WHEAT PURCHASES BY KANSAS FLOUR MILLS AND TYPE OF CARRIER USED IN TRANSPORTING WHEAT AND FLOUR

by

RICHARD DALE REIMER

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INTRODUCTION

History of Wheat Production in Kansas

The first wheat grown in Kansas was brought from Illinois in 1855 and harvested the following summer. Some of this wheat was replanted that fall.[1] However, indications are that this wheat was not well-suited to Kansas climatic conditions with numerous crop failures reported during the following years. This Illinois wheat appears to have suffered from drought and winter killing. In addition, growing conditions were such that tillage and planting methods had to be altered in order to take into consideration lack of moisture and wind erosion. Despite these changes in methods the harvest was frequently disappointing and farmers generally came to realize the need for a drought resistant wheat which would be adapted to the prairie environment.[2]

In 1873 a group of Mennonites of Dutch and German background who had settled in Russia during the reign of Catherine the Great, left their adopted country and migrated to the plains of Kansas and Nebraska bringing with them some hard red winter Turkey wheat. A large wheat grower near Salina who had tried many varieties had this to say about the new wheat, "Finally my attention was directed to the Turkey or Red Russian variety. It was a hard wheat and at first regarded as much inferior to the Red May, but it proved very hardy and yielded prolifically. I substituted it, I think, in 1877."[3]

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[1] Brachs, W. B., Wheat Country, Duell, Sloan, Pearce, New York, 1950.

[2] Shellenberger, J. A., "The Story of Wheat Development in Kansas," Cereal Science Today, Vol. II, No. 4, April, 1957, p. 75.

[3] Krahn, Cornelius, From the Steppes to the Prairies, Mennonite Publication Office, Newton, Kansas, 1949, p. 11.

The amount of wheat brought along by the Mennonites appears to have been small. A pioneer miller in the Halstead-Newton area, in an attempt to increase the production of hard winter wheat, imported a large shipment from the Crimea in Russia in 1885-86 for distribution among the farmers.[1]

With the introduction of the Turkey variety, wheat production in Kansas expanded at a rapid rate. For many years now Kansas has been the leading wheat producing state in the nation. Table 1 shows the rapid increase in production from 1870 to 1920. Since that time, although large year to year fluctuations have occurred, production has remained relatively stable. For the years 1947 through 1956 the crop has averaged 187,948,000 bushels with a low of 126,113,000 bushels in 1951 and the largest crop on record 307,629,000 bushels, in 1952.

Obviously a wheat crop of this size is of great economic importance to the state. Table 1 also shows the farm value of the wheat produced in each year. Table 2 indicates that for the years 1947 to 1956 wheat has accounted for from 30 to 54.7 percent of total farm income. During these ten years receipts from the sale of wheat have averaged 34.9 percent of total farm income.

History of Flour Milling in Kansas

The first mill in Kansas was built by an Indian near Wyandotte in 1862. Indications are that this was only a feed mill and that the first flour mill was built at Lawrence in 1857. A year or two later a mill

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[1] Krahn, Cornelius, From the Steppes to the Prairies, Mennonite Publication Office, Newton, Kansas, 1949, p. 11.

Table 1. Kansas wheat production and farm value, 1870-1956.

Year	Acres Harvested (thousands)	Production bu. (thousands)	Price	Farm Value (thousands)
1870	156	2,418	$ .77	$ 1,861
1880	2,340	23,400	.70	16,380
1890	2,160	34,400	.77	24,948
1900	4,290	78,078	.55	42,943
1910	4,870	60,475	.87	52,613
1920	9,294	144,933	1.76	255,082
1930	13,132	186,277	.63	117,355
1940	8,739	126,553	.64	80,994
1947	14,855	286,702	2.25	645,080
1948	13,221	231,368	1.97	455,795
1949	14,279	157,069	1.89	296,860
1950	12,280	178,060	2.02	359,681
1951	9,701	126,113	2.13	286,621
1952	14,643	307,629	2.14	658,326
1953	11,573	144,662	2.11	305,237
1954	10,069	176,208	2.18	384,133
1955	8,559	128,385	2.05	263,189
1956	9,244	143,282	2.00	286,564

Source: Compiled from data provided by the Federal-State Crop Reporting Service.

