1 5 6

AN ECONOMIC STUDY OF SYSTEM STRESSES ON THE STORING AND TRANSPORTATION OF KANSAS WHEAT DURING HARVEST

by

WARREN C. MEYER

B.S., Iowa State University, 1976

A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Agricultural Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1978

Approved by:

L. Orlo Sorenson
Major Professor

ACKNOWLEDGMENTS

I would like to express my appreciation to Dr. L. Orlo Sorenson, Major Professor, and to Drs. Milton Manuel and Frank Orazem for their helpful suggestions and constructive criticisms offered by them while serving as committee members.

Also to Miss Cheryl Rowley for her typing of the final manuscript.

To Patricia, my wife, I express appreciation for her encouragement and patience during my graduate work.

THIS BOOK CONTAINS NUMEROUS PAGES WITH DIAGRAMS THAT ARE CROOKED COMPARED TO THE REST OF THE INFORMATION ON THE PAGE.

THIS IS AS RECEIVED FROM CUSTOMER.

TABLE of CONTENTS

LIST of TABLES

LIST of FIGURES

INTRODUCTION

The smooth and timely harvesting of Kansas wheat requires the participants in the grain marketing system to be aware of the relationships existing among the harvesting, storing, and transportation functions at harvest.

Wheat harvest in Kansas places a significant stress upon the grain harvesting and marketing system. Failure of the system to be in harmony results in interruptions occurring in the smooth movement of grain evidenced by congestion at the local level resulting in:

1) lines of farm trucks forming at the local elevator waiting to unload.
2) local elevators not receiving grain because available storage space is filled.
3) combines with full hoppers waiting in the fields for trucks to return from the elevator.
4) grain stored temporarily in farm buildings not designed for grain storage.
5) grain piled on the ground subject to weather and pest damage until suitable storage facilities becomes available.

Delays during wheat harvest are critical for farmers because unharvested fields are susceptible to weather damage, shattering, and loss in quality when left standing after the grain has ripened.

PURPOSE of the STUDY

The harvesting-marketing flow of wheat during the harvest period is facilitated by an interdependent system involving and affected by activities and decisions at several levels or sub-systems. Each sub-system is under separate control and management; each has its own functions within the system; and each has optimization goals for its own sub-system. Functional sub-systems are 1) harvesting and local elevator delivery (farm), 2) local receiving, storing, and/or shipping (local elevator), 3) transportation activities (railroads or motor carriers), and 4) terminal receiving and storing (terminal elevator or processor).

Specific problem approaches to system bottlenecks have tended to focus on specific agencies without conceptualizing a system involving interdependencies and the influence of events or decisions at one level on performance and efficiency at other levels. System disturbances are frequently characterized as "boxcar problems" with implied decision errors when unpredictable and perhaps improbable events at other levels in the system may have generated the problems.

It is the purpose of this study to describe and characterize decisions and decision environment during the wheat harvest throughout the four system stages for a better understanding of alternatives at each decision center under a variety of conditions. Exploring the marketing logistics system will improve our understanding of why problems can occur during harvest and point the way to system changes or bring into focus research areas for possible system improvements.

OBJECTIVES

The specific objectives of this study are to:

1) Identify and describe the sub-systems involved in the flow of Kansas wheat during harvest.
2) Identify and describe potential bottlenecks or system stresses occurring during the harvest flow and system consequences of those bottlenecks or stresses.
3) Identify and evaluate possible alternatives and safeguards available to the participants prior to, or during harvest and costs associated with those alternatives.
4) Identify and evaluate proposals for system improvements and suggest areas of study offering potential for improvement.

STORAGE and TRANSPORTATION of KANSAS WHEAT

Storage

Storage is a necessary part of the marketing system to the extent there is any time lag between the production of raw materials and the consumption of the processed product.

Kohls (1)[1/] refers to two types of normal storage operations a) that which equalizes seasonal production with the pattern of demand, and b) the storage at all times necessary to keep the marketing system operating without interruption. Each type of storage operation is important for grain. When storable crops including wheat, corn, and sorghum grain are harvested once a year during a short period of time the grain must be stored and distributed for consumption during the remainder of the year. Minimum pipeline stocks must also be available to maintain a basic flow through the marketing and processing system. Storage can be accomplished by on-farm storage or off-farm commercial storage.

On-farm storage

Grain storage on the farm is usually a) to provide storage for seed grain, b) to provide a feed supply to support a livestock operation, or c) to conform to the farmers' overall marketing plan for each grain.

A survey by the Kansas Crop and Livestock Reporting Service estimates the capacity of on-farm facilities in Kansas suitable for storing grain at 453 million bushels on April 1, 1977. This compares with 459 million bushels in 1974 when the most recent previous survey was conducted (Table 1).

1/ Underlined numbers in parentheses refer to Literature Cited.

Table 1-- Kansas Farm Storage Capacity

District	Total Capacity 1974	Total Capacity 1977	Types of Structure - 1977: Metal	Other Dry Grain Storage	High Moisture
			1,000 Bushels		
NW	56,500	60,600	43,400	10,300	6,900
WC	46,700	47,400	33,500	9,500	4,900
SW	65,100	62,900	40,400	10,400	11,600
NC	61,400	68,700	50,100	11,700	6,900
C	51,700	52,900	32,700	16,200	4,000
SC	56,600	52,600	37,000	10,300	5,300
NE	39,200	37,600	25,500	7,300	4,800
EC	39,000	32,600	21,200	7,900	3,500
SE	42,500	37,300	22,100	10,600	4,600
Total	459,200	453,100	306,400	94,200	52,500

Source: Kansas Crop and Livestock Reporting Service, Grain Stock and Capacity Report, April 1, 1977.

Metal bins account for 68% of the total capacity with other dry grain storage accounting for 21%, and high moisture storage accounting for the remaining 11%. The capacity of wood structures declined between 1974 and 1977. Of the 453 million bushels of farm storage, the western one-third of the state accounts for 171.4 million bushels of storage, or 38%; the central districts 38%; while the remaining 24% is located in the eastern three crop reporting districts.

The April 1 survey also inquired as to farmers plans to add additional on-farm storage within the next year. Their intentions are to add 26.3 million bushels of on-farm storage during 1977; with plans to add 9.2 million of that storage in the West Central and Southwest districts (Table 2).

Off-farm commercial storage

Off-farm (commercial) storages are classified by the grain industry as local elevators or terminal elevators. Size is not the determining factor of classification, rather classification is according to the source of elevator receipts, with terminal elevators receiving over 50% of their grain receipts from local elevators.

Kansas has approximately 1000 commercial elevators ranging in size from under 100,000 bushels capacity to larger than 2.4 million bushels. The Kansas Grain and Feed Dealers Association (KGFDA) 1977 survey[2/] of elevator characteristics in Kansas is summarized for local elevators and terminal elevators in Table 3.

Local elevators are dispersed across production regions for receiving

---

2/ A questionnaire was sent to all members of KGFDA the week of April 17, 1977. The 395 responses to this questionnaire were used in compiling the survey.

Table 2 --Intentions to Add Grain Storage Facilities on Kansas Farms in 1977

District	Intended Storage (Dry Grain & High Moisture Grain)
	1,000 Bushels
Northwest	1,800
West Central	4,500
Southwest	4,700
North Central	3,200
Central	2,600
South Central	2,800
Northeast	3,100
East Central	2,900
Southeast	700
STATE	26,300

Source: Kansas Crop and Livestock Reporting Service, Grain Stock and Capacity Report, April 1, 1977.

Table 3   Summary of Survey of Kansas Elevators

	Country Elevator		Terminal Elevator	
	Number of units	Percent	Number of units	Percent
Location by population:				
Rural	67	17	1	6½
Less than 100	53	14	-	-
101 to 500	97	25	-	-
501 to 1000	46	12	1	6½
1001 to 2500	69	17	-	-
2501 to 5000	32	8	1	6½
5001 to 10,000	10	3	1	6½
10,001 to 20,000	13	3	6	40
20,001 to 50,000	2	1	3	20
50,001 to 100,000	0	-	-	-
Excess of 100,000	0	-	2	14
Total	383		15	
Annual volume - thruput (bushels per year)				
Less than 100,000	14	4	-	-
101,000 to 250,000	35	10	1	6½
251,000 to 500,000	101	27	2	14
501,000 to 1,000,000	119	31	3	20
1,001,000 to 1,500,000	52	14	3	20
1,501,000 to 2,000,000	25	7	1	6½
2,001,000 to 3,000,000	13	4	-	-
3,0b1,000 to 5,000,000	6	2	1	6½
Over 5,000,000	1	1	4	26½
Total	356		15	

Table 3 Continued

	Country Elevator		Terminal Elevator	
	Number of units	Percent	Number of units	Percent
Total receiving leg capacities (bushels per hour):				
Less than 1000	3	1	-	-
1001 to 2000	21	6	-	-
2001 to 3000	27	7	1	6
3001 to 5000	65	17	-	-
5001 to 7500	79	21	3	20
7501 to 10,000	71	19	2	14
10,001 to 12,500	34	9	-	-
12,501 to 15,000	30	8	2	14
15,001 to 17,500	10	3	1	6
17,501 to 20,000	10	3	-	-
20,001 to 25,000	12	3	3	20
25,001 to 30,000	5	1	-	-
30,001 to 40,000	3	1	2	14
40,001 to 50,000	2	½	-	-
Over 50,000	2	½	1	6
Total	374		15	
Receiving leg info - per location:				
1 leg	105	29	4	26½
2 legs	160	44	5	33½
3 legs	53	15	5	33½
4 legs	31	9	1	6½
5 legs	4	1	-	-
6 legs	4	1	-	-
6+ legs	5	1	-	-
Total	362		15	

Table 3 Continued

	Country Elevator		Terminal Elevator	
	Number of units	Percent	Number of units	Percent
Rail loading facilities - per location:				
None	7	2	1	6½
1 location	250	60	8	53½
2 locations	107	28	3	20
3 locations	24	6	3	20
4 locations	10	2½	-	-
5 locations	5	1	-	-
5 plus locations	3	½	-	-
Total	386		15	
Enclosed facility	15	4	8	53
Open facility	371	96	7	47
Truck loadout facilities - per location:				
None	23	6	4	25½
1 location	163	43	8	53½
2 locations	119	31	2	13½
3 locations	30	8	1	6½
4 locations	17	4	-	-
5 locations	4	1	-	-
6 plus locations	25	7	-	-
Total	381		15	
Enclosed facility	213	56	10	67
Open facility	168	44	5	33

Table 3 Continued

	Country Elevator		Terminal Elevator	
	Number of units	Percent	Number of units	Percent
Grain dryer types:				
Batch	74	29	-	-
Rack	23	9	1	6
Column	158	62	4	27
Other	-	-	-	-
Total	255		5	
Dryer capacities (bushels per hour):				
500 or less	134	52½	2	40
501 to 1000	90	35	2	40
1001 to 1500	21	8	1	20
1501 to 2000	2	1	-	-
2001 to 2500	3	1	-	-
2501 to 3000	2	1	-	-
3001 to 5000	2	1	-	-
Over 5000	1	½	-	-
Total	255		5	
Dust control equipment:				
No dust control	168	47	2	13½
Has dust control	192	53	13	85½
Total	360		15	

Table 3 Continued

	Country Elevator		Terminal Elevator	
	Number of units	Percent	Number of units	Percent
Type of dust control:				
Bag filter system	25	13	6	37½
Hi efficiency cyclone	32	17	4	25
Lo efficiency cyclone	145	76	7	37½
Total	192		17	
Expansion consideration:[1]				
Type A	147	39	6	40
Type B	88	23	5	33
Type C	207	54	4	27
Type D	93	25	4	27
None of the above	45	12	8	53
Total	380		27	

[1]The above elevators would consider the following types of expansion within the next 5 years if EPA costs were not involved: A) Add receiving leg and pit or speed up existing; B) Speed up or add aditional loadout facilities; C) Build additional storage capacity; D) Add additional grain drying capacity.

Source: U.S. Congress. Senate Congressional Record; S9417. June 10, 1977.

grain directly from farmers. Their primary function is the assembly of grain, with facilities for weighing, receiving, and/or shipping to terminal elevators or processors. When local elevators receive more grain in a year than their facilities will accommodate, the excess grain is shipped to a terminal elevator for storage.

Terminal elevators furnishing the large storage reservoirs necessary in the grain marketing system are located in principle marketing centers having access to railroad mainlines and/or barge transportation. In Kansas, terminal elevators are located in Atchison, Hutchinson, Kansas City, Salina, Topeka, and Wichita. The terminal elevator performs four basic functions a) storage of grain in excess of local elevator capacities, b) merchandising of grain to final markets, c) blending of wheat to meet grade specifications, and d) assembly of grain for domestic and foreign buyers.

As of April 1, 1977, off-farm storage capacity in Kansas was estimated at 780 million bushels (Table 4). Kansas ranks first in total off-farm storage capacity among wheat producing states in the Midwest (Table 5).

Transportation

Farm products depend upon transportation for the creation or preservation of their value. The concept of place utility - the value added to goods by moving them from areas of surplus production to areas of deficit production - constitutes a major influence on the selling price of the product.

Agriculture in Kansas depends primarily on two modes of transportation. Grain trucks, used primarily during wheat harvest for short to medium length hauls or where special handling is necessary, range in size from pickups to

Table 4 --Kansas Off-Farm Storage Capacity

District	Total Capacity
	1,000 Bushels
Northwest	41,025
West Central	51,238
Southwest	101,530
North Central	52,127
Central	118,718
South Central	194,012
Northeast	100,909
East Central	92,837
Southeast	27,604
STATE	780,000

Source: Kansas Crop and Livestock Reporting Service, Grain and Capacity Report, April 1, 1977.

Table 5 --Capacities of Off-Farm Grain Storage by States

Year	Oklahoma	Kansas	Texas	Nebraska	South Dakota	North Dakota
			1,000 Bushels			
1965	236,000	849,000	905,000	491,000	84,600	141,000
1966	234,000	845,300	916,000	487,000	86,000	144,000
1967	222,000	815,000	913,000	484,000	84,800	145,150
1968	198,400	760,000	881,300	466,100	84,800	145,700
1969	186,810	755,000	844,000	477,500	83,950	142,250
1970	187,570	767,000	845,000	477,630	82,880	139,000
1971	189,050	786,000	809,640	458,140	84,170	141,080
1972	184,880	781,000	781,470	458,840	83,830	142,530
1973	187,640	780,000	773,570	456,060	83,960	144,630
1974	191,790	782,000	719,040	452,660	83,440	144,550
1975	190,200	780,000	752,020	453,560	83,280	141,200

Source: Grain Stocks, Crop Reporting Board, SRS, USDA, Washington, D.C., Various issues, 1965 - 1975.

semi-tractor trailer trucks. A 1974 survey (2) was conducted on the characteristics of the grain trucks used in delivering grain in South Dakota from the farm to local elevators; stratifying the findings according to age, size, and annual mileage. The summary of the survey is shown in Tables 6 and 7, where the average load in bushels for the 1.5 ton, 2.0 ton, and 2.5 ton truck is assumed to be 200, 250, and 300 bushels respectively.

Railroads are involved in the long distance movement of non-perishable commodities of large volume and relatively low value where cost of transportation is important. In a 1974 study (3) of wheat shipments in Kansas 88.2% of all wheat from local elevators was shipped by rail. Four major railroads serving Kansas a) Atchison, Topeka & Santa Fe, b) Missouri Pacific, c) Chicago, Rock Island & Pacific, and d) Union Pacific; accounted for 92% of all wheat transported by rail during the 1972-73 grain marketing year.

