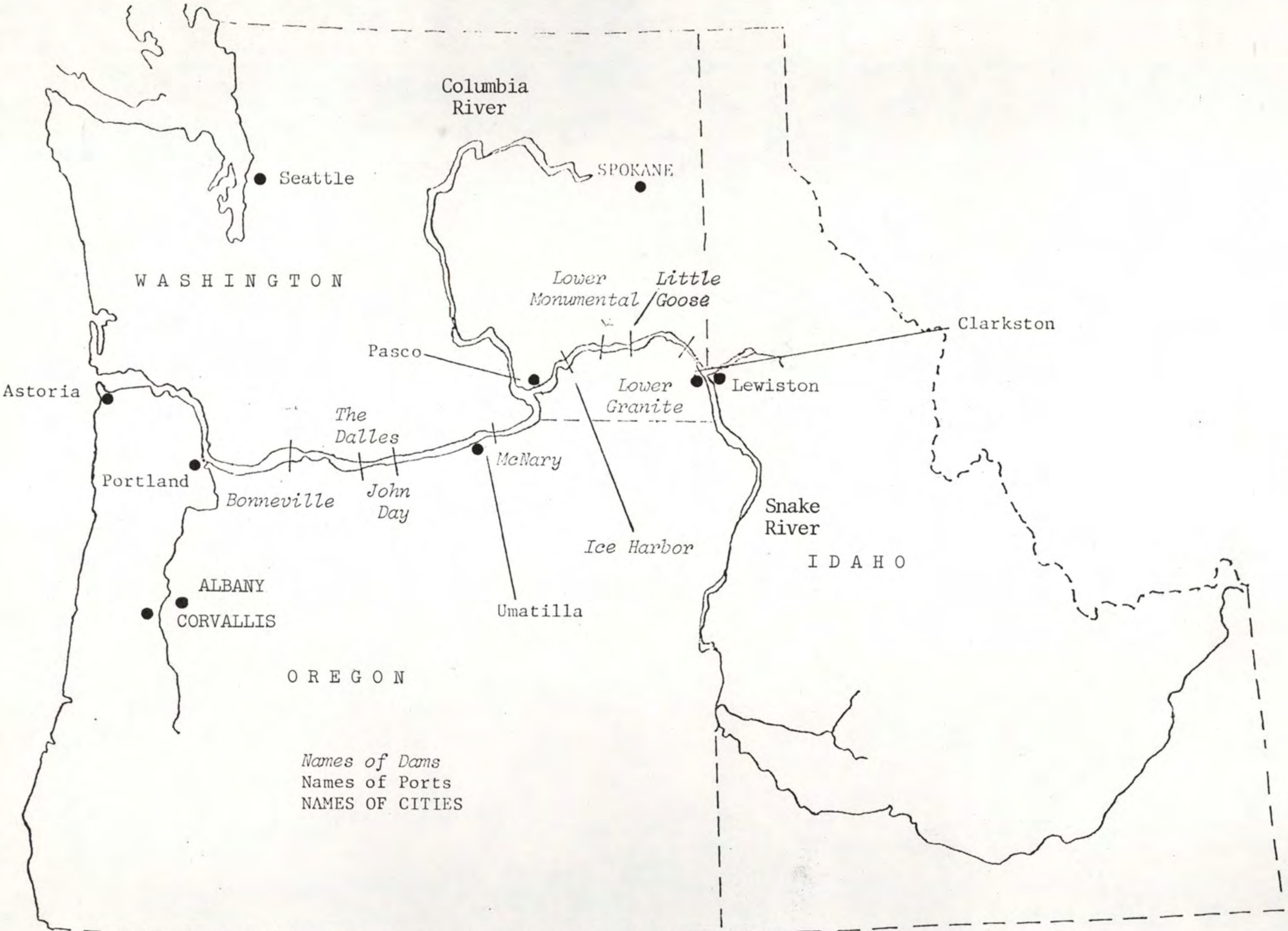

COLUMBIA SNAKE RIVER SYSTEM

INTRODUCTION

The completion of Lower Granite Dam on the Snake River in Washington in 1975 made barge access possible between Portland, Oregon and Lewiston, Idaho via the Columbia Snake river system. Low cost barge transportation provides an opportunity to open new export markets for agricultural commodities produced in interior Idaho, Washington and Oregon. Products which might benefit from container on barge movement to ocean ports include processed potatoes, hides and skins, dry peas and lentils, hay cubes, grass and forage seeds and some forest products.

