

A SYSTEMS APPROACH TO DISTRIBUTION: A CASE STUDY IN THE
DISTRIBUTION OF HYBRID CORN AND SORGHUM SEED

by *6408*

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CHAPTER I

INTRODUCTION

Purpose

The purpose of this study is to analyze the physical distribution of hybrid corn and sorghum seed in a limited segment of the industry. The objective of the analysis is to suggest procedures for seed distribution in the area analyzed that will reduce distribution costs and/or improve the timeliness of delivery or other factors related to physical handling and distribution. To the degree that the industry segment analyzed is representative of other segments of the industry, results of this study may be applicable elsewhere.

The Problem

A proper degree of attention to the importance of a function in a business firm is often focused by a full knowledge of the costs of carrying out that function.

The relative importance of the cost of transportation in acquisition of inputs and in distribution of products for an individual firm is affected by the distances by which the firm is separated from its sources of supply and its markets. Thus, two business firms located at approximately the same point in a logistics channel may have drastically different costs of physical distribution as a percentage of sales revenue. The firm with lower production costs may be willing to incur a heavier proportion of physical distribution costs in realizing

the same profit margin as its competitor. If economies of scale are present, a firm may be willing to incur greater distribution costs in an expanding market in order to realize available economies.

In the seed industry production costs will vary because of external factors, such as weather, that affect yields. Sales costs may be budgeted in an attempt to control costs, but external factors prevent accurate cost predictions. Since physical distribution is under the full control of the firm, accurate dollar costs may be predicted. Because of this control, least-cost methods that relate to production and sales may be determined.

Although the relative cost of physical distribution in the seed industry is small, total physical distribution costs are large because of the relative concentration of seed production and the shifting and expanding areas of seed use.¹ Although hybrid corn seed was first produced for sale in 1923 and the first commercial hybrid seed company was organized in 1926, it was not until 1945 that hybrid corn seed came into major use. In 1933 only one percent of the corn acreage in the central corn belt was planted with hybrid seed.² In 1953 it was estimated that 96 percent of the corn acreage in the

¹Physical distribution costs are reported to be between six to seven percent of the retail value of seed.

²Seeds, The Yearbook of Agriculture, 1961, United States Department of Agriculture, p. 145.

central corn belt and 86 percent of the national corn acreage was planted with hybrid corn seed. Hybrid corn seed production and use was largely limited to the central corn belt until 1945. After this time, hybrid corn seed use became an accepted practice in corn growing areas outside of the central corn belt. Hybrid seed processing plants were located in the central corn belt to be near large corn growing areas where seed could be produced.

Figure 1 designates the major corn producing areas in the United States and illustrates volume of seed used per square mile of area by state. Table 1 lists the acreages planted to corn in 1970 and the seed requirements necessary to plant the reported acreage. With the acceptance of hybrid corn seed use outside the central corn belt, physical distribution became a major problem in terms of cost and service due to the long distances that seed is transported.

Hybrid sorghum seed was first commercially planted in 1955. Farmers accepted the use of hybrid sorghum seed more quickly than they had hybrid corn seed. Processing plants were located in the Texas panhandle and in western Kansas, which were the centers of grain sorghum production. In 1960, it was estimated that 70 percent of the national sorghum acreage was planted with hybrid sorghum seed.¹ Shorter maturity sorghums, new grain sorghum adapted to other growing areas,

¹Seeds, The Yearbook of Agriculture, 1961, United States Department of Agriculture, p. 146.

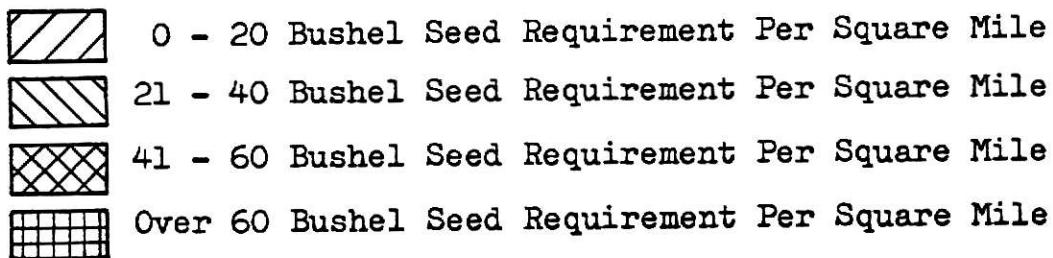
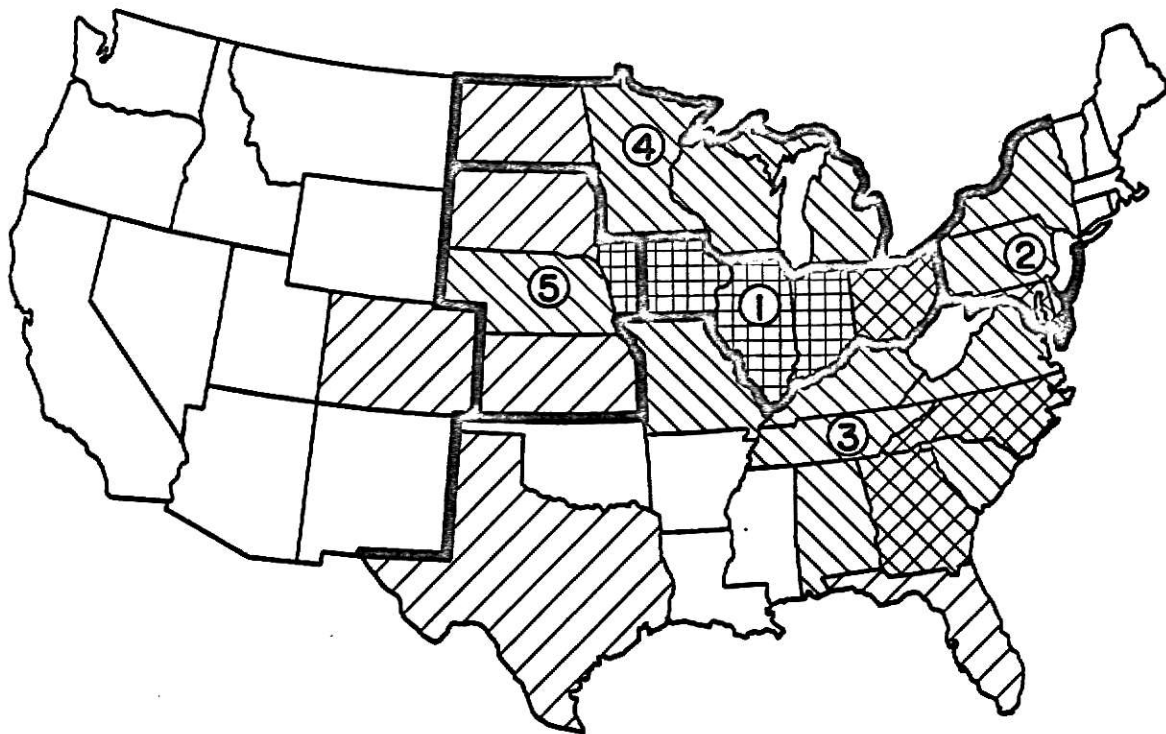
and sorghum-sudangrass crosses were developed for use outside of the original sorghum growing area. Figure 2 illustrates the original sorghum growing area and new areas of sorghum production. Table 2 lists the acreages planted to sorghums by major sorghum-producing states and the seed requirements necessary to plant the reported acreage. Here again, long distances in transporting seed occurs.

Another factor in the high total cost of physical distribution is the amount of seed returned from dealers to the hybrid seed producing company. It is reported that 90 percent of all hybrid seed is merchandised on a guaranteed sale basis. It is estimated by trade sources that 131 bushels of hybrid corn seed is required in distribution channels for every 100 bushels hybrid corn seed planted. It is also reported by trade sources that 129 50-pound bags of hybrid sorghum seed are required in distribution channels for every 100 50-pound bags planted. This inefficiency means that more seed must be transported than is necessary to meet planting requirements.

The traditional method of physical distribution has been by motor carrier. This type of physical distribution has been used throughout the 40-year span of the hybrid seed industry. A very small amount of public research has been done into the type of carrier that would prove most economical. The only change in the carrier that has occurred is in the size vehicle used by the carrier.

FIGURE 1

SEED USE PER SQUARE MILE OF TOTAL AREA FOR
STATES WITH 400,000 ACRES OR MORE OF CORN IN 1970



- ① Central Corn Belt
- ② Eastern Region
- ③ Southern Region
- ④ Northern Region
- ⑤ Western Region

TABLE 1

PLANTED ACREAGES AND SEED REQUIREMENTS
CORN FOR GRAIN AND SILAGE
STATES WITH OVER 400,000 ACRES
1970

State	Acreage Planted (1000 Acres)	Seed Use per Acre (pounds)	Seed Requirement ¹ (1000 Bushels)
Iowa	10,668	11.4	2,088
Illinois	10,442	11.2	2,175
Nebraska	5,536	9.0	889
Minnesota	5,300	11.3	1,065
Indiana	5,210	11.0	1,023
South Dakota	3,455	8.1	500
Ohio	3,247	11.5	678
Missouri	3,114	10.0	556
Wisconsin	2,715	12.4	528
Michigan	1,788	11.2	358
Kansas	1,689	8.7	262
Georgia	1,684	8.8	265
North Carolina	1,561	10.2	284
Pennsylvania	1,300	11.9	273
Kentucky	1,167	10.2	213
New York	847	16.3	246
Tennessee	722	9.8	129
Alabama	686	8.7	107
Virginia	650	10.1	117
Texas	639	8.4	96
Colorado	594	13.5	143
Maryland	565	10.4	105
North Dakota	542	8.1	89
South Carolina	490	10.3	90
Florida	434	8.0	63

Source of Acreage Planted: Crop Production, 1970 Annual Summary, December, 1970, Crop Reporting Board, Statistical Reporting Service, United States Department of Agriculture, Washington, D. C.

Source of Seed Use: Agricultural Statistics, 1970, United States Department of Agriculture, Washington, D. C.

¹Seed requirements determined by using planted acreage multiplied by average seed use per acre.

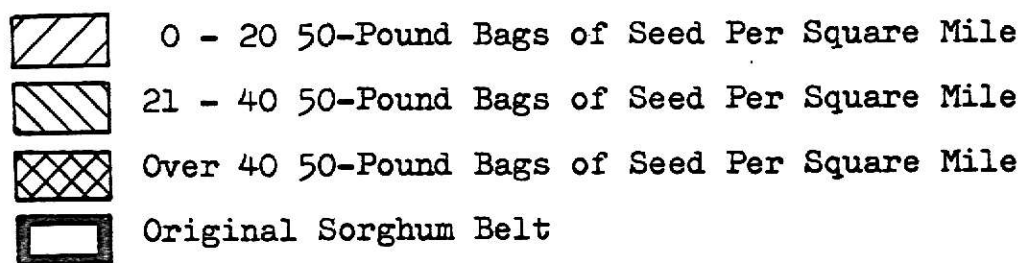
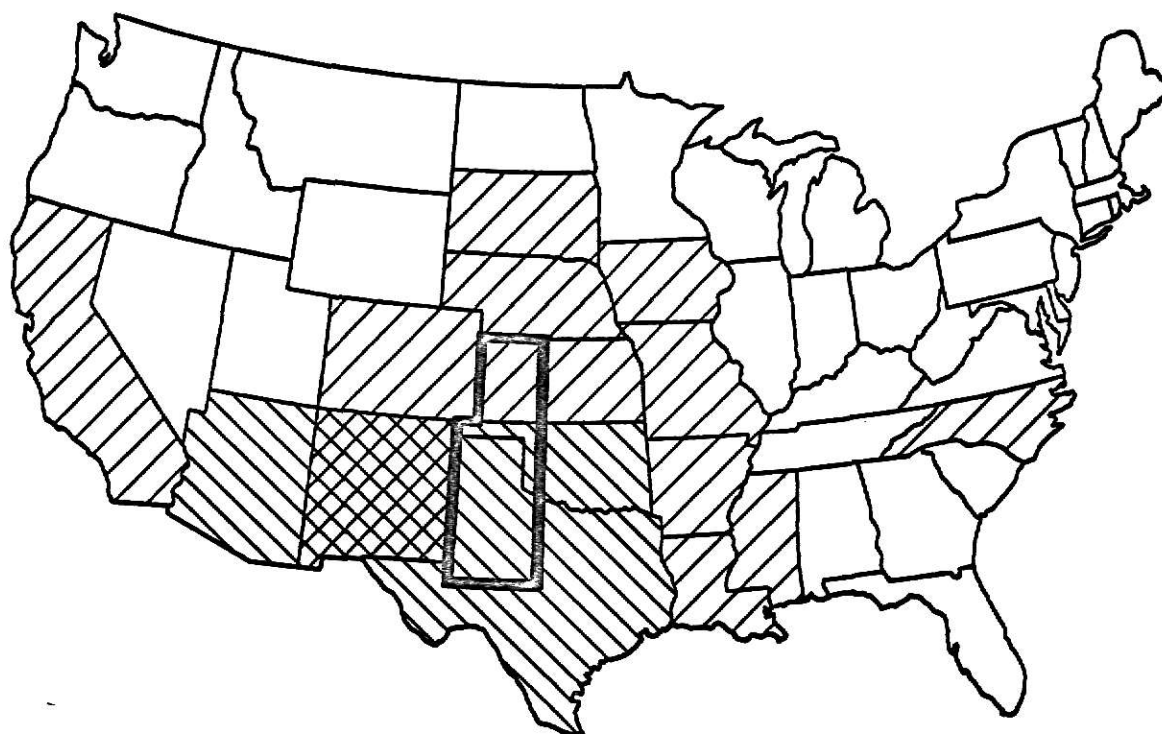


Fig. 2. Seed use per square mile of area for states with 50,000 acres or more of sorghum in 1970.