Table 2. Farm value of wheat production expressed as a percentage of total marketing receipts for Kansas, 1947-1956.

Year	Total Farm Marketing Receipts (thousands)	Farm Value of Wheat Produced (thousands)	Wheat Percentage of Total (percent)
1947	$ 1,224,686	$ 645,080	52.6
1948	1,148,113	455,795	37.2
1949	987,928	296,860	30.0
1950	1,044,317	359,681	34.4
1951	1,102,313	268,621	24.3
1952	1,205,085	658,326	54.7
1953	966,138	305,237	31.5
1954	966,810	384,133	39.7
1955	851,364	263,189	30.9
1956	836,644	286,564	34.2
Total	10,923,486	3,923,486	
Average			34.9

Source: Compiled from data provided by the Federal-State Crop Reporting Service.

was built in Atchison. No mills were built in central or western Kansas during the following decade. The first mill in Wichita, which is now the leading flour milling city in the state, was built in 1876, three years after the introduction of hard winter wheat into the area.[1]

According to census reports there were 36 flour grist mills in Kansas by 1860. This number trebled during the following decade, but after 1890 numbers started to decline and have continued to decline in recent years. Most of these early mills were very small and their grinding was for local purposes only. Water appears to have been the chief source of power, although at least one mill was run by wind power.

Although most of the flour ground by these mills was for local consumption only, the first recorded shipment out of the state occurred as early as 1859, with the first foreign shipment being made in 1882.[2] That the quality of Kansas flour milled from Turkey wheat was recognized is evidenced by a letter received from a Belgian firm by the Newton Milling and Elevator Company in 1888 stating, "Kansas flour of Turkey wheat is always welcome in this country. In fact, it is the only flour that answers well the purpose."[3]

The depression after 1888 seems to have hindered the growth of the industry. This along with the development of grain trading and milling in Kansas City, Missouri, was especially detrimental to the smaller interior mills which, as indicated earlier, started to decline in number.

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[1] Kuhlman, Charles Byron, The Development of the Flour Milling Industry in the United States, Houghton Mifflin Company, Boston, 1929, p. 198.

[2] Ibid., p. 202.

[3] Krahn, op. cit., p. 11.

The development of hard winter wheat mills in Kansas brought rivalry with the established hard spring wheat mills in Minnesota. Kansas millers at first had a hard time selling their flour in the eastern markets because the quality of Kansas wheat was not known. Northwestern millers even accused Cincinnati inspectors of passing Kansas flour which was branded with Minnesota spring wheat patents. Since Kansas wheats were not known at the time and Minnesota patents were considered supreme this may actually have happened.

Kansas millers turned the tables in 1900 by charging that Minneapolis millers were blending their spring wheat with Kansas winter wheat and advertising it as pure spring wheat. However, after 1910 the merits of Kansas wheat had become recognized and the mixing of wheats to secure a uniform flour had become such a general practice that the charge was dropped.[1]

Flour Milling in Kansas Today

For many years Kansas, along with being the leading wheat producing state in the nation, has ranked first in flour milling, even though the state has no large flour-milling centers like Buffalo, New York; Minneapolis, Minnesota; or Kansas City, Missouri.

Table 3 shows the amount of flour milled annually in Kansas during the last ten years. As can be seen from the table, the amount of flour milled in Kansas has decreased substantially during this time. The

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[1] Kuhlman, op. cit., p. 202.

Table 3. Wheat milling production in sacks, Kansas and United States, 1947-1956.