This study represents a portion of a project investigating the role of the Columbia and Snake Rivers in the export distribution system for Pacific Northwest agricultural products. The specific objective is to estimate the portion of PNW Kentucky bluegrass seed exports which could take advantage of container on barge shipment via the river system,using linear programming techniques. This limited application provides the foundation for using more sophisticated transshipment models to delineate the hinterland of the river system for major agricultural commodities.

The objective was accomplished using linear programming transshipment models developed to estimate total transportation costs for Kentucky bluegrass seed export shipments from PNW ports. The models were formulated for two purposes. Model I provided a baseline estimate of the transportation cost of the historical movement of bluegrass seed exports through PNW ports in 1976. This cost estimate corresponds to the shipment patterns which existed in 1976. Model II estimated the portion of the same years exports which could take advantage of the Columbia Snake river system by seeking a least cost solution, i.e., determining the most cost efficient modes of transportation.

Origins and Destinations of PNW Kentucky Bluegrass Seed Shipments

Four production regions for Kentucky bluegrass seed were identified for the PNW states. Each is composed of a number of counties and is delineated by proximity to a commercial center which can be considered a consolidation or transportation point (Table 1).

Seed production data were available for Idaho, Oregon, and Washington from federal or state sources for 1976. In addition, Oregon production data were listed by county. County production figures for Idaho and Washington were assumed to be the same proportion of state totals as indicated in the 1974 Census of Agriculture (U.S. Dept. of Commerce, 1977).

Export shares for each production region were assumed to be the same as each region's proportion of total production, as presented in Table 1. Since the data in Table 1 are based on this assumption, they probably do not give a true indication of export movements. Those regions which enjoy a geographical advantage to PNW ocean ports may move a larger proportion of Kentucky bluegrass seed exports than is indicated in Table 1. The problem is compounded by the fact that seed grown in the interior production regions is sometimes shipped through some of the larger processors or exporters located nearer the ocean ports. The processors may consolidate or mix seed from other regions in response to supply availability and specific export demand. Because of this situation, it is difficult to obtain a reliable estimate of exports originating in each production region.

Table 1. Kentucky Bluegrass Seed Exports as a Share of 1976 Production--PNW.

Region	Production (lbs)	% of PNW Total	Estimated Exports Through PNW Ports (lbs)
Spokane	15,119,630	49.2	2,172,240
Lewiston/Clarkston	5,505,640	17.9	794,722
Umatilla	2,901,000	9.5	419,437
Albany/Corvallis	7,179,000	23.4	1,028,723
Total PNW	30,705,270	100	4,415,122[1]

Source: USDA, 1976, 1977, U.S. Dept. of Commerce, 1977.

1. Excludes 545,600 lbs. shipped to Canada from the Idaho/Montana Customs District.

About 4.4 million pounds of Kentucky bluegrass seed (57 percent of U.S. exports) passed through the Portland or Seattle Customs Districts in 1976 (U.S. Dept. of Commerce, 1976). Quantities and value to Kentucky bluegrass seed shipped through the two PNW Customs Districts are presented in Table 2. All movements were by ocean vessel with the exception of movements from the Seattle Customs District to Canada. The larger proportion of seed exports moving through Portland is the result of the geographical advantage Portland enjoys over Seattle.

Data Sources

Ocean tariff rates were secured from the Pacific Westbound Conference in San Francisco. These rates apply to all regularly scheduled ocean carriers serving west coast ports. Barge and feeder (between port)

Table 2: Destinations of Kentucky Bluegrass Seed Exports Shipped Through PNW Ports - 1976