TABLE 2

PLANTED ACREAGES AND SEED REQUIREMENTS
SORGHUM FOR GRAIN AND SILAGE
STATES WITH OVER 50,000 ACRES
1970

State	Acreage Planted (1000 Acres)	Seed Use Per Acre (Pounds)	Seed Requirement ¹ (1000 50# Bags)
Texas	7,010	7.2	1,009
Kansas	4,391	5.0	439
Nebraska	1,778	6.1	217
Oklahoma	937	11.0	406
Colorado	504	6.8	69
South Dakota	461	7.0	65
California	421	16.5	138
New Mexico	410	10.0	82
Missouri	298	8.0	48
Arkansas	245	12.6	62
Arizona	193	12.0	46
Mississippi	167	17.9	60
Louisiana	87	18.0	31
North Carolina	72	13.0	19
Florida	54	N/A	N/A
Iowa	49	9.3	9

Source of Acreage Planted: Crop Production, 1970 Annual
Summary, December, 1970, Crop Reporting Board, Statistical
Reporting Service, United States Department of Agriculture,
Washington, D. C.

Source of Seed Use Per Acre: Agricultural Statistics, 1970,
United States Department of Agriculture, Washington, D. C.

¹Seed requirements determined by use of planted acreage
multiplied by average seed use per acre.

TABLE 3

HYBRID CORN SEED PRODUCTION AND USE BY REGIONS

Region	Production (1000 Bushels)	Use (1000 Bushels)
Northern	2,429	1,572
Michigan		
Minnesota		
Wisconsin		
North Dakota		
Western	3,225	2,439
Western Iowa		
Nebraska		
South Dakota		
Kansas		
Central	6,435	5,389
Illinois		
Indiana		
Ohio		
Eastern and Central Iowa		
Eastern	665	619
Pennsylvania		
New York		
New England States		
Mid-South	1,607	1,272
Kentucky		
Tennessee		
North Carolina		
South Carolina		
Missouri		
Deep South	535	531
Georgia		
Alabama		
Florida		
East Texas		
Unreported	1,204	
All other States		1,278
Total	16,100	13,100

Source of Production: Doanes Agricultural Service, St. Louis, Missouri.

Source of Use: Crop Production, 1970 Annual Summary, December, 1970, Crop Reporting Board, Statistical Reporting Service, United States Department of Agriculture, Washington, D. C.

Table 3 lists the production and use of hybrid corn seed by region. It would seem from this table that within each of these regions there is an adequate production of hybrid corn seed to meet the needs of each region without the long-range movement of seed. However, this is not the case. A seed production company will usually produce seed in no more than two regions and may sell this production in all the regions listed. Also, certain varieties of corn seed may be produced in one region and then sold in several regions. These features of production and distribution cause cross-hauling to occur. Cross-hauling occurs not only on industry scale, but also within an individual firm. Although cross-hauling of seed adds to the cost of distribution, this problem is related to the use of specific growing areas because of weather, soil, or other specific agronomic considerations.

The existing production and distribution pattern is due to the historical development of hybrid seed companies. The majority of seed companies originated as small firms that were individually owned and operated. As business growth occurred, some companies merged to acquire larger distribution areas. On these occasions, only certain local production facilities were retained. For other companies, growth in distribution area was not accompanied by development of seed production at new points; consequently, distances over which seed is transported have become greater. This is primarily due to the fact

that certain geographical areas are more suited by weather and soil conditions to growing specific seed crops and even specific seed varieties.

It is reported by trade sources that 80 percent of the total production as represented in Table 3 is produced by 14 large companies, 12 of which have a national distribution pattern.

Analysis

This study is undertaken with the assumptions that production of hybrid seed will remain in the presently located areas and that the areas of distribution will remain unchanged.

The case study herein analyzed is the distribution of seed by Acco Seed, a division of Anderson, Clayton & Company, to retail dealers in sales district 163 in central Kansas.

New methods and ideas of physical distribution that may prove applicable to the hybrid seed industry will be analyzed by the systems approach. The systems approach is hereby defined as that approach to a problem area which does not isolate the problem by itself, but takes into consideration the inter-relationship of the problem area with other business functions of the firm.

Procedure

The procedure in this case study is as follows:

- (1) Describe in detail the present distribution system of the firm of which distribution to sales district 163 is a part.

- (2) Explore the use of alternative modes of transportation that may improve on physical distribution or reduce the cost of transportation for sales district 163.
- (3) Impose on the present method of distribution alternative methods of operations to test for cost-reducing techniques.

CHAPTER II

PRESENT DISTRIBUTION SYSTEM

Description of Physical Organization

Data on industry structure is not available; however, it is estimated by trade sources that Acco Seed is one of the ten largest hybrid seed producers and distributors in the United States. At the present time, 30 percent of the firm's hybrid corn seed is produced in Illinois and 30 percent is produced in Iowa. This firm produces 30 percent of its hybrid sorghum seed in Kansas and 70 percent in Texas.

Processing plants are located at Belmond, Conrad, and Dewitt, Iowa, and Lexington, Illinois, for the processing of hybrid corn seed. The hybrid sorghum processing plants are located at Leoti, Kansas, and Aiken, Texas. It is estimated that the firm produces approximately 470,000 bushels of hybrid corn seed and approximately 150,000 hundredweight of hybrid sorghum seed. Acco Seed produces 2.9 percent of the total hybrid corn seed produced as stated in Table 3. There is no comparative percentage for hybrid sorghum seed produced because industry figures for the total amount of hybrid sorghum seed produced are not available.

The magnitude of the physical distribution problem is expressed in Table 4, which lists the gross shipment of seed by processing plant. Any shipments of corn seed from sorghum processing plants is arranged by shipping seed from the corn

seed processing plant to the sorghum seed processing plant for reshipment to retail dealers. This procedure is the same for sorghum seed shipped from corn seed processing plants.

The area of distribution of seed includes the states of Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, North Dakota, South Dakota, Wyoming, Montana, Colorado, New Mexico, California, Texas, Oklahoma, Kansas, Nebraska, Missouri, Arkansas, Louisiana, Mississippi, Kentucky, Tennessee, Alabama, and Georgia.

TABLE 4

GROSS SHIPMENT AND STORAGE CAPACITY
BY PLANT, 1970

Plant	Gross Shipment Corn Seed (bags) ¹	Gross Shipment Sorghum Seed (bags) ²	Storage (bags)
Belmond, Iowa	141,536	6,314	140,000
Conrad, Iowa	83,807	4,374	120,000
Lexington, Illinois	79,050	4,772	100,000
Leoti, Kansas	3,282	76,676	65,000
Dewitt, Iowa	55,563	2,458	120,000
Weeping Water, Nebr. ³	75,299	6,386	75,000
Aiken, Texas	4,514	183,209	225,000
Total	443,051	284,189	845,000

Source: Acco Seed Company, Belmond, Iowa

¹Bag weight for corn seed is either 56 pounds or 50 pounds, depending upon the variety of the seed.

²Bag weight for sorghum seed is 50 pounds.

³The Weeping Water, Nebraska, plant is being used at the present time as a warehouse facility as there is presently no seed production acreage in Nebraska under contract to Acco Seed Company.

Table 5 details the retail sales by certain specified states. Data was available for only the states listed. Table 6 lists the volume of seed shipped per state. These figures are computed by using the company's seed return percentage. By applying these return percentages to the retail sales figures as listed in Table 5, an approximate figure for total corn and sorghum seed shipments by state has been arrived at. The firm's return seed percentage is 19 percent for corn seed and 28 percent for sorghum seed. This is a percentage of the gross shipment of corn and sorghum seed.

TABLE 5

ACCO SEED
RETAIL SALES BY SPECIFIED STATES
1970

State	Corn Seed (bushels)	Sorghum Seed (50-pound bag)
Iowa	69,300	2,000
Nebraska	38,253	16,272
Kansas	17,883	34,743
Colorado	4,793	2,559
Missouri	16,873	3,932

Source: Acco Seed, Division of Anderson, Clayton & Company.

The information in Tables 5 and 6 is included to give the reader a more detailed view of the magnitude of the physical distribution problem in merchandising seed. These tables also point out the problems of returning unsold seed to processing plants.

TABLE 6

ACCO SEED
GROSS SEED SHIPMENT BY SPECIFIED STATE
1970

State	Corn Seed (bushels)	Sorghum Seed (50-pound bag)
Iowa	85,556	2,778
Nebraska	47,226	22,600
Kansas	22,078	48,254
Colorado	5,917	3,554
Missouri	20,831	5,461

Source: Acco Seed, Division of Anderson, Clayton & Company.

Sales and Physical Distribution Structure

Acco Seed Company sells approximately 90 percent of its domestic seed sales through a retail dealer organization. The company has sales territories consisting of ten counties or more. These territories are called sales districts. Each sales district is managed by a district sales manager. Retail dealers within each of these sales districts are allocated a territory in which to sell seed. The size of this territory may vary from the size of a township to one-half of a county, depending on the type of farming within the sales district.

Retail dealers submit customer seed orders to the company starting August one. They may submit orders until April one. Dealers receive a monthly report on the availability of seed by variety and seed size. The retail seed dealer is allowed the privilege of returning all unsold seed to the company

when the planting season is finished. The company pays the expense of shipping seed to retail dealers and the expense of returning unsold seed.

Ten percent of the firm's seed sales are direct sales to large farmers who use over 40 bags of seed annually. These customers do not have a return seed privilege, although the firm does pay the expense of shipping the seed to the customer.

Physical distribution of seed to retail dealers and direct customers is provided by motor truck. Company-owned and contract carriers handle the delivery of seed. Seed is delivered from the processing plants to dealers and direct customers by straight tandem-axle trucks with van or grain-type beds. The trucks have the capacity of 470 to 500 bags of seed, depending on the type of seed being hauled.

The motor carriers are termed "exempt carriers" under the Interstate Commerce Commission Motor Carriers Act of 1935. Exempt carriers are subject to rules and regulations of the Interstate Commerce Commission as to safety and hours of service of drivers, but they are not subject to regulation by the Commission as to entry into the trucking business, the rates charged, and the routes served. Exempt commodities are non-manufactured agricultural commodities such as grain, fresh fruits and vegetables, poultry and eggs, ordinary livestock, and seeds.

Seed processing plants are frequently located in rural farming areas away from rail lines. In these cases, trucks provide the only available transportation for initial movement.

Also, since the majority of retail seed dealers are farmers, the delivery of seed is to rural farming areas away from rail lines. Speed is also important late in the season, when retail dealers may run out of certain varieties of seeds and need refill orders immediately.

The rate of pay for contract haulers in 1970 was as follows: for 470 bags of seed per load, 23 cents per mile; for 480 bag minimum load, 23½ cents per mile; for 490 bag minimum load, 24 cents per mile; and for 500 bag minimum load, 24½ cents per mile.