Year	Kansas (thousands)	United States (thousands)	Kansas Percent of Total
1947	52,124	305,499	17.1
1948	51,119	279,133	18.3
1949	36,685	234,351	15.7
1950	35,151	225,697	15.6
1951	36,008	229,292	15.7
1952	35,045	228,148	15.4
1953	30,702	222,177	13.8
1954	29,727	221,756	13.4
1955	30,035	225,651	13.3
1956	30,831	229,479	13.4

Source: "The Northwestern Miller," May 28, 1957, p. 23.

decrease from 1947 to 1956 amounts to a percentage decrease of 40.9. However, the total amount of flour milled in the United States has also decreased during the same period. Thus the share milled in Kansas declined from 17.1 percent in 1947 to 13.4 percent in 1956.

Not only has the total amount of flour milled in Kansas declined since World War II, but the number of mills operating has also been sharply reduced. Table 4 lists the number of mills in operation in the state in each of the last ten years. Also given is the level of production in terms of percentage of rated capacity. The reduction in

Table 4. Number of mills in Kansas.

Year	Number	Daily Capacity (in sacks)	Percent of Activity
1947	70	174,065	111.0
1948	67	179,285	110.6
1949	67	181,555	96.0
1950	57	172,819	78.9
1951	56	172,445	81.1
1952	56	173,998	79.6
1953	53	161,990	76.7
1954	46	152,910	75.5
1955	46	148,740	79.2
1956	41	151,189	79.9

Source: "Northwestern Miller," May 28, 1957, p. 23.

number of mills amounts to 41.1 percent. With this reduction in number of mills has come a reduction in rated capacity although not as large as might be expected. This leads us to one of two conclusions. Only the smaller mills have ceased operation or else the remaining mills have increased their volume. Many of the small mills have ceased to operate during the past few years. Statistics on changes in the past ten years in rated capacity are not available; however, Table 5 shows that the total wheat purchased by the 13 mills in the sample has not changed to any extent during the past five years. A look at Table 4 will confirm the fact that percent of activity has remained relatively stable

Table 5. Total wheat purchased by 13 reporting mills.

Year	Direct from Farmer (thousand bu.)	Country Elevators (thousand bu.)	Terminal Elevators (thousand bu.)	Total (thousand bu.)
1952	5,213	10,723	9,653	25,589
1953	4,236	9,682	10,273	24,191
1954	4,731	10,882	10,145	25,758
1955	3,524	11,559	10,020	25,103
1956	4,368	10,984	10,296	25,648
Total	22,072	53,830	50,387	126,289

in the last five years. This would lead to the conclusion that many of the smaller mills have ceased operations while existing mills continue to operate at rather stable levels of production.

It should be pointed out that the decline in number of mills is continuing. At the time of the survey for this study, December, 1957, only 38 flour mills were found to be in operation. While it is not the purpose of this study to give any specific reasons for the decline in number of mills, it should be pointed out that the greatest drop occurred simultaneously with the decline in percent of activity following the high years immediately after World War II.

PROBLEM AND PURPOSE

Important changes have been taking place in the flour milling industry in Kansas since World War II. Inasmuch as these mills have

the capacity to mill approximately one-half of the wheat grown in Kansas, any changes made by these flour millers with regard to wheat purchases and type of transportation used are of tremendous importance not only to the wheat growers of the state, but also to the wheat marketing and transportation facilities which have developed through the years.

Therefore, one of the purposes of this study was to determine the marketing channels through which the wheat used by Kansas flour millers moves and the type of transportation used. Because of the importance of any changes in the area of source of supply and type of transportation used, it was also the purpose of this study to determine the extent of the changes, if any, which may have occurred in the last five years and to determine the significance of the changes with regard to the future of not only the milling industry in Kansas, but also on the future market for Kansas-grown wheat.

PROCEDURE

The entire population of 38 Kansas flour mills was stratified into three size groups on the basis of rated daily milling capacity. Group A included those mills with rated daily capacity of 4,400 sacks and over; Group B included those mills between 2,200 and 4,399 sacks per day; and Group C was made up of mills with rated capacity of 2,199 sacks per day and under. This meant that there were 12 mills in each of Groups A and B and 14 in Group C. A random sample of one-third of the mills was drawn from each strata. The population was stratified because it w as felt that differences with regard to source of supply might exist because of differences in the size of the mills.