Port (Customs District)	Destination	Pounds	Value[1]
Seattle	Canada	223,693	$115,893
	Brazil	44,000	12,276
	Sweden	39,645	44,000
	Great Britain	40,000	16,160
	Netherlands	20,000	15,000
	France	32,000	10,777
	West Germany	53,596	59,732
	Japan	127,340	52,266
	Canary Islands	2,465	4,560
Seattle Customs District Total:		582,739	$330,664
Portland	Chile	7,050	$ 2,605
	Sweden	243,815	193,360
	Norway	5,424	2,200
	Denmark	152,447	91,877
	Great Britain	261,833	160,614
	Netherlands	494,898	287,411
	France	437,184	269,612
	West Germany	450,239	470,900
	Austria	103,575	49,602
	Switzerland	108,100	71,337
	Spain	6,800	9,384
	Italy	78,538	28,001
	Japan	638,997	304,261
	Australia	732,183	338,739
Portland Customs District Total:		3,831,113	$2,279,903
PNW Ports Total		4,413,852	$2,610,567

Source: U.S. Department of Commerce, EA644 Foreign Trade Exports, 1976.

1. The variation between value and weight is the result of differing varieties, types and certifications of specific seed shipments. Importing countries have varying needs and requirements for the Kentucky bluegrass seed orders they place.

rates were requested from tug and barge operators in Portland and San Francisco.

Since grass seed is an ICC exempt commodity, (U.S. Interstate Commerce Comm., 1974), truck rates are somewhat negotiable. Rates may vary considerably between carriers depending upon scheduling, backhaul capabilities, or volume of freight moved by the carrier. Nevertheless, rates for hauling containers by truck can be quoted from either general freight tariffs or specific exempt commodity tariffs. Rates were obtained from firms in Spokane and Seattle, Washington, Portland, Oregon and Lewiston, Idaho.

Specific commodity container rates were not available from rail carriers. Rail carriers serving the PNW quoted general freight rates which were considerably higher than those of truck or barge carriers. Discussion with railroad representatives confirmed that specific commodity rates can be applied for if sufficient quantities of the commodity are shipped. Although it is generally agreed by the rail carriers that the specific rates would be competitive with truck rates, it is doubtful that sufficiently large Kentucky bluegrass seed shipments could be assembled to petition rail carriers for specific rates. The high general cargo rates, coupled with the high cost of supplying empty containers by rail, may make the rail mode appear less competitive than it actually is.

Assumptions

In order to generalize rates from competing modes for the models, several assumptions were made. All Kentucky bluegrass seed export shipments were assumed to be made in standard intermodal containers, 8 x 8 x 20 feet, loaded to 22,000 pounds. Rates for each mode were developed on a per container basis. When rates from carriers of the same mode varied, the lowest applicable rate was selected.

Rate estimates are based on 1977 data. It was assumed that the rate structure remained essentially unchanged from 1976.

The per container rates do not reflect the cost of supplying empty containers to processors or shippers. The most competitive truck carriers are able to schedule deliveries and routing in such a manner as to allow empty containers to be delivered to shippers without charge. Because of this precedent, it is felt that competing modes or carriers will have to absorb at least part of the costs of providing empty containers or otherwise facilitate their delivery if they are to compete with trucks. Since the delivery cost for empty containers varies greatly between modes and even between individual carriers, that portion of the transportation bill was disregarded in favor of providing a consistent comparison of outboard transportation costs.

The rate structure also assumed containers are stuffed or loaded by the shipper or processor. This is common practice and the rates therefore do not reflect these costs. Barge rates include wharfage, throughput and handling charges and other terminal tariffs changed by the river ports.

The barge rate does not include the cost of moving containers to the river port facilities. Transloading to the vessel and other costs related to wharfage, throughput and loading are included in ocean tariffs. Unusual charges such as storage at river or ocean ports, rehandling and the like were not included.

An additional assumption concerning tariff rates deals with the number of containers handled. Some carriers offer a lower rate for moving a quantity of containers. When a minimum number of containers is required for a movement, it was assumed that container shipments are pooled by a number of unrelated shippers to meet the minimum requirement. The rates reflect the cost of single movements and do not take advantage of economies presented by volume shipments.[1]

Destinations were regionalized to simplify the models. Rather than list each terminus identified in Table 2, destinations were aggregated in Table 3.

Table 3. Destinations of PNW Kentucky Bluegrass Seed Export Shipments

Destination	Port
Asia	Kobe, Japan
Oceania	Sydney, Australia
Europe	Rotterdam, Netherlands
Great Britain	Liverpool, England
Scandinavia	Gothenburg, Sweden

This aggregation decreased the size of the model without detracting from its usefulness since ocean conference rates are port equalized.