Physical Distribution Procedures

The delivery of seed begins approximately during the middle of January each year. Hybrid corn seed delivery begins earlier than sorghum seed because of the earlier planting season for corn. The exception to this is the southern sorghum area where planting usually begins the middle of February. This area includes the states of Texas and Arizona. Where possible, corn seed is delivered directly from a corn seed processing plant and sorghum seed is delivered from a sorghum seed processing plant to avoid the cost of reshipment.

As seed orders are submitted by dealers to the firm, the firm enters these seed orders into an electronic data-processing information program. Seed order information is printed out weekly for each sales district and mailed to the district sales manager.¹ This print-out lists the seed varieties and sizes as

¹Refer to Fig. 3, Example of Information Print-out of Orders.

ordered by each dealer. On approximately January 1, the district sales manager is provided with an availability schedule of delivery trucks.¹ It is the responsibility of the district sales manager to schedule and route trucks to deliver seed to his dealers within the limits imposed by the carrier availability schedule. It is assumed that the district sales manager, with knowledge of the area he manages, is able to do this more efficiently than anyone else.

In the scheduling of trucks, a three week lead time is necessary between the time delivery is scheduled and the actual date of delivery. This three week lead time is necessary because the truck route schedule must move from the district sales manager to the main office where load orders are printed; then the route schedule must go to the processing plant for shipment. After delivery is scheduled, the retail dealer receives a copy of the load order. This copy indicates the date of shipment, the seed varieties and sizes being shipped, and the stop number the dealer has. The retail dealer is expected to be available to help the truck operator unload the seed.

After April 15, seed delivery for late spring sales may be procured by the district sales manager calling the seed order directly to the processing plant that serves that area. In areas that are a great distance from a processing plant, seed is warehoused by certain specified dealers.

¹Refer to Fig. 4, Example of Truck Availability Schedule.

ANDERSON CLAYTON
ACCO SEED-BELMOND, IOWA

DEALER ORDERS
FOR PERIOD 02-08-71
02-08-71

REG	DEALER	TYPE	SHIPPING	STATE
DIST	NO.	DEALER	POINT	CODE

DEALER NAME

[illegible]

TOTAL SWEET CORN
TOTAL OTHER SEED
SHIPPING POINT TOTAL-

TOTAL SWEET CORN
TOTAL OTHER SEED
TOTAL FOR CUSTOMER

163	3706	01	04	17	NEIL W HOLLOWAY
			04		
			04		
			04		
			04		

TOTAL OTHER SEED
SHIPPING POINT TOTAL-

Source: Acco Seed Company, Belmond, Iowa

Fig. 3. One page example of information print-out of dealer's orders.

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REPORT NO. ASAO04

TYPE PROD	VARIETY	SIZE	TOTAL UNITS	UNITS ON L.O.	OPEN ORDERS
01	SC		400		400
10	435		10		10
20	815	F1	2		2
20	956	F2	5		5
20	1030	F2	5		5
30	R920		25		25
30	R94		2		2
30	R102		1		1
30	R1019		25		25
30	R1029		96		96
30	R1050		28		28
30	R109		483		483
30	R1090		27		27
30	S77		10		10
30	R2020		10		10
31	S SIOUX		27		27
31	SIOUX 2		2		2
31	SS1		29		29
31	FS400R		30		30
31	FS401R		40		40
31	FS531		1		1
			400		400
			858		858
THIS CUSTOMER			1,258		1,258
			400		400
			858		858
			1,258		1,258
30	R920		20		20
30	R94		11		11
30	R109		103		103
30	S77		5		5
31	S SIOUX		16		16
			155		155
THIS CUSTOMER			155		155

Fig. 3. Continued

Fig. 4. Carrier availability schedule,
sales district no. 163, 1971

<u>District No.</u>	<u>Bushels</u>	<u>Load No.</u>	<u>Date</u>	<u>Plant</u>
163	450-470	2 Co. Tandem	Feb. 2	Weeping Water
163	450-470	18 Co. Tandem	Feb. 9	Weeping Water
163	470-500	24 Malfeld	Feb. 11	Weeping Water
163	450-470	36 Co. Tandem	Feb. 16	Weeping Water
163	450-470	54 Co. Tandem	Feb. 23	Weeping Water
163	490-530	7 Gossen	Feb. 24	Leoti
163	470-500	12 Kuder	Feb. 25	Leoti
163	490-530	15 Gossen	Feb. 26	Leoti
163	480-500	19 Co. Tandem	Mar. 1	Leoti
163	450-470	69 Co. Tandem	Mar. 2	Weeping Water
163	490-530	27 Gossen	Mar. 3	Leoti
163	470-500	32 Kuder	Mar. 4	Leoti
163	470-500	74 Malfeld	Mar. 4	Weeping Water
163	490-530	35 Gossen	Mar. 5	Leoti
163	450-470	84 Co. Tandem	Mar. 9	Weeping Water
163	470-500	47 Kuder	Mar. 10	Leoti
163	480-500	52 Co. Tandem	Mar. 11	Leoti
163	470-500	55 Kuder	Mar. 12	Leoti
163	490-530	59 Gossen	Mar. 15	Leoti
163	470-500	64 Kuder	Mar. 16	Leoti
163	450-470	99 Co. Tandem	Mar. 16	Weeping Water
163	490-530	67 Gossen	Mar. 17	Leoti
163	470-500	72 Kuder	Mar. 18	Leoti
163	490-530	75 Gossen	Mar. 19	Leoti
163	490-530	84 Gossen	Mar. 23	Leoti
163	450-470	114 Co. Tandem	Mar. 23	Weeping Water
163	480-500	87 Co. Tandem	Mar. 24	Leoti
163	490-530	92 Gossen	Mar. 25	Leoti
163	470-500	119 Malfeld	Mar. 25	Weeping Water
163	480-500	95 Co. Tandem	Mar. 26	Leoti
163	470-500	99 Kuder	Mar. 29	Leoti
163	480-500	104 Co. Tandem	Mar. 30	Leoti
163	450-470	129 Co. Tandem	Mar. 30	Weeping Water
163	470-500	107 Kuder	Mar. 31	Leoti
163	480-500	112 Co. Tandem	Apr. 1	Leoti
163	470-500	115 Kuder	Apr. 2	Leoti
163	490-530	119 Gossen	Apr. 5	Leoti
163	450-470	145 Co. Tandem	Apr. 6	Weeping Water
163	470-500	127 Kuder	Apr. 7	Leoti
163	480-500	132 Co. Tandem	Apr. 8	Leoti
163	470-500	135 Kuder	Apr. 9	Leoti
163	490-530	139 Gossen	Apr. 12	Leoti
163	450-470	160 Co. Tandem	Apr. 13	Weeping Water
163	470-500	147 Kuder	Apr. 14	Leoti
163	480-500	152 Co. Tandem	Apr. 15	Leoti
163	470-500	165 Malfeld	Apr. 15	Weeping Water
163	470-500	155 Kuder	Apr. 16	Leoti
163	490-530	159 Gossen	Apr. 19	Leoti
163	490-530	167 Gossen	Apr. 21	Leoti
163	480-500	171 Co. Tandem	Apr. 22	Leoti
163	490-530	174 Gossen	Apr. 23	Leoti

Source: Acco Seed Company, Belmond, Iowa.

Cost of Physical Distribution

There is not a total cost figure available for the physical distribution of seed by Acco Seed. The firm's accounting system does not lend itself to the derivation of these figures.

The only costs that can be presented are those incurred in sales district 163 for the delivery of seed to retail dealers.¹

TABLE 7
PHYSICAL DISTRIBUTION COSTS
SALES DISTRICT 163
1970

Type of Cost	Total Cost (Dollars)	Cost Per Bag (Cents)	Bags of Seed
Seed and Delivery Trucking Cost	10,503.79	43.2	24,311
Truck Loading Labor	657.40	2.7	24,311
Return Seed Trucking Cost	2,172.66	45.5	4,776
Dealer Warehousing Cost	1,595.85	30.4	5,243
Return Seed Labor Unloading Cost	128.95	2.7	4,776
Gross Shipment Total Cost	15,058.65	61.9	24,311
Net Sales Total Cost	15,058.65	76.7	19,635

Source: Acco Seed Company, Belmond, Iowa.

¹Refer to page 25 for a description of this area; also refer to Fig. 5.

Table 7 lists the various costs involved in seed delivery to this sales district in 1970. Trucking costs are based on the rates of 23 to 24½ cents per vehicle mile as previously discussed. Dealer warehousing costs are based on the current rate paid of 35 cents per bag of seed transferred out of the warehouse to retail dealers. Truck loading and unloading labor costs are based on six man-hours required to load 500 bags of seed into a truck at a wage rate of \$2.25 per hour. Cost data for delivery of seed to sales district 163 are characteristic of delivery costs to other areas and are believed to be representative of other areas. However, since this is not a statistically representative sample, it is not possible to estimate cost for the entire distribution system based on the available data.

Special Analysis

Improved truck routing and use of alternative modes of transportation were selected for special analysis in an attempt to determine if a systems approach to physical distribution would provide a reduction in transport cost and/or better service.

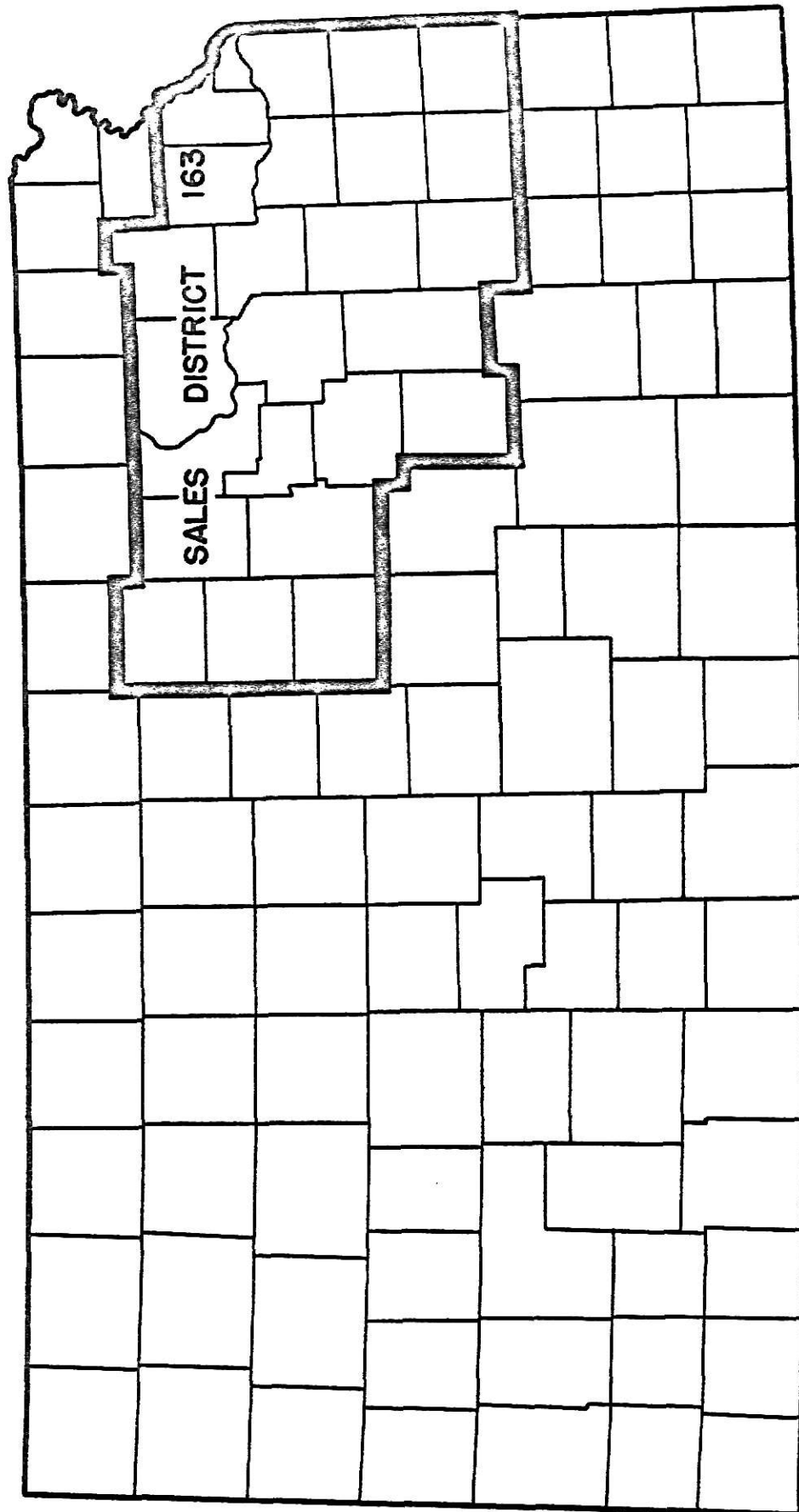
In the following chapters, improved routing techniques and alternative modes of transportation will be applied to the delivery of seed from processing plants to retail dealers in sales district 163. This area is comprised of 25 counties in Kansas.¹ The counties are Cloud, Ottawa, Saline, Dickinson,

¹Refer to Fig. 5.