A survey was conducted in which each mill drawn in the sample was visited personally. Flour millers were questioned about the size of their operation and agencies from whom purchases were made. Additional questions asked dealt with the type of transportation used in shipping wheat and flour and the final destination of flour. Millers were also asked to state the factors which they take into account in determining source of supply and expected future trends both with regard to source of supply and type of transportation.

Data secured in the survey were supplemented with additional information compiled by the Federal-State Crop Reporting Service, as well as references to various books, bulletins, and periodicals dealing with grain marketing and flour milling.

Compiled data were analyzed and subjected to appropriate statistical tests whenever possible in order to determine possible differences in source of supply because of size. Correlations were also computed to determine the possible existence of any trends within the industry. Specific statistical tests used are given in the section in which they are used.

WHEAT PURCHASES BY KANSAS FLOUR MILLERS

Table 5 shows the purchases, in bushels, from the various agencies for the five years 1952 to 1956 inclusive. Also shown are the total purchases from each agency as well as the total for each of the five years. As is evident from the table, the total amount of wheat purchases has remained exceptionally stable during the past five years. The low year was 1953 with 24,191,000 bushels being purchased. The high year in amount

purchased was 1954 with 25,758,000 bushels being purchased, a difference of 1,547,000 between the low and high years during the five year period. Amounts purchased from the various agencies vary a little more from year to year than do total purchases. The reason for this will become evident later.

When the mills are segregated into size groups A, B, and C, somewhat the same thing occurs. (Tables 6, 7, and 8). In each instance the total amount purchased remains relatively constant, while the amounts purchased from the various agencies change slightly more in comparison.

Table 9 shows the percent of wheat purchased by the three size groups from each agency each year. Using these percentage figures a two way analysis of variance was conducted to determine if the size of the mill or the particular year had any effect on the percentage of wheat purchased from each agency.[1] Differences between the mean squares were tested by means of the F-test.[2]

For purchases from terminal elevators the F value for years was .85 which is non-significant at the five percent level. For size groups the F value equaled 4.30. This is significant at the five percent level. Similar results were obtained for purchases from country elevators and for purchases direct from farmers. For purchases from country elevators the F value for years equaled .60 which is non-significant at the five percent level while for size groups the F value equaled 209.37

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[1] Snedecor, George W., Statistical Methods, Iowa State College Press, Ames, Iowa, 1956, pp. 291-300.

[2] Ibid. F is the ratio between the mean square of sample means over the mean square of individuals. The value obtained for F is used to test whether differences between samples are greater than would ordinarily be expected because of sampling variations. p. 244.

Table 6. Wheat purchased by mills in Group A.[1]

Year	Direct from Farmer (thousand bu.)	Country Elevators (thousand bu.)	Terminal Elevators (thousand bu.)	Total (thousand bu.)
1952	2,119	5,901	4,847	12,867
1953	1,759	5,301	4,919	11,979
1954	1,996	6,132	4,933	13,061
1955	1,341	6,527	4,529	12,397
1956	1,599	6,039	5,461	13,099
Total	8,814	29,900	24,689	63,403

[1] Four mills with rated daily milling capacity from 4,400 sacks and up.

Table 7. Wheat purchased by mills in Group B.[1]

Year	Direct from Farmer (thousand bu.)	Country Elevators (thousand bu.)	Terminal Elevators (thousand bu.)	Total (thousand bu.)
1952	1,606	4,415	3,547	9,567
1953	1,728	4,105	4,113	9,946
1954	1,562	4,416	4,055	10,033
1955	1,270	4,791	4,192	10,253
1956	1,501	4,784	3,576	9,861
Total	7,666	22,511	19,483	49,660

[1] Four mills with rated daily milling capacity from 2,200 to 4,399 sacks.