The Railroads industry's ability to perform its transportation function is influenced by six factors:

1. The number of freight cars in service. There were 1,699,027 freight cars in railroad service at the close of 1976, according to the Association of American Railroad's (AAR) Car Service Division. The number of cars declined from 1,822,381 in 1967 to the present 1,699,027. The decline has been attributed, in part, to heavy retirement of cars from reorganization of railroads (Table 8).

2. Types of freight equipment. Agriculture relies on the use of box cars and covered hopper cars for grain movement. Only in times of severe car shortages, such as during 1972, are other types of freight cars brought into service for the shipping of grain. The number of box cars and

Table 6--Sample of Farm Trucks in South Dakota Stratified by Size and Age, 1974

Year	Number of Trucks	Year	Number of Trucks	Year	Number of Trucks
1½ ton Trucks		2 ton Trucks		2½ ton Trucks	
1941	1	1948	1	1952	1
1942	1	1949	4	1955	2
1944	1	1950	1	1957	1
1946	2	1951	3	1959	1
1947	4	1954	2	1961	2
1948	2	1955	2	1963	1
1949	2	1956	1	1964	2
1950	5	1957	4	1965	2
1951	4	1958	4	1967	1
1952	1	1959	7	1968	2
1953	2	1960	5	1969	1
1955	3	1961	8	1974	2
1957	1	1962	4		
1958	3	1963	4		
1959	4	1964	4		
1960	2	1965	4		
1962	1	1966	5		
1963	1	1967	2		
		1968	6		
		1969	3		
		1970	2		
		1971	3		
		1972	7		
		1973	3		
		1974	6		
n = 41		n = 95		n = 18	
$\bar{y}$ = 1953		$\bar{y}$ = 1963		$\bar{y}$ = 1963	

Source: Payne W. F., Baumel P. C., and Moser D. "Estimating Truck Transport Costs for Grain and Fertilizer." Unpublished NCR research publication, April, 1977.

---

n = number of trucks in sample
$\bar{y}$ = average model year of trucks in sample

Table 7--Sample of Farm Trucks in South Dakota Stratified by Size and Annual Mileage, 1974

Annual Mileage	Number of Trucks	Annual Mileage	Number of Trucks	Annual Mileage	Number of Trucks
1½ ton Trucks		2 ton Trucks		2½ ton Trucks	
200	1	100	1	1,000	1
250	1	150	1	2,000	2
300	2	200	3	2,500	1
400	1	250	2	3,000	2
500	6	400	1	4,000	2
600	1	500	5	5,000	2
1,000	8	1,000	4	6,000	3
1,200	2	1,200	2	7,000	1
1,500	1	1,500	1	10,000	4
2,000	6	1,800	1		
2,500	1	2,000	13		
3,000	2	2,200	1		
4,000	3	2,500	4		
5,000	3	3,000	12		
5,500	1	3,500	3		
10,000	1	4,000	12		
15,000	1	4,600	1		
		5,000	4		
		6,000	8		
		7,000	1		
		7,500	1		
		8,000	5		
		9,000	1		
		10,000	5		
		13,000	1		
		15,000	1		
		16,000	1		
n = 41		n = 95		n = 18	
$\overline{am}$ = 2,310		$\overline{am}$ = 3,966		$\overline{am}$ = 5,361	

Source: Payne W. F., Baumel P. C., and Moser D. "Estimating Truck Transport Costs for Grain and Fertilizer." Unpublished NCR research publication, April, 1977.

---

n = number of trucks in sample

$\overline{am}$ = average annual mileage of trucks in sample

Table 8--Number of Freight Cars in Service

Dec 31.	Total	Class I railroads	Other railroads	Car companies and shippers
1929	2,610,662	2,277,505	46,178	286,979
1939	1,961,705	1,650,031	30,488	281,186
1944	2,067,948	1,769,578	27,434	270,936
1947	2,025,008	1,734,239	25,519	265,250
1951	2,046,600	1,752,430	25,448	268,722
1955	1,996,443	1,698,814	24,933	272,696
1961	1,905,268	1,604,241	31,101	269,926
1962	1,850,688	1,550,067	31,146	269,475
1963	1,814,193	1,512,306	30,150	271,737
1964	1,796,264	1,488,385	29,179	278,700
1965	1,800,662	1,478,005	37,164	285,493
1966	1,826,499	1,488,115	35,626	302,758
1967	1,822,381	1,477,166	33,797	311,418
1968	1,800,375	1,453,883	30,688	315,804
1969	1,791,736	1,434,824	29,373	327,539
1970	1,784,181	1,423,921	29,787	330,473
1971	1,762,135	1,422,411	27,291	312,433
1972	1,716,937	1,410,568	22,749	283,620
1973	1,710,659	1,395,105	23,114	292,440
1974	1,720,573	1,375,265	25,977	319,331
1975	1,723,605	1,359,459	29,407	334,739
1976	1,699,027	1,331,705	34,452	332,870

Source: Yearbook of Railroad Facts, 1977 edition. Association of American Railroads.

covered hoppers is important, as are the changes in numbers of each type. The number of box cars has decreased from 534,494 in 1971 to 473,953 in 1976, a change of 60,541 cars in 5 years; while the number of covered hopper cars has increased to 230,069 in 1976, an increase of 27% during the same time period (Table 9). There is a shifting preference towards the use of covered hopper cars due to their larger load capacity and ease of loading and/or unloading.

3. Average freight car capacity. Annual increases in average carrying capacity of railroad freight cars, a steady trend since record-keeping began, have been significant in recent years. In 1976 the average car capacity had increased to 73.5 ton, compared to 63.4 ton in 1967. New cars installed in 1976 have an average capacity of 92 ton, compared with a 65 ton average for cars retired (Table 10). Total capacity of box cars plus covered hopper cars increased from 43.4 million tons to 51.7 million tons from 1967 - 1977.

4. Average freight train load. Improvements in car equipment design and more powerful engines have allowed increases in the average freight train load (net ton-miles per train mile); average tonnage carried having increased 13.3% during the period from 1966 - 1976. The average freight train in 1976 carried 1,943 tons of freight (Table 11).

5. Utilization of the freight car fleet. How the present car fleet is utilized is the predominant factor in determining the volume of grain which can be moved within a time period. Table 12 summarizes the results of a 1962 - 1967 USDA study (4) where it is estimated that freight cars are moving only 8.6% of the time; while 73.3% of the time is spent either unallocated or in switching activity.

Table 9-- Types of Freight Equipment

Type	Total	Class I railroads	Other railroads	Car companies and shippers
Box cars:				
Plain	321,480	304,910	9,068	7,502
Equipped	173,679	170,179	2,621	879
Covered hoppers	228,265	156,850	1,386	70,029
Flat cars	141,316	98,320	778	42,218
Refrigerator cars	100,815	70,434	2,618	27,763
Stock cars	4,423	4,341	—	82
Gondola cars	186,773	176,408	4,923	5,442
Hopper cars	363,186	346,413	6,720	10,053
Tank cars	170,876	2,951	18	167,907
Other freight cars	32,792	28,653	1,275	2,864
Total	1,723,605	1,359,459	29,407	334,739

Source: Yearbook of Railroad Facts, 1977 edition. Association of American Railroads.

Table 10 -- Average Freight Car Capacity

Year	Tons	Year	Tons
1929	46.3	1965	59.7
1939	49.7	1966	61.4
1944	50.8	1967	63.4
1947	51.5	1968	64.3
1951	52.9	1969	65.8
1955	53.7	1970	67.1
1960	55.4	1971	68.4
1961	55.7	1972	69.6
1962	56.3	1973	70.5
1963	56.8	1974	71.6
1964	58.3	1975	72.9
		1976 Est.	73.5

Source: Yearbook of Railroad Facts, 1977 edition. Association of American Railroads.

Table 11-- Average Freight Train Load

	United States	Eastern District	Southern District	Western District
		-Tons-		
1929	804	981	622	702
1939	806	1,043	613	679
1944	1,124	1,326	878	1,050
1947	1,131	1,353	910	1,033
1951	1,283	1,466	1,108	1,201
1955	1,359	1,488	1,342	1,264
1961	1,495	1,613	1,545	1,400
1962	1,544	1,669	1,608	1,440
1963	1,590	1,722	1,640	1,486
1964	1,618	1,747	1,690	1,509
1965	1,685	1,821	1,812	1,555
1966	1,715	1,878	1,873	1,567
1967	1,740	1,939	1,905	1,566
1968	1,768	1,972	1,874	1,614
1969	1,804	1,994	1,951	1,649
1970	1,820	1,981	1,881	1,703
1971	1,751	1,797	1,829	1,697
1972	1,774	1,823	1,867	1,716
1973	1,844	1,892	1,955	1,784
1974	1,875	1,992	1,954	1,790
1975	1,938	2,011	1,994	1,883
1976	1,943	2,016	1,963	1,901

Source: Yearbook of Railroad Facts, 1977 edition. Association of American Railroads.

Table 12--Average Annual Car-Day Activity, All Cars in Service, 1962-67

Activity	Million Car-Day per Year	% of total
Switching	240.2	34.7
Loading & unloading	125.2	18.1
Running service	59.7	8.6
Unallocated car-day and repairs	267.1	38.6
Total	692.2*	100.0%

*The number of freight car-days is equal to the total numbers of freight cars multiplied by the number of days in one year.

Source: USDA Economic Research Service, Marketing Research Report No. 953, "The Freight Car Supply Problem and Car Rental Policies," April, 1972.

The AAR estimates that the average serviceable car in 1976 spent about 12% of its time in road trains, loaded or empty; this compares with 11% in 1970 (5). Improvements are being made in the utilization of the car fleet, however there is room for additional improvement.

6. Average daily freight car mileage and speed. Average daily freight car mileage in 1976 was 56.9 miles per car on line, with an average speed of 20 miles per hour (Table 13). This compares with an average daily freight car mileage of 54.6 in 1970 and an average speed of 20.4 miles per hour.

Table 13--Average Daily Car Mileage

	United States	Eastern District	Southern District	Western District
1929	34.4	31.6	37.2	37.2
1939	36.4	32.8	42.2	39.2
1944	51.9	44.8	54.7	59.9
1947	48.8	40.9	51.7	58.1
1951	47.2	38.3	49.9	57.2
1955	48.2	39.3	48.4	58.4
1961	45.5	36.2	43.0	56.4
1962	47.6	38.1	44.3	59.3
1963	49.2	39.5	45.9	61.3
1964	50.0	41.1	45.4	61.3
1965	51.7	42.7	47.1	63.2
1966	53.0	42.8	49.5	64.9
1967	51.5	42.2	48.1	62.5
1968 Rev.	53.5	41.6	52.2	66.6
1969 Rev.	54.9	41.6	54.5	69.2
1970	54.6	41.2	51.2	70.4
1971	53.3	39.7	49.2	68.8
1972	56.1	41.3	52.1	72.2
1973	57.7	41.9	53.4	74.6
1974	57.4	41.9	54.2	73.4
1975	53.6	40.2	49.6	66.9
1976	56.9	41.7	51.9	72.3

Source: Yearbook of Railroad Facts, 1977 edition. Association of American Railroads.

CHAPTER 2

FUNCTIONAL SUB-SYSTEMS of the GRAIN MARKETING SYSTEM

The harvesting-marketing flow of wheat during the harvest is composed of four levels or sub-systems. Functional sub-systems are a) the farm, b) local elevator, c) transportation agencies, and d) terminal elevator or processor.

Farm

The farm level is concerned with the harvesting and delivery of wheat to the local elevator. Objectives are to harvest and store the crop as rapidly as possible to avoid loss in market value due to exposure to unfavorable weather conditions. Farmers stress the point that once wheat is ready, every effort is made to complete harvest rapidly.

With today's modern combines, the capability of harvesting wheat has increased greatly since the days when harvest consisted of separate cutting and threshing operations. A modern combine with a 22 foot header is capable of harvesting up to 7 acres (or 245-280 bushels) per hour.

Delivery of wheat to the local elevator is accomplished by grain trucks varying in size from farm pickups to trucks with capacities of over 400 bushels. The elevator manager of the Collingwood elevator at Greensburg, Kansas, estimates that the typical truck received at their facilities during harvest has a capacity of 275-300 bushels, indicating typical delivery vehicles only slightly larger than for South Dakota (Table 6).

Local elevator

The local elevator level is concerned with the receiving, storing, and/or shipping of wheat during harvest. Local elevators provide storage facilities for the purpose of earning revenue, therefore have an incentive to attract as much grain as can be handled. Their objectives are to a) provide maximum services for customers, b) maintain or increase their share of the market, and c) maximize the elevator's profits.

The receiving operation begins as the grain truck arrives at the elevator where the truck is weighed and a wheat sample taken before the truck proceeds to the receiving facility. The wheat is then unloaded into the receiving pit and the grain moved through the elevator leg into storage bins.

The rate at which wheat can be received at the local elevator is determined largely by the capacity of the receiving pit and the speed of the elevator leg. The receiving capacity at local elevators in Kansas varies from less than 1000 bushels to over 50,000 bushels per hour, depending on the size and age of the facilities, with a modal rate of 5,000 to 7,500 bushels per hour (6).

The storing and/or shipping operation at the local elevator depends on a) storage space available, b) expectations of grain receipts, and c) availablility of transportation facilities. When rail cars or trucks are being loaded for shipment from the local elevator the grain flows back into the receiving pit, up the elevator leg, and through the load-out spout into rail cars or trucks.

Transportation agencies

Transportation agencies are concerned with the smooth and orderly movement of commodities to their destination. Movement from the local elevator can be accomplished by motor carrier or railroad, with railroads accounting for the majority of wheat shipments from Kansas local elevators (7).

For the railroads the transportation activity is accomplished by a) orders placed by an elevator manager with the railroad agent specifying the number and date for delivery of cars to the local elevator; b) the spotting and loading of cars at the local elevator, usually within 48 hours to avoid demurrage charges; c) movement toward the final destination, encountering numerous stops along the way for inspection, grading, and reconsolidation; and d) arrival and unloading at the destination.

Terminal elevators (or processors)

Terminal elevators or processors are concerned with the terminal receiving and storing of wheat. Their objectives, similiar to those of the local elevator, are to provide storage facilities for grain and to earn revenue from the storage and merchandising of grain.

Terminal elevators provide the large storage reservoirs necessary in the system and provide a location for the assembly of wheat for domestic and foreign buyers. Terminal elevators are equipped to receive wheat by rail and motor carrier.

Examining the objectives of the four components (sub-systems) involved during wheat harvest, the interest of all participants is best served when the harvesting-marketing flow of wheat (from the farm level through the channels to the terminal or processor) is acheived without major peak demand problems occurring. Optimum conditions exist when:

1. The rate of flow of harvest just matches the ability of the local elevator to receive the wheat.
2. The amount of wheat seeking storage at the local elevator is just equal to the available space at the local elevator for long-term storage plus that which can be shipped to a terminal elevator during harvest.
3. Rail cars available for movement of grain from the local elevator to terminal facilities just matches the quantity and timing of demand for such services.
4. The rate and quantity of rail cars arriving at the terminal elevator just matches the ability of the terminal to receive the grain for storage or to merchandise the grain for further movement along the market channel.