Clay, Riley, Geary, Morris, Chase, Lyon, Wabaunsee, Pottawatomie, Jackson, Jefferson, Leavenworth, Shawnee, Douglas, Wyandotte, Johnson, Miami, Linn, Anderson, Coffey, Osage, and Franklin. This sales district is delivered sorghum seed from the sorghum seed processing plant at Leoti, Kansas. Corn seed is delivered to this area from the corn seed processing plant at Weeping Water, Nebraska.

Alternative modes of transportation will also be analyzed as to their application to inter-plant shipment of seed.

FIGURE 5
OUTLINE OF SALES DISTRICT 163
EAST CENTRAL KANSAS



CHAPTER III

ALTERNATIVE MODES OF TRANSPORTATION

Rail Shipment by Boxcar

In spite of the need for truck delivery to and from points not on the railroad, rail delivery is a possible alternative method of volume movement between relatively distant points. Processing plants and retail dealers are located in rural areas away from rail spurs. The use of rail shipment would entail the loading of bagged seed on a truck for delivery to the rail spur, and then unload from the truck into the rail car. This applies to all of Acco Seed's processing plants. At the destination point, the bagged seed would have to be unloaded into a truck for delivery to retail dealers. Additional labor is required by the shipper in cleaning and lining boxcars in preparation for shipment.

The shipment of sorghum seed from the processing plant at Leoti, Kansas, to sales district 163 would involve the use of 16 man-hours of labor to prepare the boxcar for the shipping of seed.¹ The loading requirement for labor to load a 50-foot boxcar with 1600 50-pound bags of sorghum seed is

¹This is based on an analysis of Acco Seed's experience in shipping seed to seaports for export via rail boxcar. It is found that boxcars are in such poor repair that cars must be lined inside with cardboard to prevent the ripping of paper seed bags.

51.2 man-hours.¹ The number of man-hours required to unload the bagged seed from boxcar into delivery trucks is 25.6 man-hours. This would make a total of 92.8 man-hours per boxcar necessary in the use of rail shipment. The total cost of this labor is estimated at \$209.80 per boxcar containing 1600 bags of seed.²

Also under consideration is the shipment by boxcar of 1000 bags of seed.³ Here again, boxcar preparation for shipment is 16 man-hours. The labor necessary for all loading and unloading operations is 44 man-hours.⁴ A total of 58 man-hours is required for a boxcar shipment of 1000 bags of seed. The total cost of this labor is \$130.50 per boxcar load of 1000 bags of seed.⁵

The carload freight rates listed in Table 8 were quoted by the Missouri-Pacific Railroad, which is the rail line at the Leoti, Kansas, processing plant. The rates were arrived at by the use of the Missouri-Pacific Railroad commodity rate formula, e.g., Commodity Item #42-55-F, Part Two, Supplement 125, WTL Tariff 2005, for bagged grain seed.

¹This is based on the analysis of Acco Seed's experience in using boxcars for export shipment. It has been the company's experience that 1600 bags of seed is the maximum due to the deterioration of boxcars. There is no other data available on the loading and unloading of seed under these constraints.

²Based on an average wage rate of \$2.25 per hour.

³Under consideration because of damage losses. See discussion of damage losses on page 34.

⁴See footnote number 1, page 28.

⁵Based on an average wage rate of \$2.25 per hour.

Topeka and Abilene, Kansas, were selected as the destination points as they are centrally located in the area covered by sales district 163.

TABLE 8
CARLOAD FREIGHT RATES
SHIPPING POINT, LEOTI, KANSAS

Delivery Point	1600 Bags of Seed 80,000 Lbs. Minimum (In Cents Per 100 Pounds)	1000 Bags of Seed 40,000 Lbs. Minimum (In Cents Per 100 Pounds)
Abilene, Kansas	28.0	41.5
Topeka, Kansas	37.0	49.5

Source: Missouri-Pacific Railroad.

Tables 9 and 10 were prepared to present the difference in cost between rail boxcar shipment and the present method of shipment by motor truck. These tables present the total costs and cost per bag between the Leoti, Kansas, processing plant and the destination points. Different size carriers are being compared as well as the differences in the number of bags of seed hauled by one type of carrier. Because of these size and unit comparisons, the only valid cost that can be compared, is the cost per bag of seed.

Table 9 shows that in seed delivery to Abilene, Kansas, the current motor truck type of transport holds a slight cost advantage. As illustrated in Table 9, this cost advantage is due to lower labor costs.

TABLE 9
COST COMPARISON
RAIL BOXCAR VERSUS CURRENT MOTOR TRUCK CARRIER
LEOTI, KANSAS TO ABILENE, KANSAS

	Boxcar 1600 Bags	Boxcar 1000 Bags	Truck 500 Bags
Freight Cost	\$224.00	\$207.50	\$119.07 ¹
Labor Cost	\$209.80	\$130.50	\$ 13.50 ²
Total Cost	\$433.80	\$338.00	\$132.57
Freight Cost Per Bag	14.0¢	20.7¢	23.8¢
Labor Cost Per Bag	13.1¢	13.1¢	2.7¢
Total Cost Per Bag	27.1¢	33.8¢	26.5¢

TABLE 10
COST COMPARISON
RAIL BOXCAR VERSUS CURRENT MOTOR TRUCK CARRIER
LEOTI, KANSAS TO TOPEKA, KANSAS

	Boxcar 1600 Bags	Boxcar 1000 Bags	Truck 500 Bags
Freight Cost	\$296.00	\$247.50	\$161.70 ³
Labor Cost	\$209.80	\$130.50	\$ 13.50
Total Cost	\$505.80	\$378.50	\$175.20
Freight Cost Per Bag	18.5¢	24.7¢	32.3¢
Labor Cost Per Bag	13.1¢	13.1¢	2.7¢
Total Cost Per Bag	31.6¢	37.8¢	35.0¢

¹Based on 24.5 cents per mile for 486 miles round trip.

²Based on 6 man-hours required to load 500 bags of seed into a truck at \$2.25 per hour average wage rate.

³Based on 24.5 cents per mile for 660 miles round trip.

Table 10 shows that in seed delivery to Topeka, Kansas, the least-cost method is by the use of rail boxcar carrying 1600 bags of seed. As in Table 9, the advantage gained in lower cost of freight per bag of seed is offset in the 1000 bag boxcar by high labor requirements. Much of the cost advantage of the 1600 bag carload is also offset by higher labor costs.

In the case of rail shipment, cost of delivery from the rail delivery point to retail dealers must also be considered. To determine cost of delivery from rail point to retail dealers, a hypothetical delivery route was devised using sorghum seed shipments to dealers in 1970.

First, a north-south line was drawn midway between Abilene and Topeka, Kansas.¹ It is assumed that every seed dealer east of this line would be delivered sorghum seed from the Topeka, Kansas, rail destination point. A set of routes were devised with the constraint being 500 bags of seed per motor truck. The constraint may be forced to 510 bags if necessary to complete delivery to a dealer in one trip. These routes are shown in Table 11, which lists the dealer, bags of seed delivered, total weight of seed per load, and mileage per route. All routes were devised in a loop form to obtain the lowest mileage possible.

The cost of this dealer delivery from the rail destination point is based on rates issued by the Kansas

¹Refer to Fig. 5, page 27.

TABLE 11
HYPOTHETICAL DELIVERY ROUTES, BOX CAR AND TRUCK
DELIVERY COMBINATION TO RETAIL DEALERS
RAIL DESTINATION POINT, TOPEKA, KANSAS

Route	Dealer	Bags of Seed	Total Weight Per Route	Total Miles Per Route
1	Theel	35		
	Henton	73		
	Krohn	162		
	Fairbanks	35		
	Bennett	201	25,300	179
2	Bailey	48		
	Lynn	35		
	Schoonover	25		
	Domann	66		
	Smoots	121		
	Flinn	48		
	Massey	49		
	Miller	91	25,150	268
3	Gerstenberger	33		
	Crady	40		
	Hutchinson	37		
	Bratton	80		
	Markley	133		
	Holloway	76		
	Smith	90	24,450	303
4	Blum	36		
	Jones	91		
	Birk	7		
	Turner	307		
	Dubois	40	24,050	224
5	Pracht	500	25,000	138
6	Pracht	500	25,000	138
7	Pracht	500	25,000	138
8	Sergeant	500	25,000	130
9	Sergeant	500	25,000	130
10	Thompson	500	25,000	100
11	Thompson	500	25,000	100
12	Thompson	500	25,000	100
13	Lyddane	198		
	Pracht	126		
	Sergeant	141	23,250	169
14	Thompson	213		
	Micheals	192		
	Hicks	95	25,000	144
15	Hicks	500	25,000	94
16	Hicks	40		
	Davis	157	9,650	201
Total Bags of Seed--		7,641		

Motor Carriers Association Motor Freight Tariff #50-C. These rates are illustrated in Table 12.

Table 13 computes the cost of this final delivery, which results in a cost per bag of 17.9 cents. Table 14 lists the total cost of rail and truck combination shipment. It must be assumed that we are able to ship 7,641 bags of seed at 31.1 cents per bag as shown in Table 10. This assumption must be made because five 1600-bag carloads of seed would be 8000 bags of seed, requiring the warehousing of 359 bags of seed at the rail destination point. It is found in Table 14 that the total delivery cost per bag of seed is 49.0 cents.

This amount of seed delivered by current truck method would require sixteen 500-bag loads of seed traveling 600 miles round trip between Leoti, Kansas, and Topeka, Kansas. This is a total of 10,560 miles. Then 2,546 miles must be added for final delivery to dealers as illustrated in Table 13. The total mileage is 13,106 miles. At the current rate of 24.5 cents per mile, the total freight cost is \$3,210.97. The labor cost for loading of trucks is \$216.00 for 16 loads. For 7,641 bags of seed, this amounts to a total delivery cost of 43.2 cents per bag of seed.

At the present time, the rail boxcar method of shipping seed would not be economically practical. There is also another disadvantage in rail boxcar shipment of seed. It has been found that on boxcar loads of 1600 bags of seed, damage loss will be as high as six percent.¹ This damage loss would amount

¹Analysis of Acco Seed's experience in shipping seed by boxcar.

TABLE 12
 DISTANCE COMMODITY RATES
 SEED IN SACKS
 (IN CENTS PER 100 POUNDS)

Distance In Miles	Minimum Weight (In Pounds)			Distance In Miles	Minimum Weight (In Pounds)		
	LTL	10,000	25,000		LTL	10,000	25,000
5	29	19	14	285	66	56	42
15	29	19	14	295	67	57	43
25	31	21	16	305	68	58	44
35	33	23	18	315	69	59	44
45	34	24	19	325	70	60	45
55	36	26	21	335	71	61	46
65	38	28	22	345	72	62	46
75	40	30	24	355	73	63	47
85	42	32	25	365	74	64	48
95	44	34	27	375	75	65	49
105	46	36	28	385	76	66	50
115	48	38	29	395	77	67	51
125	50	40	30	405	78	68	52
135	51	41	31	415	79	69	53
145	52	42	32	425	80	70	54
155	53	43	33	435	81	71	55
165	54	44	33	445	82	72	56
175	55	45	34	455	83	73	57
185	56	46	35	465	84	74	58
195	57	47	36	475	85	75	59
205	58	48	37	485	86	76	60
215	59	49	38	495	87	77	61
225	60	50	38	515	88	78	62
235	61	51	39	535	89	79	63
245	62	52	40	555	90	80	64
255	63	53	40	575	91	81	65
265	64	54	41	600	92	82	66
275	65	55	42				

Source: Kansas Motor Carriers Association Motor Freight
 Tariff No. 50-C.