1. Movements by truck present an exception. Trucks usually handle two 20 foot or one 40 foot container(s). Therefore, virtually all truck movements of 20 foot containers take advantage of the lower cost of the dual movement. The assumption of pooling containers between unrelated shippers holds, but the per container transportation rate does reflect the savings resulting from the more realistic dual movement.

In the analysis, export shipments to Canada and South America were not considered. Canadian shipments, although large, did not necessarily move physically through the ports of Seattle or Portland; in addition, Canadian shipments have no waterborne leg. South American movements represented only about one percent of Kentucky bluegrass seed shipments through PNW ports and were therefore disregarded. Finally, it was assumed that all production regions, transshipment and/or consolidation points and river and ocean ports possess the necessary facilities to handle the physical movement of the intermodal containers.

Methodology

The transshipment models route shipments through an intermodal network. Identifying origins, intermediate transfer points and destinations allows the models to seek cost minimizing solutions which not only route shipments but also choose the most cost efficient modes of transportation.

The transshipment models may be expressed generally as:

$$\text{Minimize } C = \sum_i \sum_j C_{ij} X_{ij} \quad (1)$$

$$\text{Subject to: } \sum_j X_{ij} = S_i \quad (2)$$

$$\sum_i X_{ij} = D_j \quad (3)$$

$$X_{ij} \geq 0 \quad (4)$$

$$\sum S_i = \sum D_j \quad (5)$$

Where:

C_{ij} is cost of transporting a container of seed from origin i to destination j.

X_{ij} is containers of seed shipped from origin i to destination j.

S_i is supply of export seed at origin i.

D_j is demand of import seed at destination j.

Model I was constrained as to the quantity of seed demanded and supplied and moving through each port. Constraining the model in such a manner preserved the origins and ports of departure of seed export shipments. Since supply and demand were equated there was no residual (slack activities) and the model approximated 1976 export shipments providing a minimum cost estimate of the total transportation bill.

For Model I, twenty-nine transshipment activities were identified. These included truck, rail and ocean vessel combinations but no barge service since the river system was not utilized in 1976 historical shipments.

Adding the barge option in Model II increased the activities to forty-seven. These included barge transportation and also feeder service between the ports of Seattle, Portland and Oakland, California, providing a water link for interior seed produced in Spokane, Lewiston/ Clarkston and Umatilla.

A feeder service would involve barging loaded containers to the port of Astoria, Oregon, where they would be transloaded to a coastal vessel and carried to another West Coast port for transloading to an ocean vessel.

Feeder service to Oakland or Seattle may take on increased importance in the future as ocean carriers turn to the load center concept.

In order to cut the turnaround time and in-port expenses of high cost containerships, steamship lines are stressing calling on only two or three West Coast ports (load centers). This poses a threat to lower Columbia ocean ports which may lose service to Puget Sound or California ports. Feeder rates might be absorbed by the ocean carriers or they could be passed on to seed shippers as surcharges, depending upon the relative supply and demand elasticities of the service and of the commodities utilizing it.

Model II was also constrained as to the quantity of seed demanded and supplied. There were no constraints on ports of export, thereby allowing the model to identify the combination of origins, modes and ocean ports which would minimize total transportation costs. Given the rate structures for competing modes, Model II thus provides an estimate of the portion of PNW Kentucky bluegrass seed exports which could take advantage of container on barge transportation.

Comparing the transportation costs of Model I and Model II gives an indication of any savings realized by utilizing the most cost efficient modes. Since the transshipment model operates by seeking a least cost solution, it is implicitly assumed in both models that shippers or exporters have an adequate knowledge of alternative modes and costs as well as a desire to minimize the total transportation bill.

Transshipment Model Results

The results of the two transshipment models are presented in Tables 6 and 7. The tables provide a summary of both inland and ocean leg costs for each alternative, including the number of containers moved, modes of transportation, total costs, and costs per container.