These optimum conditions would permit the smooth flow of grain during harvest while satisfying the objectives of each sub-system.

CHAPTER 3

POTENTIAL BOTTLENECKS or SYSTEM STRESSES OCCURRING DURING HARVEST, and THEIR CONSEQUENCES

Potential bottlenecks or system stresses can occur at any of the four functional sub-systems during a) harvesting and local elevator delivery, b) receiving, storing, and/or shipping at the local elevator, c) transportation from the local elevator, and d) the receiving and storing at the terminal elevator or processor.

Isolated problems occur within particular sub-systems affecting only one part of the harvesting-marketing flow of wheat; however in a system involving interdependencies the influence of events or stresses at one level is likely to affect the performance at other levels. For example, a break in the movement of grain resulting from an embargo at Salina in the Fall of 1974 resulted in reductions in grain movements from local elevators west of Salina; grain shipments which normally would have moved to Salina during harvest. The embargo also tied up freight cars and probably forced farmers to use temporary storage.

Perhaps most evident problems (bottlenecks or system stresses) are 1) queuing of farm grain trucks at local elevators, and 2) insufficient storage capacity in quantity and location to accommodate the volume of wheat needing storage at harvest.

1. Queuing of farm grain trucks at the local elevator.

The sight of long lines of grain trucks forming at local elevators while farmers wait to unload their trucks is not unusual in many parts of Kansas and surrounding wheat producing states during wheat harvest.

Lines forming at local elevators are evidence of bottlenecks affecting the elevators ability to receive wheat and affecting the harvesting and delivering of wheat to the local elevator.

Grain trucks used for delivery of wheat to the local elevators are the same trucks used in the fields as temporary storage, allowing combines to continue their harvesting of wheat. With the harvesting ability of modern combines, a combine with a 80 bushel grain hopper and the capability of harvesting 245-280 bushel per hour will need to unload its hopper into a grain truck every 20-30 minutes if the harvesting operation is to continue without interruption.

When the farmers are waiting at local elevators to unload their trucks the consequences are felt in the unproductive use of farm labor and equipment while at the local elevators, and in unharvested wheat fields resulting from delays in the wheat harvest.

Delays in wheat harvesting are critical because unharvested wheat is susceptible to unfavorable weather conditions where a heavy rain, wind, or hail storm can destroy a crop in minutes. Favorable weather conditions can also be harmful to unharvested wheat fields, resulting in shattering, loss in weight, and loss in quality due to bleaching of the wheat if left standing after the grain has ripened. Potential loss from harvest delays is too great for farmers to calmly accept postponement when harvest condtions are favorable.

2. Insufficient storage capacity (in the quantity and location) necessary to accommodate the volume of grain needing storage at harvest.

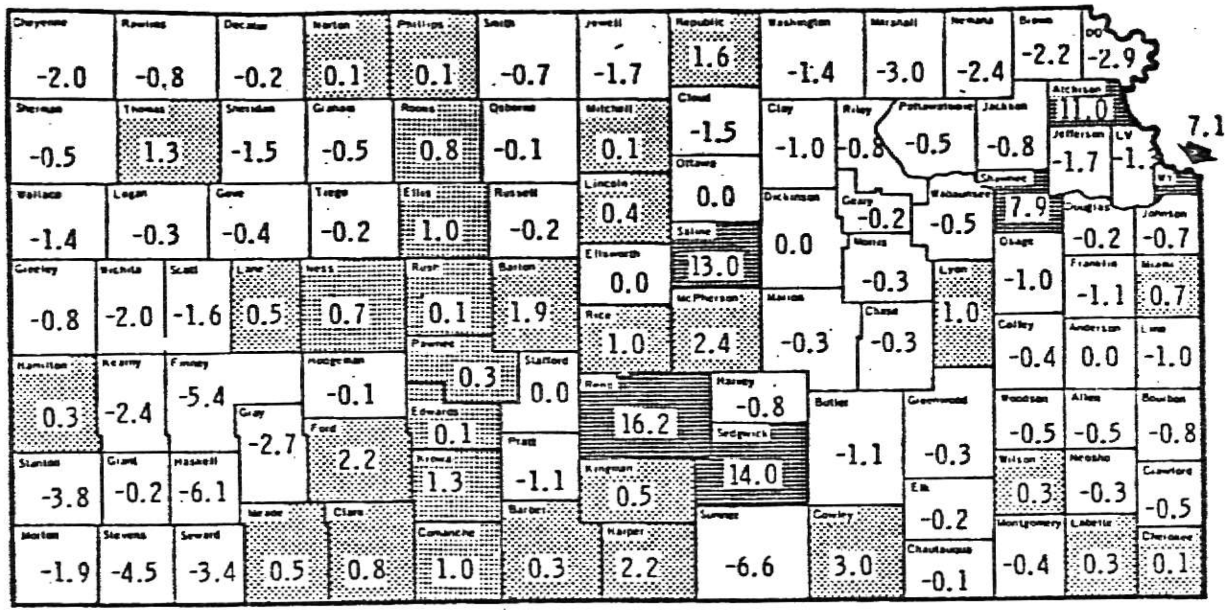
Problems and stresses caused by insufficient storage capacity available to accommodate the wheat at harvest can occur a) on the farm, b) at the local elevator, c) in the number of freight cars available to move grain from the local elevator, and d) at terminal elevators where grain is received from local elevators.

When problems of inadequate storage occur during harvest the consequences are felt throughout the grain marketing system as a) grain being stored temporarily in farm buildings not designed for grain storage, b) grain being piled on the ground subject to weather conditions and pest damage until suitable storage space becomes available, c) local elevators not receiving grain because available storage space is full, d) delays in harvest, e) freight cars used for short-term storage facilities rather than for transportation, and f) embargoes at terminal elevators and/or port facilities.

Problems of inadequate off-farm storage occurring at harvest can be local in nature resulting from inaccurate estimates of the size or speed of harvest or from unexpected shortage of transportation service. When local problems exist, stresses can be alleviated through movement of grain stocks from areas of deficit storage space to terminal elevators with available space.

A survey (8) comparing the commercial storage space available on September 1, 1976, with production estimates for corn and sorghum grain found that although the 1976 production estimates exceeded available commercial storage space in 62 counties, the available space in Kansas terminal elevators alone totaled 69.2 million bushels (Figure 1). Redistribution can lessen the system stresses due to inadequate storage capacities in an area; however redistribution can result in increased short-run demand for services from the transportation sub-system.

Figure 1 --Storage Space Available in Kansas Elevators, Fall, 1976.



Figures in each county show storage available in elevators (in million bushels). Light shading indicates counties with a surplus of storage; counties with a deficit of storage are not shaded; and terminal elevators are located in counties with dark shading.

Source: Department of Economics, Kansas State University, September,1976.

FACTORS CONTRIBUTING to the DEVELOPMENT of MARKETING BOTTLENECKS or STRESS SITUATIONS DURING HARVEST

Predominant factors contributing to system bottlenecks or stress situations are a) insufficient "timely" information on demands for services from the system, and b) unpredictable variations in demand for services occurring within each sub-system.

A. Insufficient "timely" information on demands for services from the system.

With the supply of storage and transportation facilities fixed in the short run only reallocation of resources (freight cars or trucks) and relocation of stocks (carryover grain stocks) can occur in response to changing conditions. The process (reallocation of resources and relocations of stocks) requires accurate and timely information on a sufficiently localized basis to respond to local problems. The grain harvesting-marketing system cannot operate smoothly unless the participants of each of the subsystems involved are informed of the demands to be placed on them and have adequate time to prepare to meet those demands.

"Timely" information needs to be available on a) demands to be placed on the storage system during harvest (production estimates), b) ability of the storage system to meet the demands placed upon it (available storage space), and c) supply of vehicles available to meet the demand for reallocation of stocks (number and location of available freight cars).

1. Demands to be placed on the storage system.

The demand for storage facilities for the new crop is highly correlated with production, therefore production forecasts can aid in determining new demand for storage services associated with harvest. Forecasts of expected state production are issued during the growing season by the Statisical Reporting Service (SRS) in each state (9), with the first forecast for wheat released in December, in July for corn, and August for sorghum. Winter wheat forecasts are made again in May and monthly thereafter throughout the season. Monthly forecasts are based on indications obtained from surveys, local growing conditions, yield counts in sample fields, and special questionnaires.

The Crop Reporting Board in Washington, D.C., establishes production forecasts on a regional level from which the individual state forecasts are adjusted to sum to the regional forecast level. Beginning May 1, the Kansas Crop and Livestock Reporting Service issues production estimates for wheat on a crop reporting district basis.

Having production forecasts on a sufficiently localized basis would provide elevator managers with estimates of the demands for storage in their area during harvest.

2. Ability of the storage system to meet the demand placed upon it.

An elevator's ability to satisfy the demand for grain storage is contingent on a) amount of storage space unoccupied at the beginning of harvest, and b) ability to ship to terminal storage during harvest.

With 1.23 billion bushels of storage capacity (on-farm plus off-farm) in Kansas on April 1, 1977, total storage capacity in Kansas greatly exceeds total annual production of corn, sorghum and wheat produced in Kansas during the 1976 marketing year (Table 14). The production of 678.9 million bushels of grain in Kansas during 1976 would have occupied only 55% of the total storage capacity in Kansas. Although grain production in Kansas has

Table 14--Kansas Grain Production, 1965-77

Year	Wheat	Corn	Sorghum	Total
		1,000 Bushels		
1965	236,386	61,950	139,426	437,762
1966	200,070	59,682	139,601	399,353
1967	221,620	72,080	149,408	443,108
1968	253,526	88,452	163,325	505,303
1969	305,314	95,432	182,896	583,647
1970	299,013	82,240	145,960	527,213
1971	312,605	124,545	233,550	670,700
1972	314,900	130,000	217,000	661,900
1973	384,800	154,000	218,400	757,200
1974	319,000	131,000	132,800	582,800
1975	350,900	137,760	144,060	632,720
1976	339,000	170,050	169,850	678,900
1977 Est.	350,500	161,700	201,000	713,200

Source: Kansas Farm Facts. Various issues, 1965-1976.

increased from 437.7 million bushels in 1965 to 713.2 million in 1977, an increase of 63%; total off-farm storage capacity in Kansas has decreased 69 million bushels during the same time period (Tables 5 and 14).

Storage space available for the new wheat crop is equal to total storage capacity less stocks of grain less working space requirement. In areas where production estimates exceed available storage space grain could be transported to a terminal facility if information on elevator occupancy was available.

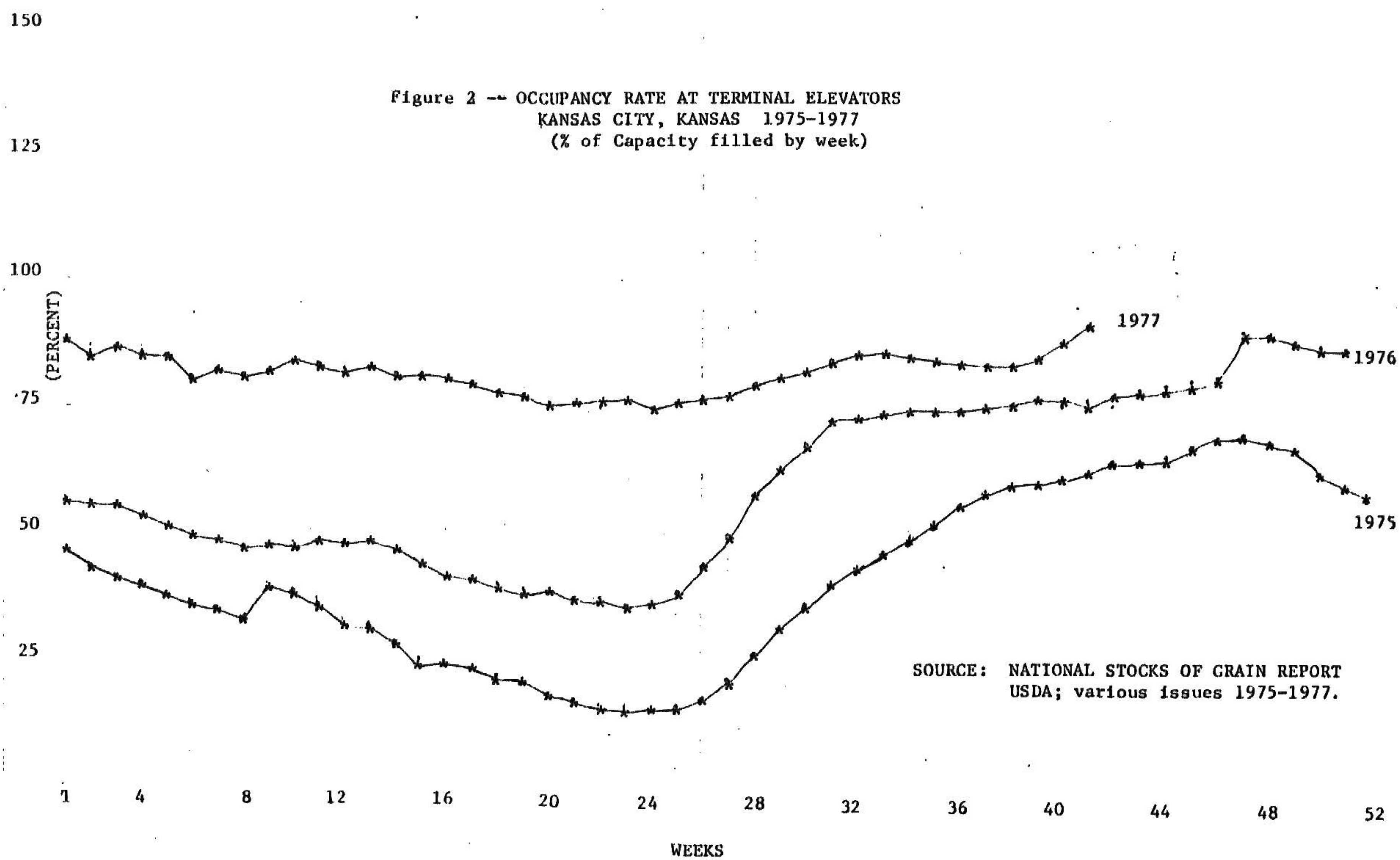
Occupancy rates[3/] at terminal elevators and port facilities are reported weekly by the Agricultural Marketing Service of the USDA (Figures 2, 3, and 4); with the stocks of grain fluctuating from year to year. Occupancy rates of state licensed elevators in Kansas are reported monthly to the Grain Inspection Department in Topeka, however this information is not compiled or released on a regular basis. To date, no known studies have been done to determine how the pattern of occupancy rates of local elevators compare with those of terminal elevators in Kansas. Having estimates of occupancy rates of Kansas elevators on a localized basis would provide valuable insight into the availability of commercial storage space during harvest.