TABLE 13

COMPUTATION OF TRUCKING COST
HYPOTHETICAL CASE OF BOXCAR AND TRUCK COMBINATION
DEALER DELIVERY

Route	Mileage	Bags of Seed	Weight	Rate Per CWT	Total Cost Per Route
1	179	506	25,300	35¢	\$ 88.55
2	268	503	25,150	42¢	105.63
3	303	489	24,450	58¢	141.81
4	224	481	24,050	50¢	120.25
5	138	500	25,000	32¢	80.00
6	138	500	25,000	32¢	80.00
7	138	500	25,000	32¢	80.00
8	130	500	25,000	31¢	77.50
9	130	500	25,000	31¢	77.50
10	100	500	25,000	28¢	70.00
11	100	500	25,000	28¢	70.00
12	100	500	25,000	28¢	70.00
13	169	465	23,250	45¢	104.63
14	144	500	25,000	32¢	80.00
15	94	500	25,000	27¢	67.50
16	201	197	9,650	58¢	56.07
Total	2,546	7,641			\$1,369.44

Cost per Bag of Seed -- 17.9 cents

Cost per Mile Traveled -- 53.8 cents

Source: Tables 11 and 12.

TABLE 14

TOTAL COSTS
HYPOTHETICAL CASE OF BOXCAR AND TRUCK COMBINATION
DEALER DELIVERY

	Number of Bags of Seed	Cost per Bag of Seed	Total Cost
Boxcar	7,641	31.1¢	\$ 2,376.35
Truck	7,641	17.9¢	1,369.44
Total	7,641	49.0¢	\$ 3,745.79

Source: Tables 10 and 13.

to as much as 96 bags of seed, valued at \$782.40.¹ It has been found that loading boxcars with only 1000 bags of seed will reduce damage losses to two percent.² This damage loss is due to bag movement inside of the boxcar. The paper bags used to hold seed are slick and with bags piled one upon another, there is considerable movement of bags as the car travels. This is especially true when a boxcar is "humped" in a sorting yard.

Even if damage loss is fully paid by the railroad, the problem of seed shortage to final delivery point presents a problem. By comparison, the damage loss on the present methods of motor truck delivery is .1 percent.²

The previous information presented indicates that a different result could be achieved if rail spurs were available for direct loading of boxcars and if boxcars were to arrive at the loading point in serviceable condition. There is also the problem of damage loss, which is a packaging and/or equipment design problem. It is possible that by a change in packaging and/or boxcar design, damage loss could be reduced to current truck levels.

If the fore mentioned problems could be corrected, then a set of external factors would dictate the success of this type of delivery. These factors are:

¹Value based on sorghum seed at an approximate wholesale price of \$8.15 per bag.

²Actual damage losses for Acco Seed's 1970 dealer deliveries.

- (1) Having available labor to unload boxcars at rail destination points.
- (2) Having available motor trucks for final delivery to retail dealers.
- (3) Having proper service provided by the railroad so that a boxcar would arrive at its destination point when scheduled.

As these factors are controllable by prior planning, it is possible that if changes were made in packaging and/or equipment design, rail boxcar shipment could be a possible alternative mode of shipping seed. There was no comparison made on corn seed shipments between the Weeping Water, Nebraska, plant and sales district 163. Because of the shorter distance involved, it is unlikely that rail shipment can compete with the cost of direct truck delivery.

Rail Shipment--Trailer on Flatcar

One of the new devices in moving freight is the innovation of transporting of motor trailers on railroad flatcars. This service is commonly known as piggy-back or T.O.F.C.

At the present time, five different plans are in use. Under Plan I the railroad transports the loaded trailers of motor carriers, the shipments moving on motor carrier rates. The railroad either receives a division of the rates or makes a flat charge per trailer. Under Plan II, the freight moves on railroad billing at railroad rates in railroad-owned trailers. The rate includes pickup and delivery of trailers. Under Plan III, the railroad furnishes the flatcars; the shipper or forwarder furnishes the trailers, providing his own pickup and

delivery service. The railroad loads the trailers on flatcars and unloads them. Plan IV requires the shipper to provide both the flatcars and the trailers. The railroad merely hauls the flatcars, empty or loaded, from point to point. Plan V provides for the movement of commodities in T.O.F.C. service on through routes and joint rail-truck rates. Under this plan the railroads publish tariffs for joint motor-rail rates for complete door-to-door piggyback service.

There are no loading ramps for the loading of trailers on flatcars at any of Acco Seed's processing plants. Therefore, a hypothetical case shall be developed to determine if any of the above listed T.O.F.C. plans are useable for the transport of bagged seed. The shipping point will be Leoti, Kansas, and the destination point, Topeka, Kansas. Abilene, Kansas, could not be included as a destination point as the Missouri-Pacific Railroad cannot enter Abilene, Kansas, with T.O.F.C. service. Any of the T.O.F.C. plans that seem to be feasible will be compared to present shipping methods.

T.O.F.C. Plan I

This plan is not feasible because it would prove unworkable. Common carriers would not haul agricultural exempt products at the current prevailing rates, except for backhauls. Under the backhaul situation, the tractor is already attached to the trailer and there is no advantage of using T.O.F.C. service under Plan I. Also, the seasonal nature of shipping seed requires a peak use of transport vehicles in a short time

span. This feature would also rule out the use of Plan I because the amount of vehicles necessary could probably not be collected to the correct shipping points.

T.O.F.C. Plan II

Under Plan II, the destination point used is Topeka, Kansas. The Abilene, Kansas, destination point previously used in the rail boxcar alternative cannot be used here because the Missouri-Pacific Railroad is not allowed to enter Abilene, Kansas, under T.O.F.C. plans.

The rate to Topeka, Kansas, from Leoti, Kansas, is 52 cents per hundredweight for a minimum of 70,000 pounds and 45 cents per hundredweight for all weight in excess of 70,000 pounds.¹ This amount of weight is limited to two trailers. Two 32-foot trailers are used, each having a capacity of 800 bags of sorghum seed with a total weight of 80,000 pounds.

Table 15 lists the costs involved in T.O.F.C. versus current motor truck delivery to the rail destination point of Topeka, Kansas. Labor cost is based on 19.2 man-hours to load two trailers at \$2.25 per hour average wage rate. Under this plan the Missouri-Pacific Railroad does not pickup or deliver the trailers.² The drayage charge to move trailers to the loading ramp at the point of shipment is \$15.00 for two

¹Missouri-Pacific Railroad Plan II½ T.O.F.C. all Freight Rates, SWL Tariffs 74,77,79,80,82 and WTL Tariffs 445,453,455.

²Ibid.

trailers.¹ It is found in Table 15 that the cost per bag of T.O.F.C. service to Topeka, Kansas, is definitely the least-cost method of shipment.

TABLE 15
COST COMPARISON
T.O.F.C. PLAN II VERSUS CURRENT MOTOR TRUCK DELIVERY
DESTINATION, TOPEKA, KANSAS

	T.O.F.C. (1600 Bags of Seed)	Truck (500 Bags of Seed)
Freight Cost	\$ 409.00	\$ 161.70
Labor Cost	43.20	13.50
Drayage Cost	15.00	
Total Cost	<u>\$ 452.20</u>	<u>\$ 175.20</u>
Freight Cost per Bag	25.6¢	32.3¢
Labor Cost per Bag	2.7¢	2.7¢
Drayage Cost per Bag	<u>.9¢</u>	
Total Cost per Bag	29.2¢	35.0¢

Again, there is a factor that would affect final delivery cost to dealers. This is the cost of labor and semi-tractor rental to make final delivery from the rail destination point. A hypothetical set of delivery routes were devised using the same retail dealers and same amounts of seed as used in the rail boxcar case. These routes are detailed in Table 16. The constraint is 800 bags of seed per trailer, allowing for the movement of 15 bags of seed or less from one trailer to another

¹Based on a quote by local trucking firm.

TABLE 16

HYPOTHETICAL DELIVERY ROUTES
T.O.F.C. FINAL DEALER DELIVERY
RAIL DESTINATION POINT, TOPEKA, KANSAS

Route	Dealer	Bags of Seed	Mileage per Route
1	Theel	35	303
	Henton	73	
	Krohn	162	
	Fairbanks	35	
	Bennett	201	
	Domann	66	
	Smoots	121	
	Schoonover	25	
	Lynn	35	
	Bailey	48	
2	Flinn	48	393
	Massey	49	
	Markley	133	
	Holloway	76	
	Smith	90	
	Jones	91	
	Bratton	80	
	Hutchinson	37	
	Miller	91	
	Crady	40	
3	Gerstenberger	33	138
	Blum	36	
4	Pracht	800	130
5	Sergeant	800	100
6	Thompson	800	100
7	Thompson	800	138
8	Pracht	113	201
	Thompson	341	
	Sergeant	157	
9	Davis	198	266
	Lyddane	26	
	Pracht	307	
	Turner	7	
	Birk	192	
10	Micheals	40	94
	Dubois	655	
	Hicks		

Total Bags of Seed -- 7,641

TABLE 17

COMPUTATION OF COST
SEMI-TRACTOR RENTAL AND LABOR
HYPOTHETICAL T.O.F.C. CASE, FINAL DEALER DELIVERY

Route	Bags of Seed	Mile- age	Hours	Truck Mileage Cost	Truck Hourly Cost	Drivers Cost	Total Truck Cost	Total Cost
1	801	303	10.1	\$ 48.48	\$ 80.80	\$ 34.34	\$129.28	\$163.62
2	804	393	13.1	62.88	104.80	44.54	167.68	212.22
3	800	138	4.6	22.08	36.80	15.64	58.88	74.52
4	800	130	4.3	20.80	34.40	14.62	55.20	69.82
5	800	100	3.3	16.00	26.40	11.22	42.40	53.62
6	800	100	3.3	16.00	26.40	11.22	42.40	53.62
7	800	138	4.6	22.08	36.80	15.64	58.88	74.52
8	611	201	6.7	32.16	53.60	22.78	85.76	108.54
9	770	266	8.9	42.56	71.20	30.26	113.76	144.02
10	655	94	3.1	15.24	24.80	10.54	40.04	50.58
Total 7641 1863								\$1005.08
Cost per Bag -- 13.2 cents								
Cost per Mile -- 53.9 cents								

TABLE 18

TOTAL COST
HYPOTHETICAL T.O.F.C. SEED DELIVERY CASE

	Number of Bags of Seed	Total Cost	Cost per Bag of Seed
T.O.F.C.	7,641	\$ 2,231.17	29.2¢
Final Delivery	7,641	1,005.08	13.2¢
Total	7,641	\$ 3,236.25	42.4¢

Source: Tables 15 and 17.

trailer so a dealer may be delivered all seed due him at one time.

The rental cost for a semi-tractor is \$8.00 per hour plus 16 cents per mile.¹ There is no charge on the trailer for the first 24 hours from the first 8:00 A.M. after notification of arrival. After the expiration of free time, a detention charge of \$10.00 per trailer per day, or fraction of a day, is made until the trailer is returned to the carrier's ramp location at the destination point. Table 17 lists the cost of delivery from the rail destination point to retail dealers. The assumption is made that an average of 30 miles per hour will be maintained to compute the hourly cost of the truck and driver. Driver cost is based upon the rate of \$3.40 per hour.²

Table 18 details the total cost for shipment via T.O.F.C. and final delivery to retail dealers. The assumption is made that 10 trailer loads, carrying 8000 bags of seed are shipped, with 359 bags being warehoused and the balance delivered to dealers.

Table 18 lists the cost of T.O.F.C. and final dealer delivery at 42.4 cents per bag of seed. This is a slight cost advantage over the current truck delivery method of 43.2 cents per bag of seed as listed on page 34. It should be noted, that to make an accurate comparison, the assumption was made that all

¹Rental rates quoted by Ryder Truck Rental, Topeka Kansas.

²Based on an analysis of local wage rates paid for local short-haul drivers, an average union rate of \$3.96 and an average non-union rate of \$2.84.

of the present delivery trucks entered the Topeka, Kansas, rail destination point before delivering seed to retail dealers. In actual delivery of seed this is not true, because trucks will in most cases take shorter routes than the ones described. Under this condition the cost per bag of seed delivered is 39.6 cents as shown in Table 21. This is because actual delivery in this area would reduce miles traveled by 1593 miles.¹ Because there is apparently no way to further reduce costs in T.O.F.C. service, it is concluded that this mode of transport has no economic advantage over the current method of truck delivery of seed.