Table 6. Model I. Baseline Movements - 1976 Kentucky Bluegrass Seed Exports Through PNW Ports

Inland Leg Origin	Ocean Port	Number of Containers	Mode	Cost	Cost per Container
Spokane	Seattle	16	Truck	$ 2112	$132
Spokane	Portland	76	Truck	10032	132
Lewiston/Clarkston	Portland	35	Truck	5390	154
Umatilla	Portland	18	Truck	2376	132
Albany/Corvallis	Portland	44	Truck	3872	88
Inland Leg Total		189		$23782	$125.83*

Ocean Leg Port	Destination	Number of Containers	Cost	Cost per Container
Seattle	Asia	6	$ 4228	$738
Seattle	Europe	6	8196	1366
Seattle	G. Britain	2	2772	1386
Seattle	Scandinavia	2	2772	1386
Portland	Asia	29	21402	738
Portland	Oceania	33	70587	2139
Portland	Europe	81	110646	1366
Portland	G. Britain	12	16632	1386
Portland	Scandinavia	18	24948	1386
Ocean Leg Total		189	$262383	$1388.26*
	Total Transportation Cost		$286165	$1514.10*

*Weighted Average

In 1976, one hundred eighty-nine 20 foot containers (about 4.15 million pounds) of Kentucky bluegrass seed were moved through PNW ports (Table 6). The total transportation bill was $286,165 or an average of $1,514.10 per container. Of that total, $23,782 or $125.83 per container was spent moving seed from origins to ocean ports. This figure represents 8.3 percent of the total transportation cost. There were no movements of containerized Kentucky bluegrass seed via the Columbia Snake river system. The remaining $262,383 or $1,388.26 per container was the cost of the ocean leg of the movements.

Although the transportation cost between Spokane and Seattle or Portland was the same, ($132), eighty-three percent of the Spokane region seed moved through Portland. This might have been the result of routing exports through producers or exporters in the Albany/Corvallis region or due to unidentified advantages offered by the port of Portland.

After the baseline transportation bill was estimated, the model was modified to seek a least cost solution utilizing the Columbia Snake river system. Savings in inland leg transportation costs were identified by comparing the two solutions. In Model II, the least cost solution routed all Lewiston/Clarkston and Umatilla region seed directly to Portland by barge. Albany/Corvallis shipments continued to be trucked to Portland. Spokane export movements to overseas destinations were routed by truck through either the port of Portland or Seattle since the truck rate to either port was the same.

The barge movements selected by Model II represent 53 containers of seed, twenty-nine percent of PNW Kentucky bluegrass seed exports (Table 7). This barge movement represents a per container savings of $32 and $41 respectively to shippers in Lewiston/Clarkston and Umatilla. The reduction in transportation costs could be used to advantage particularly in negotiated or contract sales to foreign buyers which are handled directly by processors or shippers in these interior regions.

The least cost transportation bill estimated in Model II was $284,307 or $1,504.27 per container (Table 7). This represents a savings of $1,858 over the baseline figure of Model I. The inland leg cost came to $21,294 or $116.00 per container and represents 7.7 percent of the total transportation bill. The cost of the ocean leg remained the same as Model I.

A review of Table 7 indicates that several alternatives exist for a least cost solution for the portion of seed exports originating in the Spokane growing region. Seed originating in Spokane can be shipped by truck to either Portland or Seattle at the cost of $132 per container. The Spokane region is too far removed from the Columbia Snake river system to take advantage of barge transportation given the current rate structure. Although some carriers have issued special combination rates for transshipping seed from Spokane to Pasco by truck and thence by barge to Portland, the transloading charges incurred allow the Spokane to Portland truck rates to maintain a competitive advantage.

Additional alternatives exist for the ocean leg of the grass seed shipments described in Model II. Since the ocean rates are port equalized, export shipments to overseas destinations could be shipped from either Portland or Seattle at the same cost. In terms of the least cost solution described in Table 7, this means the 92 containers of seed originating in Spokane could be shipped to overseas destinations from either Portland or Seattle for the same cost.

Although the model included rail movement as an inland transportation activity, this mode was never selected as an economical alternative.

Table 7. Model II. Transportation Alternative Utilizing Columbia Snake River System - 1976 Kentucky Bluegrass Seed Exports.