Stocks of Grain Reports issued quarterly by the Kansas Crop and Livestock Reporting Service provide information on the volume of wheat being stored on-farm and off-farm in Kansas (Tables 15, 16, and 17). By comparing the stocks of grain with the capacities of grain storage facilities in Kansas estimates can be made on the amount of storage space available

---

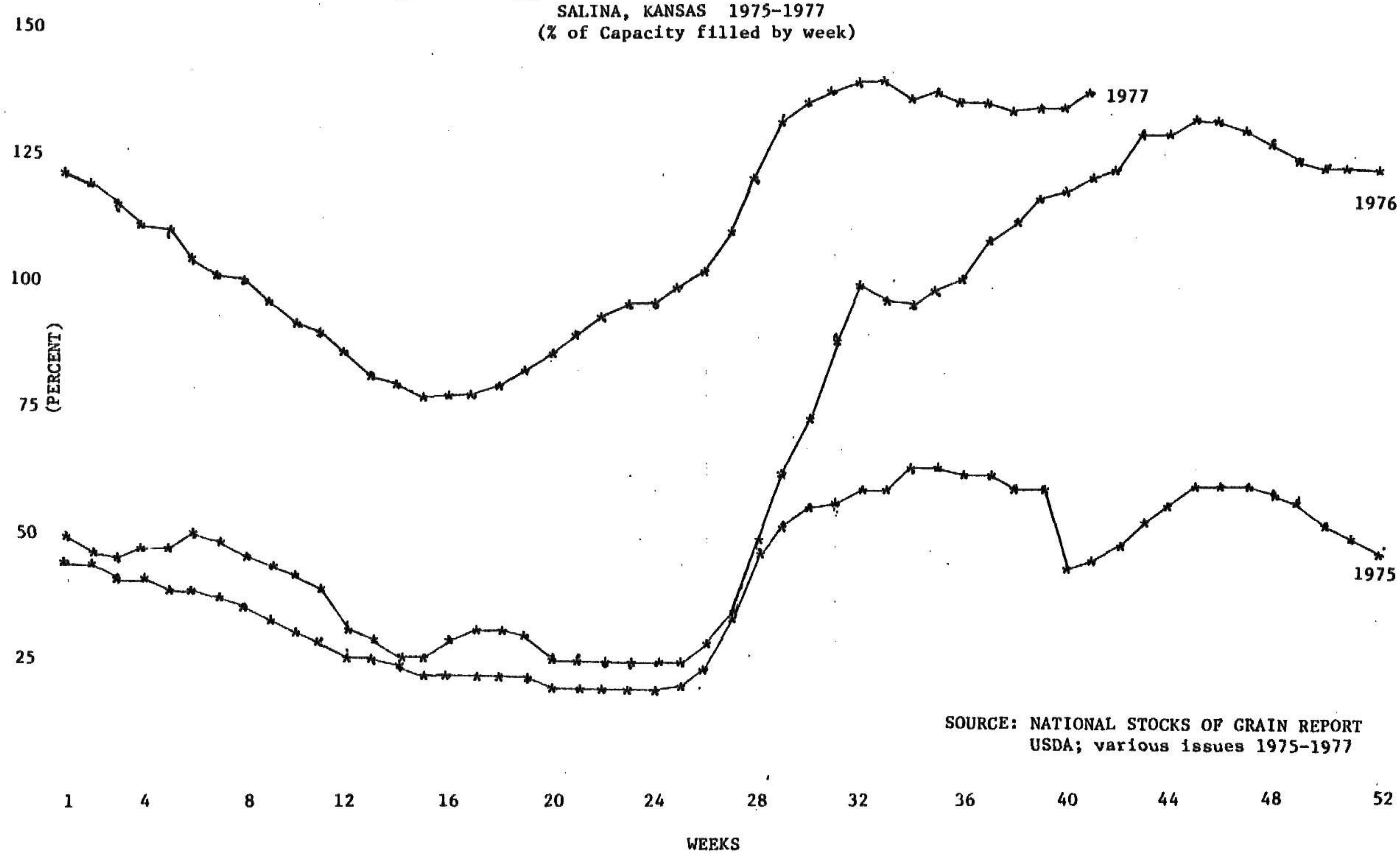
3/ Occupancy rates over 100% indicates use of storage facilities normally not used.

Figure 2 -- OCCUPANCY RATE AT TERMINAL ELEVATORS
KANSAS CITY, KANSAS 1975-1977
(% of Capacity filled by week)



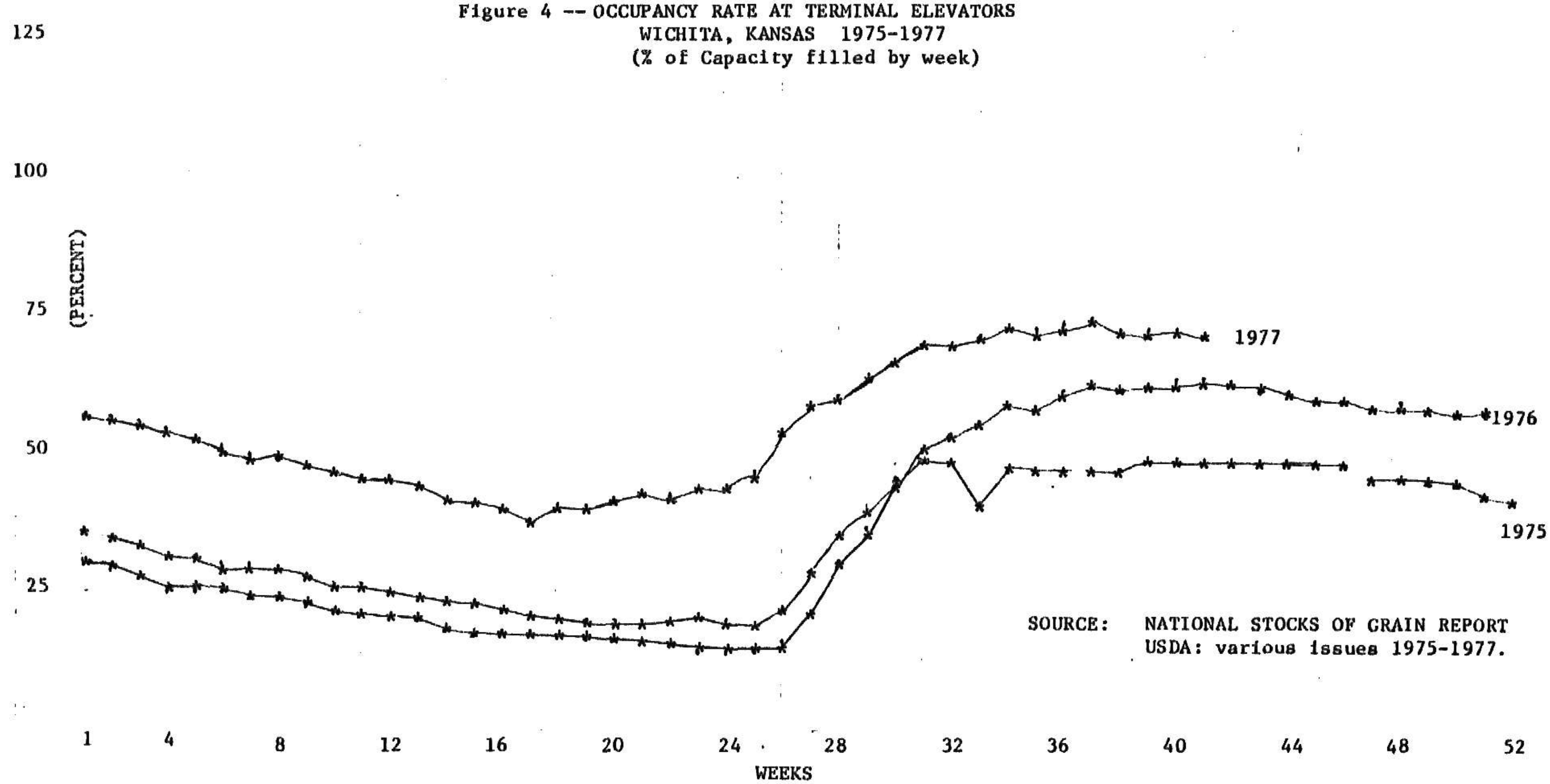
SOURCE: NATIONAL STOCKS OF GRAIN REPORT
USDA; various issues 1975-1977.

Figure 3 -- OCCUPANCY RATE at TERMINAL ELEVATORS
SALINA, KANSAS 1975-1977
(% of Capacity filled by week)



SOURCE: NATIONAL STOCKS OF GRAIN REPORT
USDA; various issues 1975-1977

Figure 4 -- OCCUPANCY RATE AT TERMINAL ELEVATORS
WICHITA, KANSAS 1975-1977
(% of Capacity filled by week)



SOURCE: NATIONAL STOCKS OF GRAIN REPORT
USDA: various issues 1975-1977.

Table 15--Total Stocks of Wheat by Quarters, Kansas, 1967-77

Year	October 1 (Previous year)	January 1	April 1	June 1
		1,000 Bushels		
1967	234,034	177,190	123,334	81,739
1968	259,730	200,249	124,161	91,961
1969	276,680	323,317	196,576	146,325
1970	404,490	341,243	263,971	216,169
1971	426,215	346,877	264,586	187,089
1972	387,243	319,686	239,027	177,354
1973	357,857	266,215	164,039	61,419
1974	288,930	177,609	90,486	45,034
1975	306,405	213,217	132,424	77,837
1976	349,303	283,060	208,286	165,492
1977	448,824	371,231	298,657	-----

Source: Kansas Farm Facts, various issues, 1967-76

Table 16--Stocks of Wheat Off Farm by Quarters, Kansas, 1967-77

Year	October 1 (Prévious year)	January 1	April	June 1
		1,000 Bushels		
1967	176,014	133,175	97,325	64,733
1968	208,757	162,574	99,783	77,556
1969	213,298	186,682	163,618	126,043
1970	325,107	280,179	230,387	196,323
1971	351,462	290,065	231,695	169,148
1972	318,470	266,543	204,640	160,161
1973	304,324	237,874	148,294	55,121
1974	211,970	139,129	71,246	33,490
1975	233,035	165,367	103,714	60,292
1976	272,105	219,898	166,178	133,911
1977	374,244	313,601	254,587	----

Source: Kansas Farm Facts, various issues, 1967-76

Table 17 --Stocks of Wheat On Farm by Quarters, Kansas, 1967-77

Year	October 1 (Previous year)	January 1	April 1	June 1
		1,000 Bushels		
1967	58,020	44,015	26,009	17,006
1968	50,973	37,675	24,378	14,405
1969	63,382	45,635	32,958	20,282
1970	79,383	61,064	33,585	19,846
1971	74,753	56,812	32,891	17,941
1972	68,773	53,143	34,387	17,193
1973	53,533	28,341	15,745	6,298
1974	76,960	38,480	19,240	11,544
1975	73,370	47,850	28,710	17,545
1976	77,198	63,162	42,108	31,581
1977	74,580	57,630	44,070	----

Source: Kansas Farm Facts, various issues, 1967-76

in Kansas according to the type of storage facility, ie., on-farm and/or off-farm. For example, on April 1, 1977, the on-farm stocks of grain (wheat, corn, oats, barley, sorghum, and soybeans) were estimated by the Kansas Crop and Livestock Reporting Service at 105,688 thousand bushel; with on-farm storage capacity of 453,000 thousand bushels (Table 1), the available on-farm storage space on April 1, 1977, was 347,432 thousand bushels. The percentage changes in stocks of wheat in on-farm and off-farm storage facilities in Kansas are more dynamic than percentage changes in wheat production. Secondly, percentage changes in stocks are not uniform among on-farm stocks and off-farm stocks (Table 18).

The estimates of storage space available obtained from the Stocks of Grain Reports however, will not provide information on the geographic location of the available storage space; or predict the farmer's preference towards (or ability of) storing his grain on-farm or off-farm during harvest.

3. The supply of transportation facilities for the relocation of stocks.

Information needs to be available on the ability of transportation agencies (primarily railroads) to redistribute stocks of grain and/or transport the new crop from areas of deficit storage capacity to areas of surplus capacity during the harvest. Elevator managers need this information when making decisions on when and how much grain to move prior to harvest, or how much grain can be shipped during the harvest.

Information on a) quantity of rail services available, b) dependability of service, and c) ability to respond to changing conditions in each area of the state is vital.

Table 18--Comparison of Percentage Change in Stocks of Wheat in Kansas on June 1, with Percentage Change in Kansas Wheat Production, by Years, 1967 - 1976

Years Compared	Stocks of Wheat			Wheat Production
	Total	On Farm	Off Farm	
		Percentage change		
1967-68	+12.5	-15.3	+19.8	+14.4
1968-69	+59.1	+40.8	+62.5	+20.4
1969-70	+47.7	- 2.1	+55.7	- 2.1
1970-71	-13.4	- 9.6	-13.8	+ 4.5
1971-72	- 5.2	- 4.2	- 5.3	+ .7
1972-73	-61.9	-63.3	-65.5	+22.2
1973-74	-26.6	+83.2	-39.2	-17.1
1974-75	+72.8	+51.9	+80.0	+10.0
1975-76	+112.6	+80.0	+ 1.2	- 3.4

Lack of localized information on a) demand for storage, b) supply of available storage space, and c) railroads ability to supply transportation; can lead to bottlenecks and stress situtations occurring during wheat harvest. Providing the participants of the sub-systems involved in the harvesting-marketing flow of wheat with "timely" and localized information would provide the time and knowledge necessary in preparing to meet the demands of the wheat harvest.

B. Variations occurring at each sub-system.

Unpredictable variations play an important role in determining how smoothly the harvesting-marketing flow of wheat progresses. Variations occur in a) weather conditions and precipitation patterns affecting the harvesting operations, b) the receipt patterns of the local elevators, c) the supply of (and demand for) freight cars with respect to time and location, and d) the receiving and shipping at terminal elevators.

1. Weather associated variations.

At the farm level unpredictable weather conditions and precipitation patterns affect the timing of harvest and the harvesting operation during wheat harvest. Heavy morning dews or periods of rain can slow down harvesting, thereby lengthening the harvest as occurred during the 1977 wheat harvest.

During June, 1977, Greensburg, Kansas, located in Kiowa county received 8.08 inches of precipitation compared with .20 inches during 1976, and 1.42 inches inches in 1971. Wellington, Kansas, located in Sumner county, received 3.19, 4.50, and 7.45 inches of precipitation during June of 1977, 1976, and 1971 respectively; both Greensburg and Wellington are located in the South Central Crop Reporting District. Tables 19 and 20 summarize the precipitation amounts for June and July of 1970 - 1977 for Greensburg and Wellington, Kansas. (Note the variations occurring year to year, and from location to location.)

2. Variations in receipts at the local elevator.

Random variations in weather result in variations occurring in the pattern of grain receipts at local elevators. Tables 21, 22, and 23 record the variations in wheat receipts at local elevators in Kansas; where Tables 21 and 22 list the daily receipts at two local elevators located 12 miles apart in Kiowa county, and Table 23 lists the weekly patterns of receipts at nine country elevators during 1974 - 1977. The pattern of receipts demonstrates the large fluctuations occurring from day to day and from one location to another. Elevator managers stress the point that the pattern of receipts is never the same from year to year.

3. Variations in the demand for freight cars.

Railroads experience variations in demand for freight cars in numbers and locations resulting from variations in harvesting patterns within the state.

Railroads are unique when variations occur in demand for freight cars because time is required to relocate cars when demand for them changes. The best measure of demand for rail car services, the number of carloads per week varies significantly from year to year (Figure 5).