Table 8. Wheat purchased by mills in Group C.[1]

Year	Direct from Farmer (thousand bu.)	Country Elevators (thousand bu.)	Terminal Elevators (thousand bu.)	Total (thousand bu.)
1952	1,489	407	1,259	3,155
1953	749	276	1,241	2,266
1954	1,173	334	1,157	2,664
1955	913	241	1,299	2,453
1956	1,268	161	1,259	2,688
Total	5,592	1,419	6,215	13,266

[1] Five mills with rated daily milling capacity below 2,199 sacks.

which is highly significant. For purchases direct from farmers the F value for years equaled 1.60 which is non-significant while for size groups the F value equaled 88.72 which is highly significant. Thus in all three instances purchases do not vary significantly from year to year, but they do vary among the size groups.

In order to determine specific differences among the groups the means of each of the groups were ranked and by the use of Duncan's New Multiple Range Test differences were detected.[1] In all three instances group C, which was made up of the small mills, differed significantly from groups A and B, while it was impossible to distinguish between groups A and B.

[1] Duncan, David B., "Multiple Range and Multiple F Tests," Biometrics, March, 1955, Vol. 11, No. 1, p. 3.

Table 9. Percentage of wheat purchased from each agency by size group by year.

Year	A	B	C	Percent of Total[1]
		Terminal Elevator		
1952	37.6	37.1	39.9	37.7
1953	41.1	41.3	54.8	42.5
1954	37.8	40.4	43.5	39.4
1955	36.6	40.9	53.0	39.9
1956	41.7	36.3	46.8	40.1
Average[2]	39.0	39.2	47.6	39.9
		Country Elevator		
1952	45.9	46.1	12.9	41.9
1953	44.2	41.3	12.2	40.0
1954	46.9	44.0	12.5	42.2
1955	52.6	46.7	9.8	46.0
1956	46.1	48.5	6.0	42.8
Average[2]	47.1	45.3	10.7	42.6
		Direct from Farmers		
1952	16.5	16.8	47.2	20.4
1953	14.7	17.4	33.0	17.5
1954	15.3	15.6	44.0	18.4
1955	10.8	12.4	37.2	14.0
1956	12.2	15.2	47.2	17.0
Average[2]	13.9	16.5	41.7	17.5

[1] Percent of total purchases.
[2] Average of percentages.

The above analysis clearly indicates that the mills in groups A and B purchase the bulk of their wheat from terminal and country elevators while the smaller mills which comprise group C prefer to purchase their wheat either from terminal elevators or directly from farmers. One reason for the large percentage of wheat purchased directly from farmers by the mills in group C is that of the five mills which comprised this group, two purchased all of their wheat in this manner. There is every reason to believe that this is rather typical of small mills, because generally they produce a family type flour primarily for local consumption. Because this type of flour does not need to meet certain requirements for mechanized baking operation, there is not as much need to blend a number of wheats with different characteristics to produce the desired type of flour. Also because most of the flour produced by these mills is consumed locally any wheat which is shipped in from a distance carries with it an additional freight cost which can not be applied to outgoing shipments.

PURCHASING TRENDS WITHIN THE INDUSTRY

As was indicated earlier, total purchases of wheat by the flour millers included in the sample have remained fairly constant during the past five years. However, some variation was noted in amounts purchased from the various agencies. In order to determine the existence of any possible trends regarding source of supply, scatter diagrams were drawn for each of the size groups of mills showing the total amounts of wheat, in bushels, purchased by all of the mills in the particular group from each of the three agencies in each of the last five years. Regression lines were plotted for each of the agencies using the formula,