T.O.F.C. Plan III

The same rates apply to Plan III as previously outlined in Plan II. However an allowance of \$5.00 per calendar day is credited to the shipper for the use of his own trailer. However, in the use of company-owned trailers in the delivery of seed by T.O.F.C., the trailer must be returned to the processing plant for reloading. Since there is no other way to return these trailers because of the lack of a motive unit, these trailers would have to be returned to the processing plant by T.O.F.C. By returning these trailers T.O.F.C., a flat charge of \$287.51 per trailer would be assessed.¹ This return charge

¹Determined by using routes in Table 11 and determining mileage from Leoti, Kansas, directly rather than from Topeka, Kansas.

²Missouri-Pacific Railroad Plan II½ T.O.F.C. All Freight Rates, SWL Tariffs 74,77,79,80,82 and WTL Tariffs 445,453,455.

per trailer would place final delivery of seed under Plan III at 75.5 cents per bag of seed, as illustrated in Table 19. Although there is no drayage charge under this plan and a credit of \$15.00 is allowed for an estimated three days transit time, the cost per bag of seed is so high that this plan is not considered feasible.

TABLE 19
COMPUTATION OF COST
T.O.F.C. PLAN III

	T.O.F.C. (1600 Bags)
Inbound Freight	\$ 409.00
Labor Cost	43.20
Credit for Company Trailers	- 30.00
Final Delivery Cost at 13.2¢ per Bag	211.20
Freight Charge to Return Trailers	<u>575.02</u>
Total Cost	\$1,208.42
Cost per Bag of Seed --	75.5 cents

T.O.F.C. Plan IV

This plan is not considered feasible because the capital investment by the shipper in flatcar ownership for the seasonal shipping of seed would not be a sound investment.

T.O.F.C. Plan V

This plan is determined not feasible as there are no joint-rail truck rates that apply to bagged grain seed.

Inter-plant Shipment by Boxcar and T.O.F.C. Versus Motor Carriers

The alternative modes of transport that have been analyzed for dealer delivery could prove to be sound alternatives for inter-plant shipment over long distances. Table 20 was constructed to develop the costs by modes of transport. These alternative modes of transport are compared to backhaul semi-trailer motor truck and primary haul semi-trailer motor truck.

The rate given for rail boxcars is based on Missouri-Pacific Railroad Commodity Item #42-55-F, Part Two, Supplement 125, WTL Tariff 2005, Rate Base 578. The rates given for the T.O.F.C. Plan II are based on Missouri-Pacific Railroad Plan II½ All Freight Rates, SWL Tariff 74,77,79,80,82 and WTL Tariffs 445,453,455. Backhaul semi-trailer truck rate is based on a 40 cents per mile rate currently being paid by Acco Seed. The rate for primary haul semi-trailer motor truck is based on the Kansas Motor Carriers Association Tariff Number 50-C. Labor loading costs are the same as previously determined. The drayage cost listed applies to T.O.F.C. transport for the movement of trailers to and from loading ramps.

Because of the different capacity of carriers, the results must be analyzed on the per bag basis. It is found that the least-cost methods are T.O.F.C. Plan II, primary haul semi-trailer motor truck, and backhaul semi-trailer motor truck.

The cost difference between these carriers amounts to only .8 cents per bag, with the T.O.F.C. Plan II having the slight cost advantage.

It should be noted that if railroads would provide rail spur service and equipment in good condition, the labor costs shown in Table 20 could be considerably reduced. Also, if package design and/or equipment design were altered to lower damage losses, rail boxcar shipment in lots of 1600 or more bags of seed could conceivably be the most economical method to ship seed between processing plants. If this were to prove true, inventory control in warehousing at processing plants would have to be altered to take into consideration the time necessary to move a boxcar over this route as compared with motor truck. If two-day rail service could be provided, this would compare favorably with present truck shipment. At the present time, the minimum time of rail movement between these two points is four days, with the average time of movement being six days.¹ This time of movement problem could conceivably prevent the use of this method except as a preseason shipment form of transport. It is also possible that a different processing time schedule could eliminate this problem.

This time of movement problem is present in T.O.F.C. service. Although this mode of transport has a slight cost advantage over semi-trailer motor carriers, the same time of

¹From an analysis of farm machinery shipped by boxcar and flatcar over a comparable route.

TABLE 20

COST COMPARISON
INTER-PLANT SHIPMENT BY BOXCAR, T.O.F.C., AND SEMI-TRAILER MOTOR TRUCK
BELMOND, IOWA TO LEOTI, KANSAS

	Boxcar (1600 Bags)	Boxcar (1000 Bags)	T.O.F.C. Plan II (1600 Bags)	Backhaul Semi-trailer (800 Bags)	Primary Haul Semi-trailer (800 Bags)
Rate	70¢ CWT	84¢ CWT	66¢ CWT 59¢ CWT	40¢ Mile	70¢ CWT
Minimum Weight (Pounds)	60,000	40,000	70,000	N/A (703 Miles)	25,000
Full Load Weight (Pounds)	80,000	50,000	80,000	40,000	40,000
Labor					
Loading Cost	\$ 209.80	\$ 130.50	\$ 43.20	\$ 21.60	\$ 21.60
Drayage Cost			30.00		
Freight Cost	560.00	420.00	521.00	281.20	280.00
Total Cost	\$ 769.80	\$ 550.50	\$ 594.20	\$ 302.80	\$ 301.60
Labor Cost					
Per Bag	13.1¢	13.1¢	2.7¢	2.7¢	2.7¢
Freight Cost					
Per Bag	30.1¢	42.0¢	34.4¢	35.2¢	35.0¢
Total Cost					
Per Bag	43.1¢	55.1¢	37.1¢	37.9¢	37.7¢
Estimated Damage Loss	6.0%	2.0%	N/A	.1%	.1%

movement differential applies as stated for rail boxcar shipment. Unless drayage cost could be eliminated and time of movement service quite drastically improved, the slight cost advantage held by T.O.F.C. service is of small consequence.

The costs of the rail boxcar carrying 1000 bags of seed are so high as to eliminate this alternative mode of transport from any further consideration.

Conclusions

Table 21 details a cost comparison of the present mode of transport and the alternative modes of transport discussed in this chapter. The costs per bag of seed are detailed by labor, freight, and final delivery costs.

In rail boxcar shipment, the 1000-bag car is hereby eliminated because it is the highest cost method of any of the modes of transport listed. However, the 1600-bag rail car-load holds some possibility of future use. If the labor cost could be lowered to 2.7 cents per bag by the provision of serviceable boxcars and rail spurs, the total cost of shipment per bag of seed could be reduced to 39.1 cents. Also damage loss would have to be eliminated and time of movement imposed as previously discussed. These factors are elements of railroad service and equipment and package design problems; all of which are solvable.

T.O.F.C. service as previously discussed is not a least-cost economic alternative to the current method of motor truck delivery. It also has another disadvantage in that the time of movement over rail lines cannot be controlled by the shipper.

TABLE 21

COST COMPARISON
ALL TRANSPORT MODES, DEALER DELIVERY
RAIL DESTINATION POINT, TOPEKA, KANSAS

	Current Method Truck Delivery	Boxcar	Boxcar	T.O.F.C. Plan II	Truck Delivery Comparison Case
Bags of Seed Per Load	500	1600	1000	1600	500
Labor Cost	\$ 213.50	\$ 209.80	\$ 130.50	\$ 43.20	\$ 13.50
Drayage Cost				15.00	
Freight Cost	184.50	296.00	247.50	409.00	161.70
Final Dealer Delivery Cost		286.40	179.00	211.20	41.00
Total Cost	\$ 197.00	\$ 792.20	\$ 557.00	\$ 678.40	\$ 216.20
Labor Cost Per Bag	2.7¢	13.1¢	13.1¢	2.7¢	2.7¢
Freight Cost Per Bag	36.9¢	18.5¢	24.8¢	26.5¢	32.3¢
Final Dealer Deliv- ery Cost Per Bag		17.9¢	17.9¢	13.2¢	8.2¢
Total Cost Per Bag	39.6¢	49.5¢	55.7¢	42.4¢	43.2¢
Damage Loss	.1%	6.0%	2.0%	N/A	.1%

Source: Tables 10, 13, 15, 17.

There is the problem of return seed. This is a factor which would dictate a choice in transport alternatives. The cost of returning seed by any of the previous listed modes of transport would be approximately on the same cost comparison, but at higher cost per bag of seed. This is because more miles must be traveled with a smaller amount of seed. The present method of transport is more favorable for the pickup of return seed because no time limits have to be met as in the case of railroad demurrage costs.

Since none of the alternative modes of transportation examined have a significant cost advantage over the present method of delivering seed to retail dealers, there are no influences in warehousing, processing, dealer delivery, or sales district operations that can be examined. The only influences asserted by the alternatives examined are those discussed in the use of alternative modes of transport in inter-plant shipment of seed.

CHAPTER IV

ALTERNATIVE METHODS OF OPERATION

Given existing delivery conditions and 1970 transportation rates by available carriers, motor trucks are apparently the least-cost carrier in the delivery of seed to retail dealers. However, improvement in this method of transport could conceivably result in additional savings in physical distribution.

One of the major areas in which improvement can be made is the routing of these carriers. Routing may be defined as the determination of paths or routes over which to dispatch goods. The typical methods in use today is one of trial and error, and generally consists of looking at a map, picking out routes consistent with available carrier capacities, and then by trial and error attempting to find shorter routes.

Problem

Basically the problem is one of determining routes so that some objective is optimized and the restrictions on the system satisfied. An example of this type of problem would be to determine routes where distance traveled is a minimum with the following conditions being satisfied.

- (1) All demands are supplied.
- (2) The distance that can be traveled on each route is limited.
- (3) The carriers may have different capacities.

The problem is concerned with the determination of the shortest route which passes through each of N given points once.

Assuming that each pair of points is joined by a link, the total number of different routes through N points is $\frac{1}{2}N!$; where N is the number of stops and each route is reversible. Even for small values of N the total number of routes is exceedingly large, e.g., for $N=15$, there are 653,837,184,000 different routes.¹ According to Churchman, Ackoff, and Arnoff, for 20 stops on a route, a computer programming a sequence per micro-second and working eight hours per day, 365 days per year, would take about 250,000 years to find a solution.² Since the truck dispatcher faces a number of alternatives as he proceeds to schedule deliveries, the calculation of distance for each possible route is impossible under actual operating conditions.

The most elementary type of routing problem is that of selecting a sequence of stops when the stops on that route are given. This is generally referred to in the literature as the "traveling salesman problem".³ The only condition imposed is that a given set of delivery stops be joined by a route having the shortest distance.

Since delivery points in the physical distribution of hybrid seed are too numerous to be included in one trip, a

¹G. B. Dantzig and J. H. Ramser, "The Truck Dispatching Problem," Management Science, VI (October 1959), p. 80.

²C. West Churchman, Russell L. Ackoff, and Leonard Arnoff, Introduction to Operations Research (New York: John Wiley and Sons, Inc., 1957), p. 472.

³Dantzig, loc. cit.

multiple route problem exists. Also, the total quantity involved is also greater than can be loaded on one carrier. A carrier allocation system developed by L. W. Schruben, professor of Agricultural Economics, Kansas State University, Manhattan, Kansas, has been selected to be applied to determine routes that should be used in the delivery of seed by Acco Seed. This system is known as the Lockset Method of Sequential Programming.

This carrier allocation system was selected because it (1) selects the stops to be incorporated into each route set, (2) determines the sequence of stops within each route set, and (3) assigns a carrier to be used in servicing each route. Capacity and distance restrictions are imposed by the physical nature of the delivery vehicle and work policies affecting driving hours.

This program will put problems of large size into the computer and return them quickly; or it can be used on an intermittent basis. This program also provides the ability to (1) simulate combinations of product, inventory, loading, routing, and unloading operations, (2) balance work assignments, (3) measure costs of adding or subtracting customers, and (4) measure the relative value of different kinds of equipment.

The objective of the Lockset Method is to minimize the total distance traveled by all carriers; achieving this objective also tends to use the minimum number of carriers. Minimization is not subject to mathematical proof, but results can

be tested by comparing ex-post routings actually used under operating conditions. In actual operation, the application of this method is an aid for the truck dispatcher and not his replacement. There are many considerations which a dispatcher can easily apply once he has before him a suggested solution.