Table 19 -- Daily Precipitation Amounts (inches)
Greensburg, Kansas; Kiowa County

	1977	1976	1975	1974	1973	1972	1971	1970
June 1			.14	T				.35
2	.70		T					.05
3		T	T	T			.97	.02
4			.22	.32	.24		.04	.08
5				.11				.08
6				1.23				
7			.40	.03				
8			T	.58				
9		.01	.53	.33			.50	
10			.05	T			.28	
11			.13			.81	T	
12	1.18					T		T
13				.12		T		
14	.12				T	.51	.32	.18
15		T		T				.57
16				T				
17			2.20	.04				
18		T						
19		T	T			1.27		.08
20	T		.27			T	1.35	
21			.84		.08			
22			T	.01				
23	5.30		2.10	T		.30		
24	.02	.04	.05			.42		.01
25	.51							
26	.25							
27								
28			1.15		.03	T		
29		.15			.20			
30				.13			.22	
Total	8.08	.20	8.08	2.90	.55	3.31	3.68	1.42

Table 19 --Continued

	1977	1976	1975	1974	1973	1972	1971	1970
July 1		.38				.71	.83	
2		.09				.25	.36	
3		.06				1.10	.10	T
4					.17	.27	.06	
5						.04		
6								T
7			.15			T		
8	.21					.43		.04
9	.23							
10			.27					
11			.41			T		
12	T							
13								
14					1.28			
15				T	.22			
16		T				.86	.11	
17						.22		.05
18		.34				2.18		
19						.04		
20					.43	.05		.07
21								.66
22	.24				.58	.07	.85	
23					.73		.34	
24				.04				
25				.18	1.45			T
26	1.19	.06				T	.08	
27	.16							
28					.42	1.60	.50	
29	.32			T		1.48	1.35	
30				.43		.42	T	
31			.02		T			
Total	2.35	.95	.85	.65	5.28	9.72	4.58	.82

Source: Department of Commerce, National Oceanic Atmospheric Association (NOAA), Climatology Data, various issues 1970-77.

Table 20 -- Daily Precipitation Amounts (inches)
Wellington, Kansas; Sumner County

	1977	1976	1975	1974	1973	1972	1971	1970
June 1							T	.98
2			.06		.20			.47
3		.01	1.02	.01			1.45	.84
4			T	.02				.30
5			.33	.02	.87			
6				1.57	T			
7			.50	.06			1.46	
8				.08			.51	.34
9			.20	.87				T
10			.60				.01	
11			.20				.09	T
12	.02					T	.11	1.45
13							1.04	1.26
14					.01	.18		
15		.54			.08	.10		1.74
16								
17			1.38		T			.02
18		1.19	T					
19		T				.88		
20	T					.01		.05
21	T		.31		.14			
22	.96	.20	.13					
23	.91	T	1.10					
24	.09	1.85	T			.36		
25	1.15		.03		T	.10		
26	T							
27	.01				T			
28					T			
29	T	.71			1.25			
30			.14		.02			
Total	3.19	4.50	6.00	2.91	2.57	1.63	4.67	7.45

Table 2C --Continued

	1977	1976	1975	1974	1973	1972	1971	1970
July 1		1.96				.42	.63	
2		1.34				1.30	.20	
3		1.57				.70	.06	
4				.08	.02	.22	1.71	
5						.01	.37	
6							.08	
7								
8	.71					T		
9			.21			T		
10			.06					
11			T			T		.06
12						.14		
13			.04					
14					.29			
15		.74			T			
16	.16		T			.02	.10	
17						.07	.06	1.87
18			T			.13		
19						.84		
20								
21								.25
22	.28				.04			
23	.16		T		.80		.11	
24			T		1.90			
25			T	.21	.03	T		
26			.14				.40	
27	.42							
28		.72				.22	1.25	.63
29	T					.63	.50	.07
30								
31	.49				.16			
Total	2.24	5.13	.45	.29	3.24	4.70	5.47	2.88

Source: Department of Commerce, National Oceanic Atmospheric Association (NOAA), Climatology Data, various issues 1970-77.

Table 21 --Daily Grain Receipts, a Local Elevator in Kiowa County, Kansas
1977 Wheat Harvest

Date	Receipts (bushels)	% of total	Date	Receipts (bushels)	% of total
May 28	203	.1	July 1	4,460	2.34
June 2	345	.18	2	9,578	5.0
3	697	.36	5	27,890	14.6
4	937	.49	6	2,012	1.0
6	161	.08	7	2,490	1.3
7	693	.36	8	1,977	1.0
8	893	.47	9	171	.09
9	660	.36	11	474	.24
10	482	.25	12	0	0
11	3,467	1.8	13	892	.46
13	1,453	.76	14	349	.18
14	0	0	15	256	.13
15	1,316	.69	16	8	.003
16	12,855	6.76	18	0	0
17	12,686	6.67	19	0	0
18	23,858	12.55	20	0	0
20	21,316	11.32	21	77	.04
21	24,677	12.98			
22	18,645	9.8	Total	189,721	100.00%
23	829	.43			
24	0	0			
27	946	.49			
28	4,601	2.42			
29	3,052	1.6			
30	4,323	2.3			

Table 22--Daily Grain Receipts, a Local Elevator in Sumner County, Kansas
1977 Wheat Harvest

Date	Receipts (bushels)	% of total	Date	Receipts (bushels)	% of total
June 6	1,218	.25	July 1	17,629	3.68
7	277	.06	2	11,138	2.32
8	1,249	.26	3	1,397	.29
9	1,886	.39	4	2,732	.57
10	12,096	2.52	5	3,031	.63
11	22,118	4.6	6	2,237	.47
13	1,627	.34	7	360	.07
14	19,196	4.0	8	230	.048
15	61,117	12.76	11	1,285	.27
16	53,701	11.2	12	608	.12
17	55,551	11.6	13	856	.18
18	23,033	4.8	14	313	.06
19	16,085	3.36	15	880	.18
20	40,183	8.4	16	213	.04
21	31,748	6.6	17	101	.02
22	4,547	.95	19	1,286	.27
23	1,293	.27	21	539	.11
24	66	.014	22	1,072	.22
25	247	.05	25	440	.09
27	21,348	4.45	26	0	0
28	22,462	4.7	28	123	.025
29	22,469	4.7	29	0	0
30	18,932	3.9			
			Total	478,919	100.00%

Table 23 Approximate Weekly Patterns of Wheat Receipts in June & July at Nine Country Elevators in the Study Area, 1976-77

Elevator Number	June 1-7	June 8-15	June 16-23	June 24-30	July 1-7	July 8-15	July 16-23	July 24-31	Total Bushels (1,000)	Percent of Annual
					-Percent-					
1976-77										
1	-	-	50.5	47.9	-	1.6	-	-	897	97.8
2	0.6	-	-	84.6	-	14.8	-	-	383	98.5
3	1.7	5.2	-	78.7	-	14.0	0.4	-	1,240	97.3
4	-	10.0	59.8	26.3	-	3.9	-	-	1,030	91.0
5	-	0.5	12.6	57.7	22.6	6.1	0.5	-	616	79.4
6	1.3	-	5.7	86.8	-	6.1	0.1	-	586	96.9
7	-	-	-	29.1	68.7	2.2	-	-	686	99.5
8	0.2	-	-	62.1	34.2	3.5	-	-	493	100.0
9		-Not Available-								
% of June/July	0.5	2.9	19.9	56.9	13.1	6.3	0.4	0.0	5.931	94.5
% of Annual	0.5	2.7	18.8	53.8	12.3	5.3	0.4	0.0	6,275	100.0

Table 23 Continued

Elevator Number	June 1-7	June 8-15	June 16-23	June 24-30	July 1-7	July 8-15	July 16-23	July 24-31	Total Bushels (1,000)	Percent of Annual
					-Percent-					
1975-76										
1	-	2.4	8.9	-	80.4	8.3	-	-	563	94.0
2	-	-	0.4	-	99.6	-	-	-	260	97.3
3	0.3	-	58.9	40.3	-	0.4	-	0.1	1,420	96.5
4	-	20.4	44.9	25.7	7.7	1.3	-	-	1,094	88.4
5		-Not Available-								
6	-	78.1	-	21.3	-	0.6	-	-	1.153	96.9
7	-	-	0.3	91.0	-	5.5	3.2	-	922	98.6
8	-	1.9	72.7	-	25.4	-	-	-	550	78.3
9	-	.1	0.6	24.7	57.6	15.3	1.6	0.1	660	93.8
% of June/July	0.1	17.4	27.0	31.7	19.9	3.4	0.5	0.0	6,622	95.1
% of Annual	0.1	16.5	25.7	30.2	18.9	3.2	0.5	0.0	6,960	100.0

Table 23 Continued

Elevator Number	June 1-7	June 8-15	June 16-23	June 24-30	July 1-7	July 8-15	July 16-23	July 24-31	Total Bushels (1,000)	Percent of Annual
					-Percent-					
1974-75										
1		-Not Available-								
2	0.6	-	98.4	-	-	-	*	-	206	95.4
3	0.7	73.4	25.6	-	0.3	-	*	-	2,130	94.5
4	16.6	70.5	11.3	1.6	-	-	-	-	837	89.4
5		-Not Available-								
6	12.3	84.1	3.5	-	-	0.1	-	-	1,657	98.5
7		-Not Available-								
8		-Not Available-								
9	0.2	1.0	36.1	60.8	1.0	0.2	0.2	0.5	488	79.2
% of June/July	6.8	66.8	20.3	5.8	0.2	0.1	*	*	5,318	93.2
% of Annual	6.3	62.3	18.9	5.4	0.2	0.1	*	*	5,706	100.0
3 Year Average										
% of June/July	2.2	27.3	22.6	32.5	11.8	3.3	0.3	*	17,871	94.3
% of Annual	2.1	25.7	21.3	30.6	11.1	3.1	0.3	*	18,941	100.0

* = > 0 but < 0.5 percent

Source: Department of Economics, Kansas State University, 1977

Figure 5 a.

CARLOADS OF GRAIN FOR THE
ATCHESON, TOPEKA & SANTA FE RAILWAY CO.,
FOR WEEKS, YEAR 1972

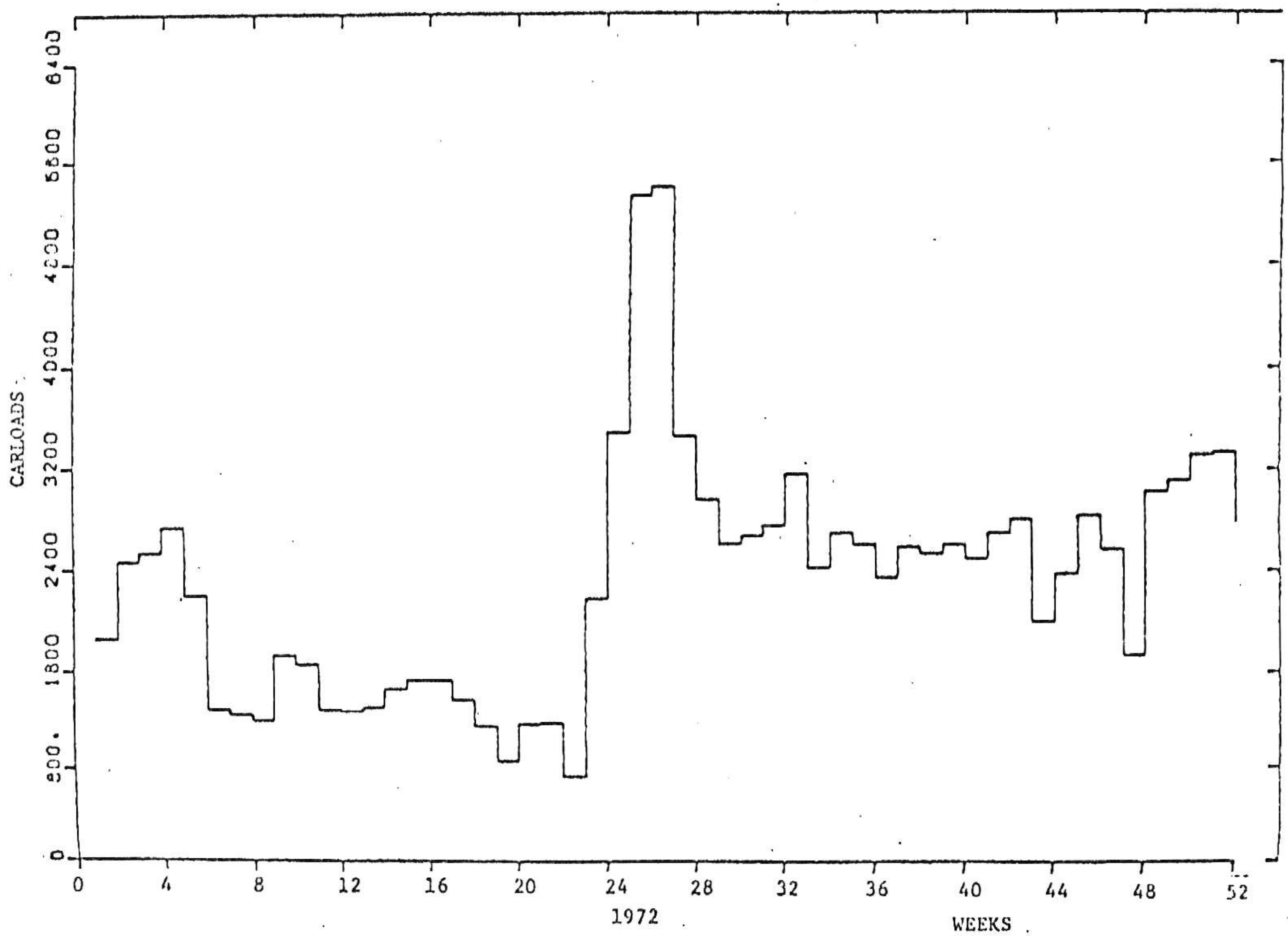


Figure 5b.
CARLOADS OF GRAIN FOR THE
ATCHESON, TOPEKA & SANTA FE RAILWAY CO.,
FOR WEEKS, YEAR 1973

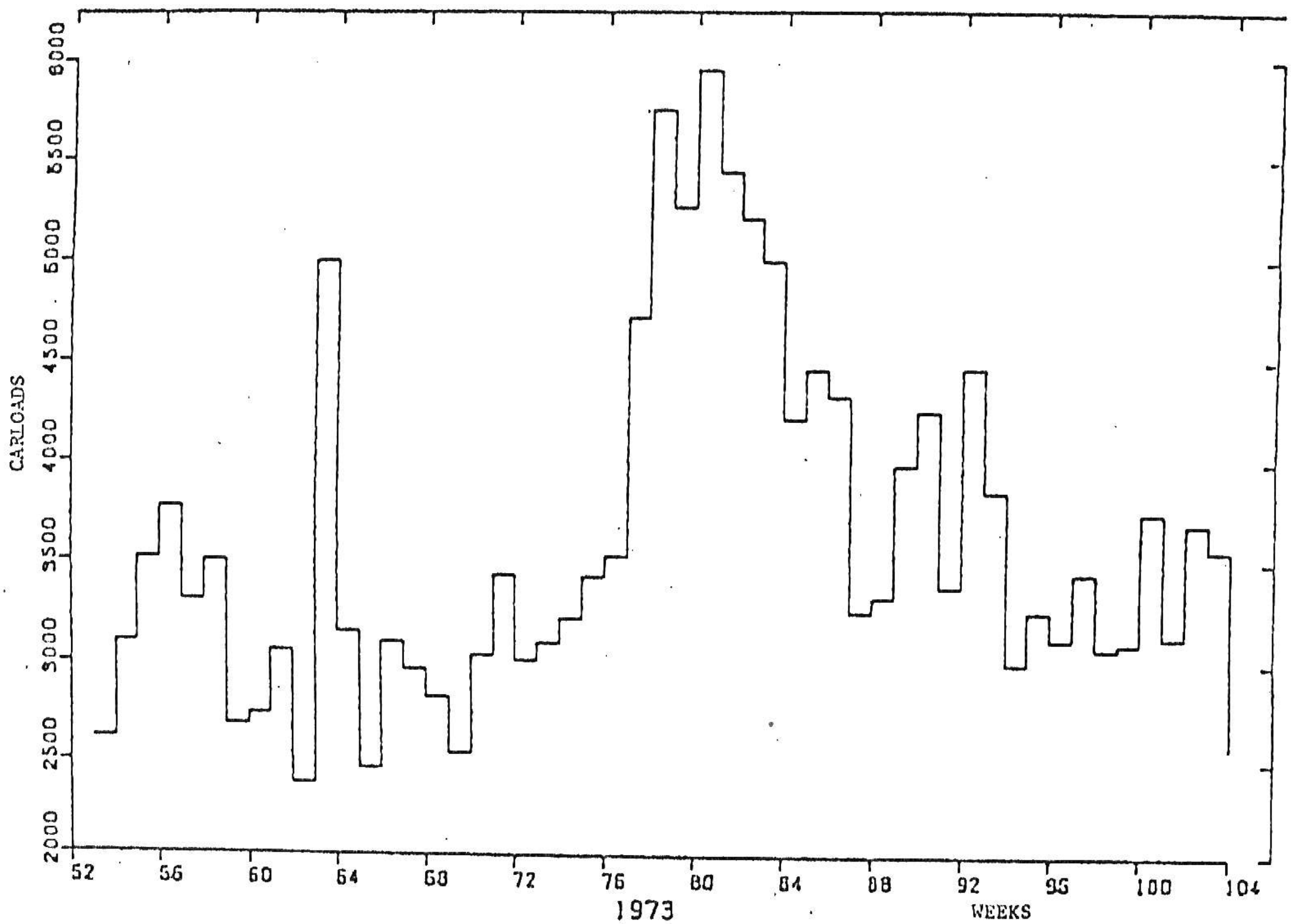


Figure 5c.