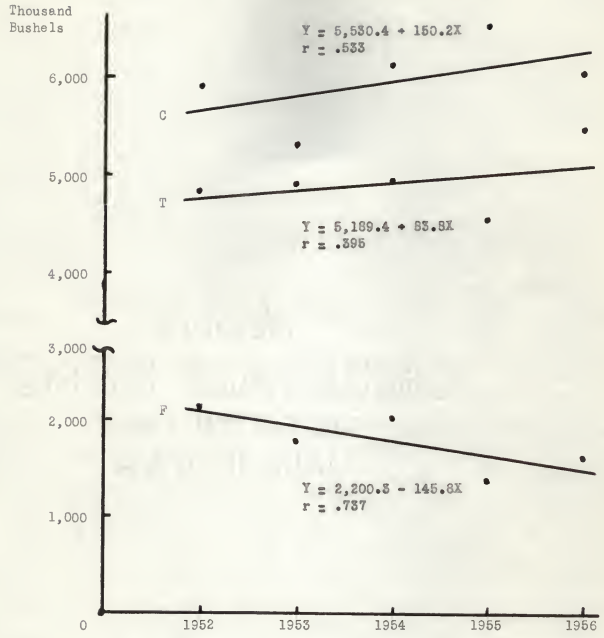

Fig. 1. Purchasing trends of mills in size groups A 1952-1956.

T - Purchases from terminal elevators

C - Purchases from country elevators

F - Purchases direct from farmers

$Y = a + bX$.[1] In order to determine if b, the slope of the line, differed from "0", it was tested by means of the t-test.[2] Specific hypothesis tested was, Ho ($B = 0$).

Fig. 1 shows the regression line for the amounts purchased from each of the three agencies for size group A. The "b" value of -14.8 computed for purchases direct from farmers is significant at the 20 percent level. This would indicate that there is a slight trend away from direct purchases. The "b" values computed for purchases from country elevators and from terminal elevators are not significant indicating no trend in either direction.

For the mills in group B the "b" values computed for purchases from farmers and from terminal elevators were non-significant while the "b" value of 142.4 for purchases from country elevators was significant at the 20 percent level. This would lead to the conclusion that mills in group B are buying slightly more wheat from country elevators.

The exact opposite of this was true for mills in the smallest size group, group C. The "b" value of -52.7 for purchases from country elevators was significant at the 10 percent level, thus indicating a trend away from purchases from country elevators. Neither of the "b" values for purchases direct from farmers or from terminal elevators were significant.

Fig. 2 gives the regression line for purchases from each of the agencies by all 13 mills included in the sample. None of the "b" values are significant at the 10 percent level indicating that when the entire sample is grouped together no trends are ascertainable.

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[1] Snedecor, op. cit., p. 124.
[2] Ibid., p. 126.

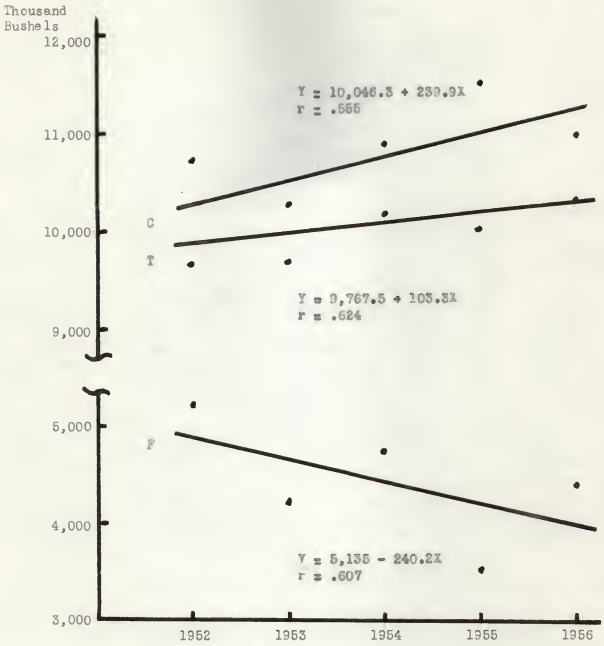

Fig. 2. Trends in purchases of all mills included in survey 1952-1956.