Procedure

The procedure for the use of this program is to develop a matrix showing the distance between the shipping origin and all delivery points and the distance between each pair of delivery points. A hypothetical distance matrix is illustrated in Table 22.

The procedures for solving a multiple route problem are:

- (1) To examine the delivery order list to see if any stops require a quantity larger than the capacity of the largest carrier. If so, the largest carrier is assigned to deliver a full load to those stops. A notation is made on the delivery list that the balance is to be delivered as a partial load on another route.
- (2) To compute the distance-saved coefficient for each pair of stops not connected with the origin. The distance-saved coefficient is the distance to be saved by serving a pair of stops on the same route compared with the distance required to service each stop on a separate route.
- (3) To consider joining the pair of stops having the largest distance-saved coefficient value.
- (4) To test the revised route for feasibility. Four tests are required. The four tests are as follows:
 - (a) Each stop must have at least one leg connected with the origin.
 - (b) Each stop must have previously been on a different route.

TABLE 22
HYPOTHETICAL DISTANCE MATRIX

From To	Plant	Point 1	Point 2	Point 3	Point 4	Point 5
Point 1	30					
Point 2	32	56				
Point 3	40	63	51			
Point 4	45	48	74	41		
Point 5	47	42	50	86	85	
Point 6	53	65	75	26	23	99

Source: Leonard W. Schruben and Ruth E. Clifton, "The Lockset Method of Sequential Programming Applied to Routing Delivery and Pickup Trucks," American Journal of Agricultural Economics, Vol. 50, No. 4 (November 1968).

- (c) A carrier of sufficient size must be available to carry the combined load.
 - (d) A carrier capable of traveling the required distance must be available.
- (5) To select from the remaining pairs of stops the one to consider joining on the same route. The pair of stops with the largest distance-saved coefficient not previously tested is selected. If this pair meets all four tests as stated in step 4 and the carrier assigned to this route is capable of hauling the additional load, then this stop is added to the route. This procedure is repeated until all pairs have been considered. As each succeeding pair is accepted or rejected, consideration is shifted to the remaining pair having the largest distance-saved coefficient. If the pair meets all four tests, it is accepted; if not, it is rejected. When all pairs have been considered, the "feasible-rational"

solution is identified and carriers have been assigned to each route. Carrier assignments may be changed as they are not locked to routes; only the links connecting points are locked.

Application of the Lockset Method of Sequential Programming

To determine if this program is applicable to the delivery of seed to retail dealers, it will be applied to retail dealer seed delivery in sales district 163 in 1970. This program will also be applied to larger capacity motor trucks to determine if the use of larger capacity motor trucks has an advantage over the present carrier size.

The following information was compiled:

- I. Customer Orders
 - A. Dealers to whom seed is to be delivered.
 - B. Amount of seed to be delivered to each dealer.
- II. Carrier List
 - A. Carriers that will be available for delivery of seed.
 - B. Maximum size and distance capability of carriers.
- III. Numerical Model of Customer Location
 - A. Distance of each dealer from processing plants.
 - B. Distance between each pair of dealers.

The amount of seed to be delivered to each dealer is listed in Tables 23 and 24. Table 23 lists the amount of sorghum seed to be delivered to each dealer and Table 24 lists the amount of corn seed to be delivered to each dealer.

Carrier availability was provided by a truck schedule similar to the truck schedule illustrated in Fig. 4. The maximum size of carrier was a straight tandem-axle motor truck with the capacity of 470 bags of corn seed or 500 bags of sorghum seed. There was no maximum distance restriction.

TABLE 23
DEALER SEED DELIVERY
SORGHUM SEED
1970

Dealer	Number of Bags of Seed Shipped	Dealer	Number of Bags of Seed Shipped
Affolter	151	Kepple	14
Allaman	567	Krohn	162
Agr. Src. Cnt.	30	Lyddane	198
Bailey	48	Lynn	35
Bennett	201	Markley	133
Birk	7	Massey	49
Blum	36	Micheals	192
Biehler	150	Miller	91
Bratton	80	Nagely	350
Brenner	147	Nelson	273
Constable	80	Pracht	1,626
Crady	40	Ramsey	110
Davis	157	Schoonover	25
Doberer	420	Sergeant	1,141
Domann	66	Sheedy	1,701
Fairbanks	35	Smith	90
Flinn	48	Smoots	121
Gerstenberger	33	Tate	130
Henton	73	Theel	35
Hicks	735	Thompson	1,713
Hillan	56	Timm	568
Hollen	714	Turner	307
Holloway	76	White City Gr.	66
Hutchinson	37	Wolf	728
Johnson	167	Dubois	40
Johnston	86		
Jones	91	Total	14,229

Source: Acco Seed, Division of Anderson, Clayton and Company.

TABLE 24
DEALER SEED DELIVERY
CORN SEED
1970

Dealer	Number of Bags of Seed Shipped	Dealer	Number of Bags of Seed Shipped
Affolter	3	McPherson	95
Agr. Svc. Cnt.	10	Markley	72
Allaman	52	Massey	22
Bailey	43	Micheals	49
Birk	19	Miller	107
Biehler	52	Nagely	20
Blaker	50	O'Keefe	162
Bratton	61	Nelson	48
Crady	64	Pletcher	79
Davis	49	Povenmire	45
Doberer	29	Pracht	675
Domann	453	Ramsey	32
Dziadura	99	Schafer	117
Fairbanks	57	Schoonover	45
Gerstenberger	283	Sergeant	321
Henton	8	Sheedy	235
Hanson	97	Smith	60
Hicks	115	Smoots	279
Holloway	63	Tate	48
Hutchinson	105	Thompson	500
Johnson	33	Turner	241
Jones	39	Wolf	177
Krohn	19		
Lyddane	91	Total	5,323

Source: Acco Seed, Division of Anderson, Clayton & Company.

A numerical model of dealer to dealer distance in miles and dealer to plant distances in miles was designed.

This information was entered into the Lockset Method of Sequential Programming and by computer analysis a set of routes was determined.

Results

Table 25 presents the delivery of sorghum seed to sales district 163 as it was delivered in 1970. Table 26 presents the delivery of corn seed to sales district 163 as it was delivered in 1970. These tables list the load number, date of delivery, number of stops per route, number of bags of seed per route, miles traveled per route, and the cost per route based upon trucking rates previously discussed.

Tables 27 and 28 present the routes determined by the Lockset Method of Sequential Programming. The type of information listed in these tables is the same as in Tables 25 and 26. Table 27 lists the routes determined by the Lockset Method of Sequential Programming for the delivery of sorghum seed to dealers. In comparing these results to actual shipment as shown in Table 25, it is found that 30 loads would have delivered the amount of seed rather than the 31 loads used. Dealer stops were reduced from 99 to 68 and mileage was reduced from 22,273 miles to 18,683, a reduction of 3,590 miles. Because of the reduction in miles traveled, sorghum seed trucking costs could have been reduced from \$5,305.64 to \$4,467.78. This is a savings of \$837.86 or 5.8 cents per bag of seed delivered.

TABLE 25
SORGHUM SEED DEALER DELIVERIES
LEOTI PROCESSING PLANT TO SALES DISTRICT 163
1970

Load	Date	Number of Stops	Number of of Bags of Seed	Miles Traveled	Cost
1	3-4	3	500	648	\$ 158.76
2	3-6	1	500	513	125.69
3	3-10	3	500	738	180.81
4	3-11	1	500	500	122.50
5	3-13	2	500	558	136.71
6	3-16	1	500	524	128.38
7	3-17	1	505	697	170.77
8	3-17	3	258	658	151.34
9	3-18	1	500	741	181.55
10	3-19	4	290	844	194.12
11	3-20	2	500	678	166.11
12	3-20	1	500	660	161.70
13	3-21	2	290	869	199.87
14	3-23	3	505	605	148.23
15	3-23	2	483	657	154.40
16	3-24	1	500	570	139.65
17	3-25	9	500	877	214.87
18	3-27	5	449	709	163.07
19	3-30	5	469	759	174.57
20	3-30	2	499	631	151.44
21	3-31	7	509	881	197.72
22	3-31	2	271	738	169.74
23	4-1	2	500	700	171.50
24	4-1	1	270	732	168.36
25	4-3	3	512	789	193.31
26	4-6	2	517	668	163.66
27	4-7	8	505	1,036	253.82
28	4-8	1	467	608	160.54
29	4-10	9	461	1,005	231.15
30	4-13	4	480	632	148.52
31	4-14	8	489	948	222.78
Total		99	14,229	22,273	\$5,305.64

Source: Acco Seed, Division of Anderson, Clayton and Company.

TABLE 26
CORN SEED DEALER DELIVERIES
WEEPING WATER PROCESSING PLANT TO SALES DISTRICT 163
1970

Load	Date	Number of Stops	Number of of Bags of Seed	Miles Traveled	Cost
1	2-11	5	471	471	\$ 108.33
2	2-18	6	439	561	129.03
3	2-25	4	444	488	112.24
4	3-4	6	476	609	140.07
5	3-7	15	450	600	138.00
6	3-7	11	488	750	176.25
7	3-11	4	465	395	90.85
8	3-18	8	473	672	154.56
9	3-21	7	467	742	170.66
10	3-25	8	322	663	152.49
11	4-1	16	344	908	208.84
12	4-1	3	484	435	102.23
Total		79	5,323	7,294	\$1,683.55

Source: Acco Seed, Division of Anderson, Clayton and Company.

TABLE 27

TRUCK ROUTES FOR SORGHUM SEED SHIPMENTS
 LOCKSET METHOD OF SEQUENTIAL PROGRAMMING

Load	Number of Bags of Seed	Number of Stops	Miles Traveled	Cost
1	273	1	438	\$ 100.74
2	447	5	788	181.24
3	429	2	536	123.28
4	500	1	502	122.99
5	500	1	502	122.99
6	500	1	502	122.99
7	500	1	524	128.38
8	467	4	634	145.82
9	420	1	594	136.62
10	500	1	592	145.04
11	465	3	657	151.11
12	500	1	552	135.24
13	350	1	502	115.46
14	457	5	706	162.38
15	500	1	528	129.36
16	471	3	694	159.62
17	500	1	584	143.08
18	500	1	584	143.08
19	500	1	584	143.08
20	471	4	732	168.36
21	500	5	743	182.04
22	500	1	652	159.74
23	500	1	648	158.76
24	500	1	648	158.76
25	500	1	648	158.76
26	500	1	616	150.92
27	500	1	616	150.92
28	495	6	814	195.36
29	488	3	692	162.62
30	496	9	871	209.04
Total	14,229	68	18,683	\$4,467.78

TABLE 28

TRUCK ROUTES FOR CORN SEED DELIVERY
LOCKSET METHOD OF SEQUENTIAL PROGRAMMING

Load	Number of Bags of Seed	Number of Stops	Miles Traveled	Cost
1	417	6	478	\$ 109.94
2	405	6	444	102.12
3	470	1	413	94.99
4	457	5	494	113.62
5	444	3	465	106.95
6	396	2	363	83.49
7	465	8	642	147.66
8	445	5	534	122.82
9	453	1	330	75.90
10	466	6	478	109.94
11	405	3	453	104.19
12	500	1	455	111.48
Total	5,323	47	5,549	\$1,283.10

Table 28 lists the routes determined by the Lockset Method of Sequential Programming for the shipment of corn seed to dealers. The results, as compared to actual delivery in Table 26, show no reduction in the number of loads. However, the number of stops was reduced from 79 to 47 stops. Mileage was reduced from 7,294 miles to 5,549 miles for a reduction of 1,745 miles. Due to the reduction of miles traveled, costs of trucking corn seed could have been reduced from \$1,683.55 to \$1,283.10 for a saving of \$400.45.

Application of Results

To apply the results from the Lockset Method we must first state the costs of shipping to warehouses located in sales district 163 in 1970. Warehouses were located at Lebo, Woodbine, Abilene, and Leonardville, Kansas. The amount of seed shipped to these warehouses was 4,759 bags. This seed was shipped from the Leoti Processing Plant. The trucking cost for the shipment of seed to these warehouses was \$3,514.60.