CARLOADS OF GRAIN FOR THE
ATCHESON, TOPEKA & SANTA FE RAILWAY CO.,
FOR WEEKS, YEAR 1974

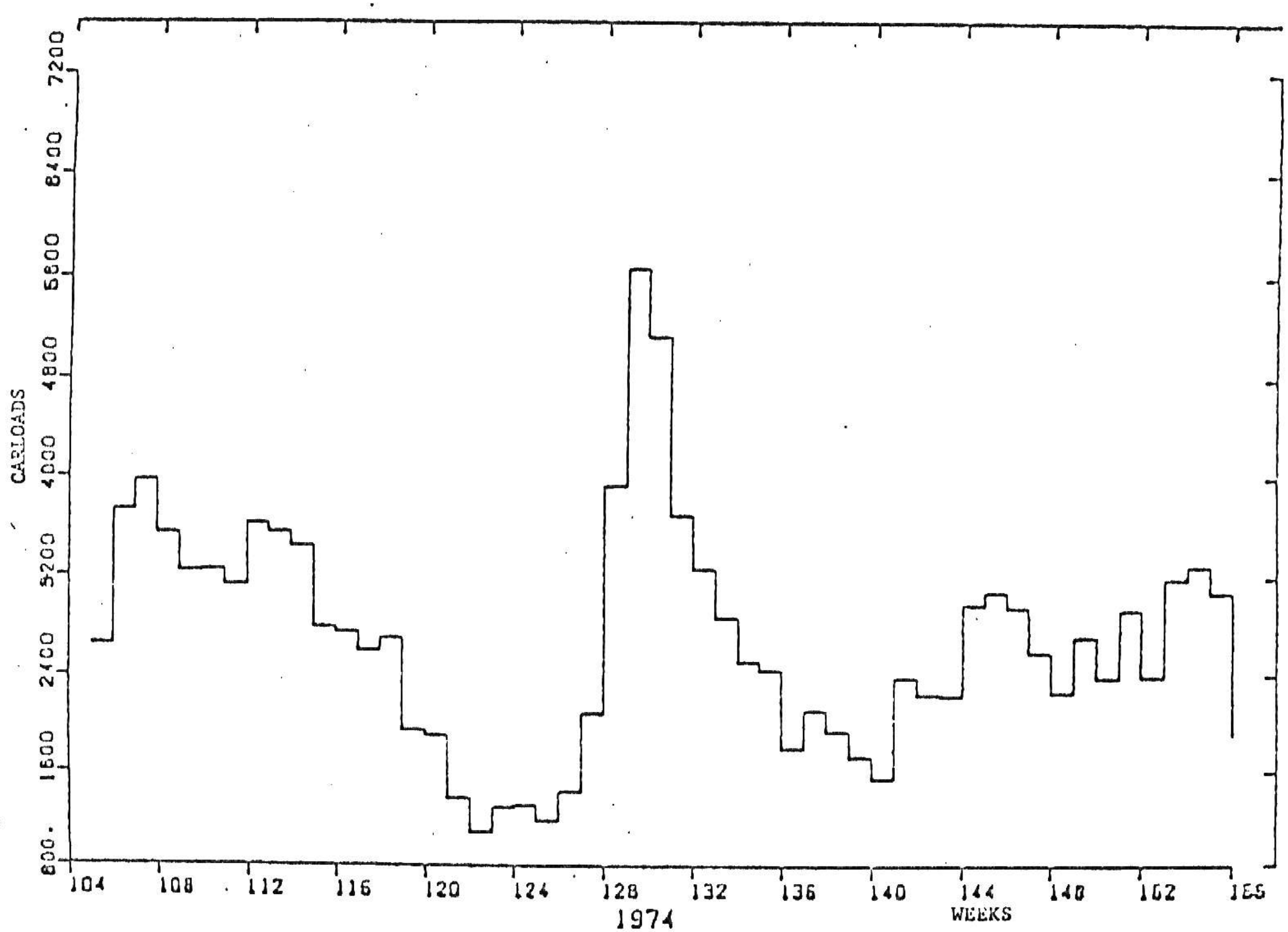
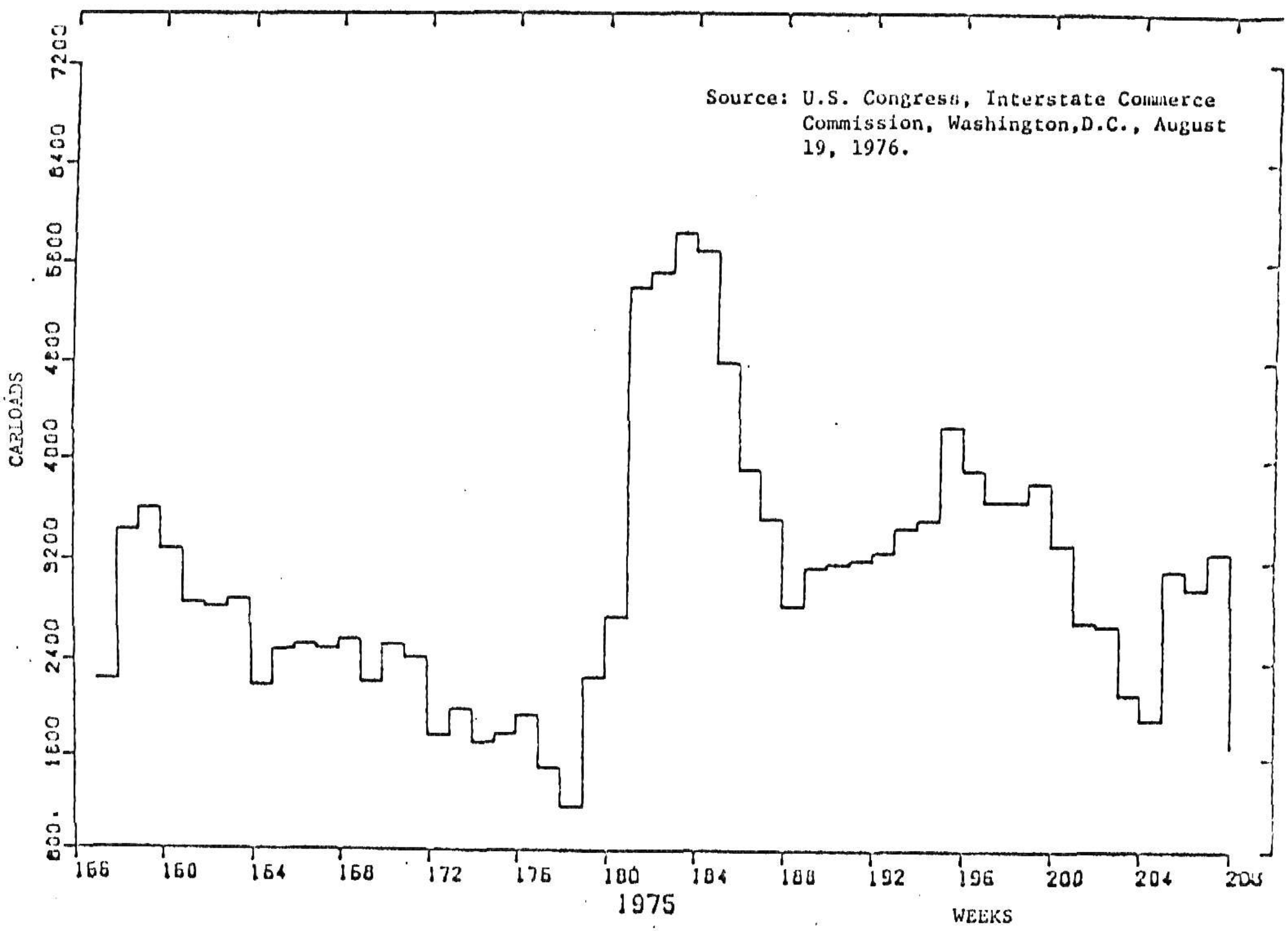


Figure 5d.

CARLOADS OF GRAIN FOR THE
ATCHESON, TOPEKA & SANTA FE RAILWAY CO.,
FOR WEEKS, YEAR 1975



4. Variations in the receiving and shipping of carloads at the terminals.

At terminal elevators variations affecting the receiving, storing, and/or subsequent movement of wheat further along the marketing channel, occur in the day to day carlot receipts and shipments (Table 24). There seems to be no pattern in the receipts and shipments at the terminal, with significant daily fluctuations and fluctuations in total carlot receipts during June and July from year to year. The variations in receipts at terminals can be attributed, in part, to variations in wheat production; however it is plausible that the volume of wheat moving through terminal elevators is the result of factors such as demand for wheat exports (Table 25).

Table 25-- Carlot Receipts at Kansas City vs Kansas Wheat Production (% Change) 1974-77

Year	Receipts in June & July	% Change	Production Wheat(1000bu.)	% Change
1974	11,218		319,000	
		-19.07		+10.00
1975	9,078		350,900	
		+52.6		- 3.4
1976	13,849		339,000	
		-39.4		+ 3.4

The variations discussed, complicate the harvesting-marketing flow of wheat during harvest; adding to system stresses and contributing to the development of peak demand problems or bottlenecks.

Table 24 --Carlot Receipts and Shipments of Wheat at Terminal Elevators in Kansas City

Date	Receipts (carlot)				Shipment (carlot)
	1977	1976	1975	1974	1977
June 1	13	9	20	56	29
2	5	31	40	14	10
3	25	121	59	140	14
6	91	239	151	124	3
7	45	43	34	48	17
8	32	77	39	45	8
9	70	105	85	27	15
13	329	416	114	338	23
14	70	48	28	180	97
15	132	190	82	197	45
16	206	913	76	180	31
17	148	274	110	205	47
20	307	530	276	622	30
21	68	330	202	260	118
22	114	184	11	344	56
23	119	282	227	436	88
24	158	312	238	483	25
27	365	927	533	934	14
28	31	144	252	572	52
29	95	296	255	428	54
30	222	148	355	Holiday	59
July 1	143	461	Holiday	909	19
5	595	1,020	260	175	68
6	192	253	347	289	34
7	223	392	401	366	54
8	301	428	443	372	153
11	778	1,263	840	768	110
12	168	202	306	142	125
13	182	324	182	181	54
14	310	473	255	217	124
15	265	283	272	216	182
18	550	909	572	495	167
19	142	251	292	86	122
20	255	209	166	168	181
21	183	356	231	91	119
22	253	293	259	119	135
25	534	563	303	411	122
26	229	74	316	106	48
27	148	102	84	107	135
28	142	243	251	150	136
29	161	131	111	217	101

Kansas City Grain Market Review. Various issues.

CHAPTER 4

ALTERNATIVES and/or SAFEGUARDS AVAILABLE to the PARTICIPANTS PRIOR to, or DURING HARVEST; and THEIR COSTS

The alternatives and/or safeguards available to the participants involved in the harvesting-marketing flow of wheat during harvest are of three types: 1) temporary storage in on-farm storage facilities with subsequent movement to commercial facilities; 2) "sufficient" available storage space at the local elevator to meet the demand for storage space; and 3) transportation of wheat to a more distant country (local) elevator during the harvest period. Although each alternative and/or safeguard offers means of alleviating or avoiding system stresses during wheat harvest, there exists trade-offs between the benefits and costs. In theory, the optimal level of safeguards would exist where the additional cost of the safeguard is just equal to the expected cost of system stresses occurring.

1. Temporary storage in on-farm facilities.

Temporary storage in on-farm storage facilities during harvest with subsequent movement to commercial facilities will lessen the stresses placed on the local elevator to receive, store, and/or ship grain during harvest; decreasing the demands on transportation agencies for the orderly movement of grain during wheat harvest. Costs resulting from the use of on-farm storage facilities during harvest for temporary storage are a) construction and maintainance of on-farm storage facilities, and b) the additional cost to the farmer for in-loading, out-loading, and delivery to the commercial elevator after harvest.

Where the farmer chooses to store the wheat crop in on-farm storage facilities adequate handling and storage facilities (including aeration and drying equipment) must be provided to handle his production. A study of the cost of on-farm storage in Kansas (10) found modern on-farm grain storage systems require large initial capital investments. Where drying systems are included, total investment per bushel varies from $1.32 for a 10,000-bushel system to $.65 for a 120,000-bushel system. The study found that the cost of on-farm storage systems versus commercial storage depends on length of storage and volume stored. Where grain is stored for less than a 6-month period storage on-farm becomes more expensive compared with storage at commercial facilities. Only for periods of greater than 6-months and volumes larger than 80,000 bushels does farm storage become less expensive (Figure 6). Cost estimates for a 20,000-bushel capacity are $.1082 per bushel annual fixed cost and $.0376 per bushel variable cost; while for a 60,000-bushel system costs are $.0807 per bushel fixed cost and $.0354 per bushel variable cost.

Temporary storage on-farm results in additional costs to the farmer for equipment and labor involved in the in-loading and out-loading at storage facilities, and additional transportation costs. A recent study (11) estimates these additional costs at $.0294 per bushel.

2. "Sufficient" available storage space at the local elevator.