Inland Leg Origin	Ocean Port	Number of Containers	Mode	Cost	Cost per Container
Spokane	Portland or Seattle[1]	92	Truck	$12144	$132
Lewiston/Clarkston	Portland	35	Barge	4270	122
Umatilla	Portland	18	Barge	1638	91
Albany/Corvallis	Portland	44	Truck	3872	88
Inland Leg Total		189		$21924	$116.00*
Ocean Leg **Port[2]**	**Destination**	**Number of Containers**		**Cost**	**Cost per Container**
Portland or Seattle	Asia	35		$25830	$738
Portland or Seattle	Oceania	33		70587	2139
Portland or Seattle	Europe	87		118842	1366
Portland or Seattle	G. Britain	14		19404	1386
Portland or Seattle	Scandanavia	20		27720	1386
Ocean Leg Total		189		$262383	$1388.26*
Total Transportation Cost				$284307	$1504.27*

*Weighted Average

1. Alternative solution exists since freight rates from Spokane to Portland and Seattle are equal.

2. Alternative solutions exists since rates from Portland and Seattle to overseas destinations are equal.

IMPLICATIONS

Use of the linear programming transshipment technique for determining mode and port of export has limitations. Perhaps the most important limitations result from the implicit assumption of product homogeneity. In the transshipment model it is assumed that supplies from any origin serve equally well to satisfy demand from any destination (Heady and Chandler, 1958, p. 341). This is not strictly the case as evidenced by the export price disparities depicted in Table 2. Grass seed is not a totally homogeneous commodity since it has a range of varietal and certification requirements.

Because of this situation, the estimates of supplies of seed at each origin may not be totally reliable. Expost shares were estimated to be the same as regional proportions of total Kentucky bluegrass seed production. Since such estimates are not actual measurements of regional exports, they may have altered the study results. This should be born in mind when interpreting the results. However, because of confidentiality and consolidation problems[2] specific to the industry, the authors had no indication that more costly and time consuming formal surveys and direct interviews would have produced more accurate results.

The modest reduction in transportation costs identified in this case study represent an insignificant portion of distribution costs for PNW

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2. The industry is characterized by relatively few export firms. Processors sometimes consolidate seed from various origins in response to supply availability or to specific demand requirements.

agricultural exports. Since containerized commodities are beginning to utilize barge tranportation on the river system however, the implications extend beyond grass seeds.

Utilizing more sophisticated transshipment models for more homogeneous major commodities such as processed potatoes and hides and skins will serve several purposes. First, it will allow the most cost efficient modes and routes to be identified. Depending on market structure, transportation cost reductions may benefit producers, processors, shippers, the national balance of payments and consumers. Second, by identifying the hinterland of specific transportation systems, insights can be gained as to the role that transportation plays in both domestic and international trade. Such insights may include structure of tariffs, volume of cargo movements, and effects on public and private facilities development.

A number of implications can be drawn with regard to the containerized movement of agricultural commodities via the Columbia Snake river system.

Containerized shipment costs could be reduced if full containers could be backhauled to inland points rather than be delivered empty. One problem in dealing with backhauls is the ownership of containers. Most ocean carriers maintain their own equipment; therefore, loaded backhauls would require considerable coordination between shippers. Several "container pools" are operating efficiently, but this alternative is not generally well received by West Coast ports and ocean carriers.

There will likely be enough tug and barge companies authorized to operate on the Columbia Snake river system to insure continued competition and very probably an overall increase in general cargos moving up and downriver. This increase will take place slowly; however, as growth occurs, it should reduce problems with backhauls and availability of containers.

In the future, barge tariff rates can be expected to increase due to general upward trends in prices and also due to the imposition of user's fees for inland waterways. If the industry is required to absorb some or all of the construction and maintenance costs of inland waterways, the transition will probably be at such a pace as to allow the industry to remain competitive with other modes of transportation.

The final determining factor for truck versus barge movements will be tariff rates for these competing modes. If barge carriers are willing to absorb some of the cost of supplying empty containers or to otherwise facilitate the delivery of empty containers to up river locations, they may maintain a competitive advantage over highway routes which parallel the Columbia Snake river system. On the other hand, exempt truck tariffs are extremely flexible and truck carriers are in a position to compete effectively with the river system. Cooperation between barge and truck carriers may result in increased movements from inland regions such as Spokane with could be mutually advantageous to shippers and carriers.

Finally, as both in- and out-bound trade develops between the inland PNW and the coastal ports, problems with scheduling, availability of containers and rate disparities should diminish, resulting in an increase of total freight moved at a reduced per unit cost.

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