Table 29 illustrates that by use of the Lockset Method of truck routing it is possible to reduce trucking costs in the delivery of seed. In delivery to dealers, a 6.3 cents per bag saving could have been realized through the use of this system. In total seed shipment to sales district 163, a 5.1 cents per bag saving could have been realized even with the extremely costly warehouse shipments. This saving is significant in that it is a reduction of 11.8 percent in per bag cost of truck delivery.

External Factors

There were two external forces in operation in the 1970 spring season. These external forces account for the high cost of seed shipment to warehouses located in sales district 163 as shown in Table 29. One external factor was the weather situation. Rainfall in excess of normal rainfall pattern delayed sorghum planting. Because of this, shorter maturity sorghums were required. These were shipped into warehouse locations for delivery to dealers by the district sales manager.

TABLE 29
 COST COMPARISON, DEALER DELIVERIES
 SALES DISTRICT 163, 1970
 ACTUAL DELIVERY VERSUS LOCKSET METHOD ROUTES

	Total Cost	Cost per Bag of Seed	Number of Bags of Seed
1970 Actual Dealer Deliveries	\$6,989.19	35.7¢	19,552
1970 Warehouse Deliveries	<u>3,514.60</u>	<u>78.3¢</u>	<u>4,759</u>
Total	\$10,503.79	43.2¢	24,311
Lockset Method Truck Routes	\$ 5,750.88	29.4¢	19,552
1970 Warehouse Deliveries	<u>3,514.60</u>	<u>78.3¢</u>	<u>4,759</u>
Total	\$9,265.48	38.1¢	24,311
Savings Dealer Delivery	\$1,238.31	6.3¢	19,552
Warehouse Delivery	<u>---</u>	<u>---</u>	<u>4,759</u>
Total	\$1,238.31	5.1¢	24,311

Source: Tables 25, 26, 27, and 28.

The other external factor that was in operation was the market situation. In this sales district, Acco Seed's percentage of the market was rising rapidly. Sales moved from approximately six percent of the market in January to well over nine percent by May 1. This increase was larger than anticipated in the sales forecast for this area. Consequently, it was impossible to estimate final total sales and as a result more seed was shipped to district warehouses than necessary. In an

attempt to control the amount of seed being shipped to warehouses, trucks usually carried half-loads. This caused a higher cost per bag of seed and was ultimately found to be a mistake.

Conclusions on Lockset Method of Sequential Programming

Even with the external forces operating as described, a saving in delivery costs could have been realized by the use of the Lockset Method of Sequential Programming to determine truck routes.

Other adjustments must be made in sales procedures in the use of this carrier allocation program. These are sales controls which must be initiated by the district sales manager. There must be put into effect a control that will prevent dealer and district warehouse overstocking. This will prevent excessive seed being delivered and high rates of returned seed. This control must be initiated by a study of the prevailing market. The factors that must be considered are an increase or decrease in farmer planting intentions, government farm programs, and the percentage of the market the firm is attempting to attain.

The use of the Lockset Method of truck routing has enabled Acco Seed to have an improved delivery service to retail dealers within sales district 163. With the distance model available, time of delivery may be closely calculated. Therefore a dealer may be informed of the approximate time of truck arrival. This is a psychological factor in the firm's relationship with the

dealer and tends to give the dealer a more favorable view of the firm. The result of this improved relationship with the firm has in several cases increased sales made by dealers.¹

It is assumed that the Lockset Method of truck routing would effect the same savings on the cost of seed return as on the cost of seed delivery. This would be a reduction in costs of 6.3 cents per bag of seed returned. Table 30 is developed to illustrate the savings achieved by this carrier allocation system. As compared to actual costs listed in Table 7, there would have been a saving of 6.3 cents per bag in physical distribution costs based on gross shipment of seed. The savings per bag of seed, based on net sales, is 7.8 cents per bag. This is a substantial saving of 11.3 percent.

At this writing, 1971 seed deliveries to sales district 163 are two-thirds completed. The delivery routes are devised by the use of the Lockset Method of Sequential Programming. It appears that there will be a substantial cost reduction by the use of this program and sales controls previously discussed.

Carrier Size Determination

To determine if the proper capacity motor truck is currently being used, a larger capacity motor truck will be considered. Semi-trailer motor trucks are eliminated because they are not available in the quantity needed for the transport of seed during the seed shipping season.

¹1971 results using the Lockset Method of truck routing in sales district 163. The psychological frame of mind of several dealers made more conducive to selling seed.

TABLE 30
 PHYSICAL DISTRIBUTION COSTS BY USE OF
 THE LOCKSET METHOD OF SEQUENTIAL PROGRAMMING
 SALES DISTRICT 163
 1970

Type of Cost	Total Cost (dollars)	Cost per Bag (cents)	Bags of Seed
Seed Delivery Trucking Cost	9,265.48	38.1	24,311
Truck Loading Labor Cost	657.40	2.7	24,311
Return Seed Trucking Cost	1,872.19	39.2	4,776
Dealer Warehousing Cost	1,595.85	30.4	5,243
Return Seed Labor Unloading Cost	128.95	2.7	4,776
Gross Shipment Total Cost	13,519.87	55.6	24,311
Net Sales Total Cost	13,519.87	68.9	19,635

Source: Table 7 and 29.

The adaptation of a trailer to the currently used system of straight tandem-axle trucks is an attempt to gain cost reduction by an increase in quantity hauled, yet retain the flexibility of use of the straight tandem-axle truck.

For Kansas, this type of unit would have to conform to an overall length limit of 55 feet. The total load weight limit is 73,200 pounds with distance between first and last axle being a minimum of 43 feet. Since the allowable weight per axle is

16,000 pounds, five axles would be necessary. This would require the use of two axles under the trailer.

This type of unit would not be useable in Minnesota due to lower weight limits. In the following states into which Acco Seed ships seed, the following weight limits in pounds are imposed: Illinois - 73,000; Iowa - 68,500; Nebraska - 69,800; South Dakota - 70,900; Texas - 72,000; Wyoming - 70,900. All other states have the same or larger weight limits than Kansas. The overall length limit as stated previously is the same or greater for all other states into which Acco Seed ships seed. The capacity of this type of motor vehicle is 800 bags of sorghum seed; the truck having a capacity of 500 bags of seed and the trailer unit having a capacity of 300 bags of seed. The seed weight is 40,000 pounds. The truck and trailer have an estimated weight of 18,800 pounds. The total weight for this type of vehicle loaded to full capacity is 58,800 pounds, which is below the weight limits previously listed.

The rate per mile quoted for the delivery of seed to retail dealers is 37 cents per mile.¹ This rate was based on the assumption that the trailer unit would be uncoupled from the truck when completely unloaded and would be picked up by the truck upon the return trip to the processing plant.

To determine if the use of a larger capacity vehicle is feasible, a carrier with the capacity of 800 bags of seed was

¹Quoted by contract haulers currently hauling seed for Acco Seed.

inserted into the Lockset Method of Sequential Programming. The information used to determine routes was the 1970 delivery of sorghum seed to sales district 163 as listed in Table 23.

Table 31 lists the routes as determined by the Lockset method of truck routing. In comparison to routes determined by the Lockset method for a 500-bag capacity carrier as shown in Table 27, it is found that the number of loads necessary is reduced from 30 to 19. The number of stops is reduced from 68 to 59. Miles traveled are reduced from 18,683 to 12,030 for a reduction of 6,653 miles.

Conclusions on Carrier Size

Although there was a significant reduction in mileage by the use of a larger carrier, the trucking cost was reduced by only \$16.68 as illustrated in Tables 27 and 31. To determine if the uncoupling of the trailer after unloading and picking up the trailer on the return trip to the processing plant is feasible, all routes with two or more stops were diagrammed onto a map. It was found that in routes 10, 13, and 19 in Table 31 that an additional 279 miles would have to be traveled to pick up the empty trailer. This mileage would add \$102.76 to the total trucking cost in Table 31. When this cost was added, the larger carrier had a cost disadvantage of \$86.08.

Since there is no significant difference in the cost of either size of carrier, it is possible that this alternative size and type of carrier could be used if the number of current type of motor trucks required could not be obtained. It is

also possible that this alternative size and type of carrier could be used if the time requirement for the shipping of seed indicated the need to ship a smaller number of larger loads in a shorter time span.

TABLE 31

800 BAG CAPACITY MOTOR TRUCK AND TRAILER
SORGHUM SEED DEALER DELIVERY, SALES DISTRICT 163, 1970
ROUTES DETERMINED BY LOCKSET METHOD OF SEQUENTIAL PROGRAMMING

Route	Number of Bags of Seed	Number of Stops	Miles	Cost
1	623	2	508	
2	668	2	552	
3	800	1	502	
4	800	1	502	
5	627	7	650	
6	728	1	524	
7	714	1	592	
8	734	3	657	
9	784	3	556	
10	752	8	774	
11	800	1	584	
12	800	1	584	
13	782	8	841	
14	775	2	660	
15	800	1	648	
16	800	1	648	
17	648	2	632	
18	800	1	616	
19	794	13	1,000	
Total	14,229	59	12,030	\$4,451.10

CHAPTER V

SUMMARY

Available information on the industry suggests substantial distribution cost even though total production and use of hybrid seed by area is reasonably in balance. Comparative costs of use of various rail and truck techniques for delivery of seed to sales district 163 were compared using the current warehousing and processing system and rates currently in use by existing commercial carriers.

Rail carload rates resulted in higher transportation costs because of the increased labor requirement to handle seed. It was found that with improved service, packaging and/or equipment design change, this mode of transport may have an economic advantage for delivery over long distances from processing plants as compared to the current method of motor truck delivery.

The T.O.F.C. service resulted in a slightly higher transport cost than the current method of motor truck delivery. The inability of the shipper to control the time of movement of this type of transport is also a serious disadvantage.

The application of a carrier allocation system to determine routes to be used by the present motor truck form of delivery resulted in a substantial saving in trucking cost. This system also improved delivery service by enabling time of arrival at delivery points to be accurately estimated. Through the use of this system, it became apparent that other procedures in the sales organization of a sales district should be modified.

A carrier size determination problem was processed by application of the carrier allocation system. It was found that in the case of shipping seed there was no cost advantage in using a carrier larger than the current size of motor trucks being used. However, there appeared to be a possible time advantage in that the larger carrier could deliver a greater quantity of seed with a smaller number of loads in a shorter time span than the currently used motor truck.

The results of this case study suggest a need for further study in the hybrid seed industry. The following are suggested for further study:

- (1) A study of industry structure and distribution aimed at reducing overall cost of production and distribution of hybrid seed.
- (2) A study in improvement in service and equipment for rail systems for the longer-distance deliveries.
- (3) A study for changes in packaging, warehousing, sales management, and related techniques to reduce overall cost of distribution.

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A SYSTEMS APPROACH TO DISTRIBUTION: A CASE STUDY IN THE
DISTRIBUTION OF HYBRID CORN AND SORGHUM SEED

by

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1971

The purpose of this paper is to analyze physical distribution of hybrid corn and sorghum seed in a limited segment of the seed industry. Physical distribution costs are high because of the relative concentration of seed production and the expanding area of seed use.

The magnitude of this problem is emphasized by the total amount of hybrid seed used. There is approximately 13.1 million bushels of hybrid corn seed and $3/4$ to 1 million hundredweight of hybrid sorghum seed used annually.

The present distribution system is discussed as to physical organization, sales and physical distribution structure, and procedures. Physical distribution costs are detailed for a specific territory within the seed firm under study.

Alternative modes of transport are compared in delivery of seed by one seed producer to retail dealers within a specified area. The modes of transport of rail boxcar and trailer-on-flatcar shipment are compared to the current method of delivery by motor truck. The modes of transport are also compared by the shipment of seed between processing plants. It is found that at the present time there is no economic advantage in the use of these alternatives. There is a possible use in the future of one of these modes of transport if packaging, equipment design, and service were changed.

A systems approach to routing the current form of motor truck delivery was applied to the delivery of seed to retail dealers in a specified area. This is a system of routing

trucks via a computer analyzed program. It was found there was a definite cost reduction in the use of this program due to the program's ability to originate shorter mileage routes. The other benefits from this program included improved delivery service, and a more accurate control over the amount of seed shipped to retail dealers.

When carrier size was increased there was no economic advantage due to higher mileage rate for shipment, although there was a reduction in miles traveled.

It is found that the emphasis on costs of physical distribution has raised questions concerned with packaging of the product and the nature of transport equipment design. This emphasis on cost has also focused attention on the need in this industry to institute more workable sales control systems.