Having sufficient storage space available at the local elevator to accommodate the amount of grain the manager anticipates receiving during harvest requires the elevator manager to estimate the volume of wheat expected to be delivered to the elevator and to take the steps necessary to

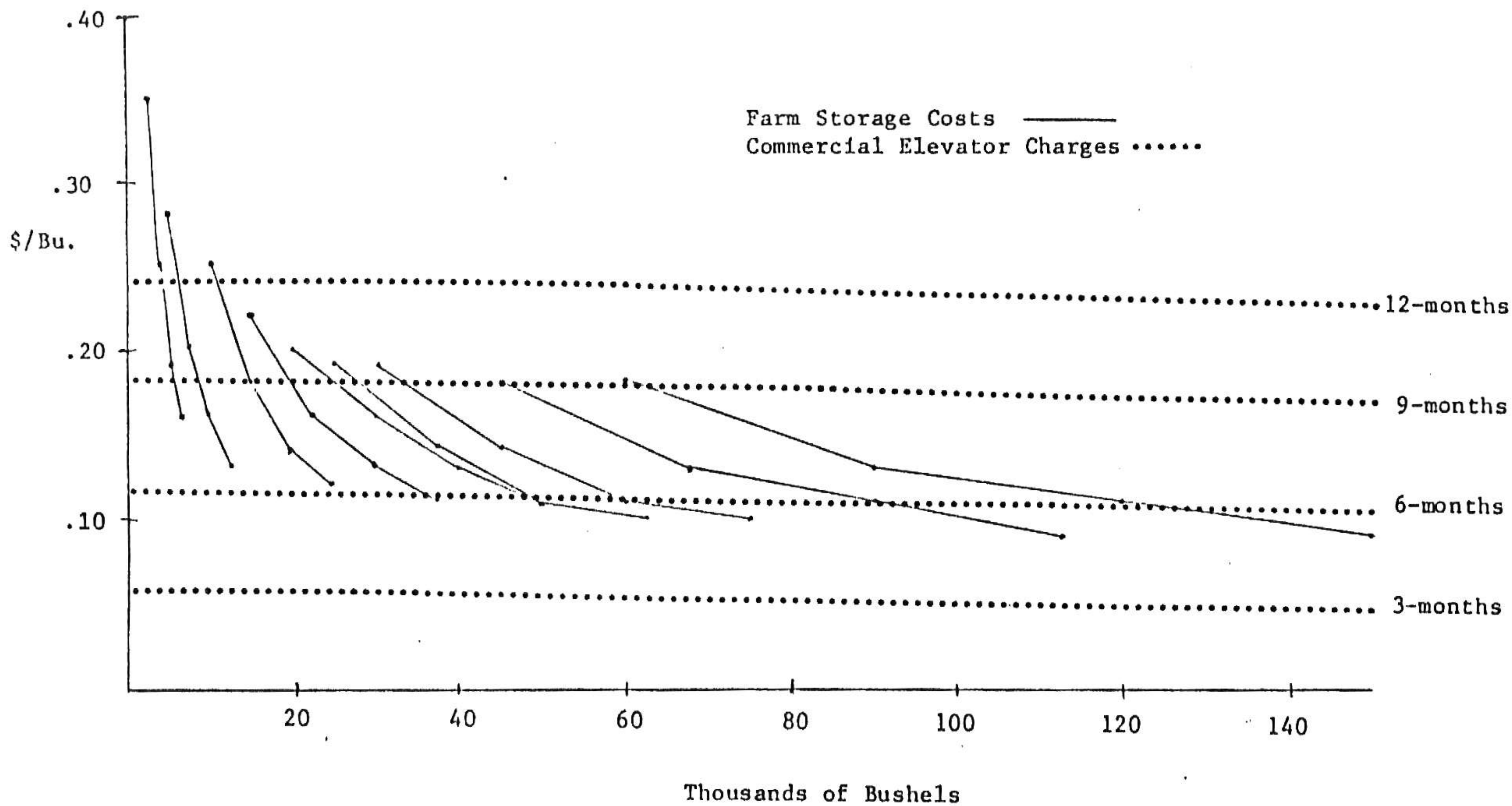


Figure 6 -- Comparison of Farm Storage Costs to Commercial Elevator Charges for Storing Grain 3,6,9,and 12 month periods

Source: Linville, Randy, "The Economics of Farm Grain Storage and Drying in Kansas. (Unpublished Masters Thesis, Kansas State University, 1977), pp.54

make that amount of storage space available. The local elevator manager will begin transferring grain to terminal elevator facilities a "sufficient length" of time prior to harvest depending upon the ability of the railroads to transport the grain.

The cost involved with the movement of grain from the local elevator to terminal facilities prior to harvest is the loss in storage revenue resulting from the local facilities being less than 100% occupied. If an elevator manager anticipates receiving 800,000 bushels of wheat during harvest and needs to make that quantity of space available by April 1 in order to be assured of getting the grain moved in time for harvest, the elevator manager is foregoing 28,000 dollars in revenue (800,000 bushels X $.0175 X 2 months = $28,000).

Where transportation facilities are available for movement of wheat during harvest the elevator manager will ship out part of the grain prior to harvest, yet only the amount which he anticipates having problems shipping during the harvest. For example, if the manager expects to receive 800,000 bushels of wheat during the harvest and anticipates being able to ship 400,000 bushels during the harvest he will only ship 400,000 bushels prior to harvest and earn an additional $14,000 in revenue by not shipping out more grain prior to harvest.

An alternative available to the local elevator manager is the construction of storage facilities capable of handling the largest crop expected (including carryover stock). This alternative would guarantee ample storage space during the peak demand periods of harvest, although ignoring the fixed costs associated with providing "safeguard" storage space.

A 1977 Oklahoma study (12) using previous ERS studies and simple linear regression calculated storage costs according to the equation: $Y_t = A_o + B_i X_i + e_t$; where t = 1, 2, ..., 6 years, representing 1969-70 through 1974-75. The estimates of the equation are used in calculating storage costs (Y_t's) for the omitted years as well as for the forecasted years. Storage cost values are recorded in Table 26, where the estimates are designated by an asterisk in the fiscal year column. Costs in cents per bushel are classified as fixed and variable storage costs.

In 1977, a storage space safeguard of 200,000 bushels used only for four months in one year out of five would result in an annual fixed cost of $32,424 while earning a gross revenue of only $14,000 during the one year in which the safeguard space is used. With the high fixed cost involved in the construction of storage facilities (concrete storage bins), elevator managers are unable to provide "safeguard" storage space for use during peak demand periods.

An alternative form of "safeguard" storage space used by elevators is "normally unlicensed space" used primarily to store feed, minerals, or other agricultural supplies. In periods of inadequate grain storage space the unlicensed facility can be used for temporary grain storage; significantly reducing the cost of providing storage space for use during peak demand periods.

3. Transportation of wheat to a more distant elevator during the harvest.

Where farmers must deliver their wheat to a "more distant" elevator during harvest due to lack of available storage space either on-farm or at the local elevator, trade-offs exist between time (delays in harvest) and

TABLE 26 Costs in Cents Per Bushel of Storing Grain, Using Weighted Average Standardized Book Values, at Country Elevators for Fiscal Years 1964-65 to 1977-78.

	FISCAL YEARS													
	64-65	65-66 *	66-67 *	67-68	68-69 *	69-70	70-71	71-72	72-73	73-74	74-75	75-76 *	76-77 *	77-78 *
Fixed Storage Costs	4.200	5.729	6.603	8.583	8.350	8.194	11.301	10.556	12.192	12.399	13.350	14.465	15.338	16.212
Variable Storage Costs	1.873	2.323	2.592	3.185	3.129	3.394	3.660	3.910	4.059	4.415	4.829	5.008	5.276	5.545
Total Storage Costs	6.073	8.052	9.195	11.768	11.479	11.588	14.961	14.466	16.251	16.814	18.179	19.473	20.615	21.757

*Estimated using least-square regression

Source: Oehtrman,R. "Costs of Receiving, and Loading Grain by Truck, Rail and Water, and the Costs of Storing Grain at Country Elevators for Fiscal Years 1964-65 to 1977-78", Oklahoma State University, September 23,1977.

transportation costs. A farmer having a field 15 miles from the local elevator and road conditions allowing an average speed of 45 miles per hour would spend 40 minutes in traveling time. If the same farmer needed to drive an additional 50 miles to deliver his wheat to an elevator the result would be an additional 2 hours spent in traveling.

The farmer is faced with the alternatives of a) adding an additional grain truck to keep the harvesting continuing, b) building additional on-farm storage as discussed, or c) accepting the delays in harvesting resulting from the increase in traveling time, a solution unacceptable to farmers.

Investment in an additional grain truck is a major capital investment for the farmer. A study of the cost of grain trucking (13) found that trucking costs per bushel[4/] varies with the quantity of grain and the distance traveled (Table 27).

Table 27-- Cost Functions of Grain Trucking

Quantity	Direct Delivery
12,000 bu.	Cb = \$.0265 + \$.00248m
60,000 bu.	Cb = \$.0161 + \$.00202m
120,000 bu.	Cb = \$.0126 + \$.00198m

Cb = cost per bushel m = one way miles

Trade-offs faced by the farmer

The cost and benefits of the alternative (construction of on-farm storage facilities versus transporting the grain to an alternative destination) facing the farmer is a complex trade-off involving a) cost of temporary storage on the farm, and b) cost of transporting to a more distant elevator, including costs of delays resulting from the additional distance traveled in transporting the wheat during harvest.

4/ Cost functions are calculated from averaging the cost functions of 1½-ton, 2-ton, and 2½-ton trucks.

The least cost alternative for the farmer will depend upon the severity and/or frequency with which the farmer experiences problems storing his grain during harvest. As the distance to alternative storage and the frequency with which the farmer is faced with obtaining alternative storage increases, farm storage becomes a relatively better alternative. Although studies have not dealt specifically with this trade-off, hypothetical examples can illustrate the trade-off.

Situation 1: Storage problems occurring annually (20,000 bu.)

Alternative A: temporary on-farm storage for six months.

Costs:

i) fixed and variable storage costs.
($.1082 + $.0376) X 20,000 bu. = $2916

ii) additional cost of grain moving through on-farm storage.
($.029 per bu. X 20,000 bu) = $ 588

Total: $3504

Alternative B: transporting an additional 50 miles during harvest.

Costs:

i) transportation cost.
($.00248 per mile X 50 miles) X 20,000 bu. = $2480

ii) costs resulting from delays in harvest.
20,000 bu. ÷ 300 bu. per truck X 2 hours per trip X $20 per hour delay. = $2666

iii) commercial storage costs.
20,000 bu. X $.0175 per bu. per month X 6 months = $2100

Total: $7246

Under situation 1, where the farmer is faced with a storage problem each year, the least cost alternative is on-farm storage.

Situation 2: Storage problems occurring one year out of five (20,000bu.)

Alternative A: temporary on-farm storage for six months.

Costs:	i) fixed and variable storage costs. ((.1082 X 5) + .0376) X 20,000 bu.	=	$11572
	ii) additional cost of grain moving through on-farm storage. ($.0294 per bu. X 20,000 bu.)	=	$ 588
			$12160

Alternative B: transporting an additional 50 miles during harvest.

Costs:	i) transportation cost. ($.00248 per mile X 50 miles) X 20,000 bu.	=	$2480
	ii) costs resulting from delays in harvest. 20,000 bu. ÷ 300 bu. per truck X 2 hours per trip X $20 per hour delays.	=	$2666
	iii) commercial storage costs. 20,000 bu. X $.0175 per bu. per month X 6 months	=	$2100
			$7246

Under situation 2, the farmer would be better off transporting the wheat to an alternative destination rather than to invest in on-farm storage.

The frequency and/or delivery distance associated with the storing of grain during harvest will determine the benefits and cost of building on-farm storage versus transporting the wheat to an alternative elevator when storage problems occur.

CHAPTER 5

PROPOSALS for SYSTEM IMPROVEMENTS and AREAS of STUDY OFFERING POTENTIAL for FURTHER RESEARCH

Proposals for alleviating peak demand problems during wheat harvest have focused on two areas a) improving the allocation and utilization of the freight car fleet, and b) improving the receiving, storing, and/or shipping operations at the local elevator.

Literature on problems of harvesting and marketing grain has failed to treat the flow of grain from the farm through the marketing channels as one system; ignoring the interdependencies of the system.

A. Improving the allocation and utilization of the existing freight car fleet.

Felton (14) has done significant work on methods of improving the allocation and utilization of the freight car fleet. He concludes that transportation problems in the marketing of grain are in part due to the present method of car allocation, affecting the utilization of the car fleet.

Felton contends that with the present car rental system and interline car movements there is a failure of the system to solve satisfactorily the economic problem of the allocation and utilization of the present car fleet. In dealing with the system problems of railroads in the movement of grain he offers four proposals 1) railroad mergers, 2) a national carpool, 3) an integrated computerized information system, and 4) an auction market for freight cars.

1. Railroad mergers

According to Felton, if the problem of the adequacy and efficiency of the freight car fleet arises primarily as a result of interline freight car movements, one solution to the problems would be extensive railroad mergers. The problem of "interline freight car movement", referred to by Felton, is that as long as the daily car rental rates are less than the projected daily ownership costs Railroad A will pay car rental charges to Railroad B rather than investing in additional freight car.

Felton's proposal for extensive railroad mergers would decrease the amount of interline car movement, increasing the utilization of the car fleet. In addition the incentive to invest in new cars would increase since the cost of renting cars would be similiar to the cost of owning them.

A railroad merger to the extent necessary to accomplish the elimination of all interline movements would require a complete restructuring of the railroad system in the United States. If a complete consolidation of the railroads (to eliminate interline movements) could be acheived, it is likely that diseconomies of scale would set in long before such a system could be acheived.

2. A national carpool

Under a national carpool the railroads would relinquish control of a portion of their freight cars to either a governmental department or a railroad-owned corporation which would have the responsibility for the distribution of the cars. Before a national carpool could be beneficial the controlling agency would need to determine a method of allocating the cars to each of the participating railroads and determine if they (the agency) would control the purposes for which the cars could be used. Opponents fear that a national carpool would deprive individual railroads of effective control over an input (freight cars) vital to the services the railroads perform.

3. An integrated computer information system.

The information system proposed by Felton would provide current information on the location of each freight car, matching the movement of the car with its schedule and keeping track of whether or not the car is on schedule. When a freight car gets off schedule the computer system keeps track of both the original schedule and the actual schedule; providing assistance to management in determining ways of improving the performance of the freight car fleet.

Although the information system would aid in monitoring the location and performance of the cars in the fleet, it would not inform management of how the cars should be allocated or where the cars should be located in order to best utilize the car fleet.

4. An auction market for freight cars.

Felton discusses an auction market for freight cars where a teletype auction market could exist for the renting (allocation) of the existing car fleet. Railroad officials, shippers, freight car brokers, private car companies, grain companies, and elevator managers would participate as buyers and sellers of freight car services. Through a classification system, buyers would be informed of the type and condition of cars being bid on. The auction market system would have the potential of letting the market place determine how the fleet of freight cars would be allocated and what rental rates would be charged.

The auction market system would eliminate freight car shortages as far as the railroads are concerned; however the shippers would still be subject to potential car shortages. The shippers would also be faced with more uncertainty as to what freight rates would be charged. A second criticism of an auction market system is its failure to take into consideraion the ability and/or length of time necessary to move an empty car from its original location to the location of the shipper who has purchased its services. An elevator manager in Western Kansas may successfully bid for freight cars, but if those empty cars are at an embargoed port facility system stresses will occur.

Peak-period rates

An important aspect of transportation in Agriculture is its seasonal, variable, and for the most part unpredictable demand for services. Under the recently passed Public Law 94-210, cited as the Railroad Revitalization and Regulatory Reform Act of 1976, rail carriers have been given the authority to vary rates up or down by 7% throughout the year. The Act is designed to provide incentives for shippers to reduce peak period shipments through rescheduling and advance planning.

The concept of "peak-period rates" or "peak-load pricing" is to shift the demand for services from periods when demand is high to periods when the demand is lower.

Peak-load pricing is not unfamiliar in the United States where Americans experience the peak-load pricing system everyday, ie., electric and telephone rates; however the concept is new to the railroad industry. It is the opinion of John Hansen, Kansas City Board of Trade, that Public Law

94-210 does have application for some commodities, but not for the movement of grain. In an appearance before a Senate Hearing (15), Hansen stated that if the carriers decide to use the new law (Public Law 94-210) to increase rates at harvest time it will not create a rescheduling or change the timing of the attack by combines on the grain fields. The consequence of Public Law 94-210, if used, will result in lower prices to the producer and loss of revenue by the carriers due to diversion to other modes of transportation to escape the higher rail rate charges.

B. Improving the receiving, storing, and/or shipping operation at the elevator.

Proposals for improving the harvest-marketing flow of wheat through the local elevator have focused on a) receiving of grain, b) movement of wheat into storage, and c) shipping of wheat to the next channel in the system. Although each elevator is unique with its own areas of potential system stresses, some generalized suggestions and guidelines have been stated for improving the operation of elevators (16). Suggestions and Guidelines are:

1. Structure the working hours of the elevator to better conform to the schedule of the harvesting operation, such as from 10 am to 12 midnight.
2. Try to even out the arrival of grain trucks at the local elevator. The idea was suggested that the elevator pay a small premium for truckloads of dry grain arriving before noon and after 9 pm. Elevator managers agree that evening out the arrival pattern of receipts would be beneficial; however they felt that paying a premuim would have little impact during Kansas wheat harvest, where weather conditions

determine the harvesting pattern.

3. Encourage the use of grain trucks with endgates capable of rapid unloading or have separate receiving facilities for small, slow unloading trucks.
4. Provide better communication during harvest between harvesting crews, truckers, farmers, and elevator operators by means of radio or television reports. Being informed of potential problems can aid in solving or preventing severe problems from occurring.
5. Update the elevator facilities to accommodate the large volume of wheat being harvested with modern machinery in a relatively short span of time, ie., increase the capacities of receiving facilities, elevator legs, and rail siding.
6. Schedule rail car loadings to coincide with the slack times of the work day by loading the cars early in the mornings before the harvesting crews get into full operation.

The suggestions offered for improving the local elevator operation will aid in smoothing out the isolated and minor problems as they arise at the local elevator. Major problems (inadequate storage space or inability to obtain freight cars) however are not going to be eliminated by dealing only with the individual sub-system.

To make significant progress in alleviating system stress occurring during the wheat harvest in Kansas, the harvesting-marketing flow of grain must be treated as one system composed of interdependent sub-systems.

AREAS of STUDY OFFERING POTENTIAL for FURTHER RESEARCH

Research into the system stresses occurring during the wheat harvest has raised unanswered questions and brought into focus areas where further research is needed. Issues for further investigation can be summarized into five research objectives.

OBJECTIVES:

A. To estimate the storage space available at local elevators in Kansas at the beginning of harvest.

B. To estimate the geographic and seasonal demand for (and supply of) transportation services during harvest.

C. To identify and evaluate factors contributing to the large variations in the pattern of receipts and shipments occurring at terminal elevators in Kansas.

D. To estimate the cost function associated with delivering grain to an alternative destination during harvest.

E. To identify and evaluate factors affecting the allocation of grain stocks among on-farm and off-farm storage facilities; and the effect of changes in production on the level of grain stocks.

PROCEDURES:

Objective A.

1. Establish and maintain a data base on the occupancy rates of local and terminal elevators in Kansas.
2. Identify and describe the relationship existing between the occupancy

rates of local and terminal elevators in Kansas.

3. Collect historical data (for the time period of data in step 1) on changes in occupancy rates at local and terminal elevators with respect to a) season of year, b) carryover stocks of grain, c) changes in cash and futures prices, and d) production estimates.
4. Develop a model based on time series analysis to estimate the occupancy rates of local elevators in Kansas on a localized basis.

Objective B.

1. Develop procedures to measure the geographic demand for transportation of grain in Kansas.
2. Collect historical data on the number and types of freight cars available in Kansas for the movement of grain prior to, and during harvest.
3. Evaluate the reliability of rail service to Kansas elevators, focusing on the timing and number of cars ordered versus number and timing of cars received.
4. Measure the effect of weather variations on the location and timing of demand for transportation services.
5. Measure the effect of elevator carryover stock on the demand for transportation prior to, and during harvest.
6. Evaluate the alternatives of rail-truck substitution privileges.

Objective C.

1. Identify factors affecting the supply and demand of grain moving through terminal elevators.
2. Collect historical data on the factors determined in Step 1, and

analyze situations contributing to the large variations in receipts and shipments at terminal elevators.

3. Estimate the costs resulting from the large variations (in receipts and shipments) occurring at terminal elevators.

Objective D.

1. Develop procedures for identifying the characteristics of farm trucks used for delivery of grain in Kansas.
2. Develop estimates of the cost of transporting grain by farm trucks.
3. Develop estimates of the distances farmers will transport wheat during harvest before investing in an additional grain truck or additional on-farm storage.
4. Develop estimates of the delays in harvest resulting from delivering grain to an alternative storage facility during harvest.
5. Develop dollar estimates of the value which farmers place on time when weather conditions permit harvest.
6. Based on the estimates of Steps 2-5, develop estimates of the cost functions of delivering grain to an alternative destination during wheat harvest.

Objective E.

1. Identify the variations in stocks of grain excluding wheat.
2. Test the hypothesis that as the total level of stocks increase, on-farm storage facilities play a larger role in absorbing that increase than does off-farm storage facilities.
3. Test the hypothesis that as the general price level decreases, farmers

view the use of on-farm storage as an economical method of long term storage.

CONCLUSION

The relationships between the storing and transportation of Kansas wheat during the harvest period have been found to be extremely complex, complicated by an interdependent system involving and affected by activities and decisions at each of the four sub-systems.

System stress occurring during the wheat harvest can be the result of 1) failure of the participants of the sub-systems involved to be aware of the demands to be placed on them by harvest, or to take the necessary steps to prepare for the harvest; and 2) variations beyond the control of the participants involved which give rise to the occurrence of stresses or bottlenecks.

The consequences of system stresses occurring depend on the severity and/or frequency with which problems develop. One problem facing the participants of the grain marketing system is measuring the trade-offs between costs (losses) resulting from bottlenecks occurring and costs (benefits) of providing safeguards (alternatives) to prevent system stresses. A second problem is determining the incidence of costs of preventing or continuing bottlenecks among the participants in the grain marketing system.

On the basis of this study, there are no simple solutions to the problems associated with the storing and transportation of wheat during harvest. This study has identified characteristic variations in the demand for and supply of services for handling wheat during harvest and traced the effects of system stresses on various sub-systems throughout the system, exploring the alternatives available to the participants at each sub-system and bringing into focus further research areas for possible system improvements.

LITERATURE CITED

1. Richard L. Kohls and W. David Downey, Marketing of Agricultural Products, (4th ed.; New York: Macmillian, 1972),pp. 296.

2. W.F. Payne, P.C. Baumel, and D. Moser, Estimating Truck Transport Costs for Grain and Fertilizer, Unpublished NCR research publication, April,1977.

3. Department of Agricultural Economics, Kansas Agricultural Experiment Station, Kansas State University, Wheat Shipments from Kansas 1972-73, Contribution No. 575, (Manhattan, Kansas: Agricultural Experiment Station,1974),pp. 18.

4. Patrick P. Boles, The Freight Car Supply Problem and Car Rental Policies, USDA, Marketing Research Report No. 953, (Washington, D.C.: Government Printing Office,1972),pp. 11.

5. Association of American Railroads, Yearbook of Railroad Facts,(1977 ed.; Washington, D.C.),pp. 43.

6. U.S., Congress, Senate, Senate Congressional Record; S9417, June 10,1977. (Washington, D.C.: Government Printing Office,1977).

7. Department of Agricultural Economics, Kansas Agricultural Experiment Station, Kansas State University, Wheat Shipments from Kansas 1972-73, Contribution No. 575, (Manhattan, Kansas: Agricultural Experiment Station,1974),pp. 18.

8. Department of Economics, Kansas State University, Cooperative Extension News Release, (Manhattan, Kansas: Office of Extension News, September 29, 1976).

9. USDA Statistical Reporting Service, Scope and Methods of the Statistical Reporting Service, Miscellaneous Publication No. 1308, (Washington, D.C.: Government Printing Office,1975),pp. 27.

10. Randy Linville, The Economics of Farm Grain Storage and Drying in Kansas, Unpublished Masters Thesis, Kansas State University,1977, pp. 54.

11. Preliminary study by Dr. Orlo Sorenson, Department of Economics, Kansas State University, Manhattan, Kansas, 1977.

12. Robert L. Oehrtman, Costs of Receiving, and Loading Grain by Truck, Rail and Water, and the Costs of Storing Grain at Country Elevators for Fiscal Years 1964-65 to 1977-78. Technical Memorandum, Oklahoma State University, Stillwater, Oklahoma, September 23, 1977.

13. Randy DeBey, The Cost of Transporting Grain by Farm and Commercial Trucks, Unpublished Masters Thesis, Kansas State University, 1977, pp. 61.

14. John Richard Felton, Freight Car Shortages in Grain Transport: An Institutionalized Disequilibrium, University of Nebraska, Lincoln,1974, pp. 97.

15. U.S., Congress, Senate, Committee on Commerce, Science and Transportation, Rural Transportation, Hearing, 95th Cong., 1st Sess. April 16,1977, (Washington,D.C.: Government Printing Office, 1977), pp. 121.

16. Heber D. Bouland, Selecting the Best Capacity of Truck Receiving Facilities for Country Elevators, USDA, Agricultural Research Service, Marketing Research Publication No. 671, (Washington, D.C.: Government Printing Office,1967), pp. 43-44.

BIBLIOGRAPHY

1. Association of American Railroads. Yearbook of Railroad Facts. 1977 ed. Washington, 1977.

2. Boles, P.P. The Freight Car Supply Problem and Car Rental Policies. USDA Marketing Research Report No. 953. Washington: Government Printing Office, 1972.

3. Bouland, Heber D. Selecting the Best Capacity of Truck Receiving Facilities for Country Elevators. USDA Agricultural Research Service. Marketing Research Publication No. 671. Washington: Government Printing Office, 1967.

4. DeBey, Randy. The Cost of Transporting Grain by Farm and Commercial Trucks. Unpublished Masters Thesis, Kansas State University, 1977.

5. Department of Agricultural Economics, Kansas Agricultural Experiment Station, Kansas State University. Wheat Shipments from Kansas 1972-73. Contribution No. 575. Manhattan: Agricultural Experiment Station, 1974.

6. Department of Economics, Kansas State University. Cooperative Extension News Release. Manhattan: Office of Extension News. September 29, 1976.

7. Felton, John Richard. Freight Car Shortage in Grain Transport: An Institutionalized Disequilibrium. University of Nebraska, Lincoln, 1974.

8. Kohls, R.L., and W.D. Downey. Marketing of Agricultural Products. 4th ed. New York: Macmillian, 1972.

9. Linville, Randy. The Economics of Farm Grain Storage and Drying in Kansas. Unpublished Masters Thesis, Kansas State University, 1977.

10. Oehrtman, R.L. Costs of Receiving, and Loading Grain by Truck, Rail and Water, and the Cost of Storing Grain at Country Elevators for Fiscal Years 1964-65 to 1977-78. Technical Memorandum. Oklahoma State University, September 23, 1977.

11. Payne, W.F., B.C. Baumel, and D. Moser. Estimating Truck Transport Costs for Grain and Fertilizer. Unpublished NCR research publication, April, 1977.

12. Sorenson, Orlo. Preliminary study. Department of Economics, Kansas State University, 1977.

13. U.S. Congress. Senate. Committee on Commerce, Science and Transportation. Rural Transportation. Hearing, 95th Cong., 1st Sess.; April 16, 1977. Washington: Government Printing Office, 1977.

14. U.S. Congress. Senate. Senate Congressional Record. S9417. Washington: Government Printing Office, June 10, 1977.

15. USDA Statistical Reporting Service. Scope and Methods of the Statistical Reporting Service. Miscellaneous Publication No. 1308. Washington: Government Printing Office, 1975.

AN ECONOMIC STUDY OF SYSTEM STRESSES ON THE STORING AND TRANSPORTATION OF KANSAS WHEAT DURING HARVEST

by

WARREN C. MEYER

B.S., Iowa State University, 1976

AN ABSTRACT OF A REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Agricultural Economics

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1978

Abstract

An Economic Study of System Stresses on the Storing and Transportation of Kansas Wheat During Harvest

Wheat harvest places a significant stress upon the grain harvesting and marketing system. During the harvest, peak demand problems can occur evidenced by 1) lines of farm trucks waiting at local elevators to unload, 2) local elevators closing down the receiving of grain, 3) grain being piled on the ground, and 4) farmers being forced to temporarily store grain in farm buildings not designed for grain storage.

The harvesting-marketing flow of wheat during the harvest period is facilitated by an interdependent system involving and affected by activities and decisions at several levels or sub-systems. Functional sub-systems are 1) harvesting and local elevator delivery (farm), 2) local receiving, storing, and/or shipping (local elevator), 3) transportation activities (railroad or motor carriers), and 4) terminal receiving and storing (terminal elevator or processor).

Specific problem approaches to systems bottlenecks have tended to focus on specific agencies without conceptualizing a system involving interdependencies and the influence of events or decisions at one level on performance at other levels.

The purpose of this study is to describe and analyze the flow of wheat during harvest as one system composed of several sub-systems. Each sub-system is under separate control and management; each has its own function within the system; and each has optimization goals for its own sub-system.

The procedural approach of this study is to focus upon the harvesting-marketing flow of wheat (from the farm level through the channels to the terminal elevator or processor) as one system. Secondly, drawing upon past research along with primary and secondary data, analyze the grain flow and identify system stress points and factors contributing to these conditions.

Predominate factors contributing to system bottlenecks or stress situations appear to be of two types:

1. Insufficient "timely" information on the demands for services from the system. With the supply of storage and transportation facilities fixed in the short run only relocation of stocks and reallocation of resources can occur in response to changing conditions. Responding to system needs requires accurate and timely information on a sufficiently localized basis.
2. Variations occurring at each sub-system. Unpredictable variations play an important role in determining how smoothly the harvest progresses. Variations occur in a) weather conditions, b) the receipt patterns of grain at the local elevators, c) the supply of (and demand for) freight cars with respect to time and location, and d) the receiving and shipping patterns of grain at terminal elevators.

The consequences of system stresses occurring depend on the severity and/or frequency with which problems develop. One problem facing the participants of the grain marketing system is measuring the trade-offs between costs (losses) resulting from bottlenecks occurring and costs (benefits) of providing safeguards (alternatives) to prevent system stresses. A second problem is determining the incidence of costs of preventing or continuing bottlenecks among participants in the grain marketing system.