T - Purchases from terminal elevators

C - Purchases from country elevators

F - Purchases direct from farmers

CRITERIA USED BY FLOUR MILLERS IN DETERMINING SOURCE OF SUPPLY

The preceding material indicates that flour millers purchase their wheat from various sources and that there is some variation between mills of various sizes. On the basis of the data secured in the survey it was found that some mills may purchase all of their wheat from one agency while another mill may bypass that particular source of supply completely. For instance, one mill included in the survey purchased all of its wheat from terminal elevators while two other mills did not purchase any wheat in this manner. Assuming that each miller is trying to maximize profit it would, at first observation, appear that one or more of these millers were making purchases in an irrational manner. However, upon closer observation it becomes evident that millers may be completely rational in making purchases from various agencies because each situation may be different because of location of the particular mill, type of flour milled, final destination of flour, etc.

Therefore, in order to understand why wheat is purchased from different agencies and why various mills differ in their purchasing procedure it is necessary to know what criteria are used by the millers in determining the source of their supply.

Grain buyers interviewed in the survey were asked, "What factors do you take into consideration when purchasing wheat?" The predominant answer given was, quality of the wheat in question. Quality can mean different things to various people; therefore, before proceeding any further a definition of quality needs to be given.

When looking for quality in wheat the farmer, miller and baker all desire some of the same characteristics of quality in wheat but each emphasizes different ones. The farmer desires a wheat which will yield well, be resistant to weather extremes and have a good test weight.

The miller wants a wheat that has normal bolting or sifting properties. It should be neither too hard nor too soft. A very hard wheat requires extra power in grinding. A soft wheat means that certain adjustments will need to be made in the milling process. A good hard wheat provides from 69 to 75 percent of a 95 percent straight grade flour with acceptable ash.

A good flour for baking should have high absorption, a medium dough development time and a good mixing tolerance. The dough should be elastic and stable during the entire baking process. The resulting bread should have good crumb color, grain and texture and loaf volume. Unfortunately few wheats possess all of these quality characteristics.[1]

Because it is almost impossible to find one wheat which combines all of these quality requirements flour millers resort to blending different wheats in order to obtain a uniform flour.

In order to determine quality certain tests for quality have been established. These can be roughly divided into four categories: Physical tests performed on the grain and chemical, physical dough, and baking tests performed on the flour.

Physical Tests. Test weight is the oldest and perhaps most important of the physical tests. This is important to the farmer because high

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[1] Miller, Byron S. and Johnson, John A., Testing Wheat for Quality, Production Research Report No. 9, United States Department of Agriculture, Washington, D.C., 1957, p. 1.

test weight means more money for him. It is important to the miller because usually flour yield is associated with test weight. Shriveled grain may be more difficult to mill into low ash flour with the desired freedom from germ specks. However, for sound wheats and within reasonable limits there is no correlation between test weight and flour quality.

Chemical Tests. Perhaps the most important single test of quality is the test for determination of the total amount of crude protein in wheat and flour. This is because of the normal direct relationship between protein content and loaf volume.

The ash test is used to differentiate between flour grades, but some milling authorities assert its value in determining flour quality has been greatly overestimated.

Therefore, when grown under favorable environmental conditions the quantity of protein remains as the best indicator of flour quality. However, when wheat is grown under abnormal conditions the quality of the protein is extremely important.[1]

The Physical Dough Test. The Brabender faranograph is one of the most widely used physical dough testing instruments. The faranograph shows the amount of water required by the dough. This amount of water is called optimum absorption. In addition, the curve on the graph also shows the amount of mixing, dough development time, required to develop the dough properly in order to produce the best bread. It also shows the stability of the dough to mixing. Stability is defined as the time difference to the nearest $\frac{1}{2}$ minute between the point where the top of the curve first intersects the 500 Brabender line and the point where the top of the curve leaves the Brabender 500 line. (See Fig. 3).

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[1] Ibid., p. 3.

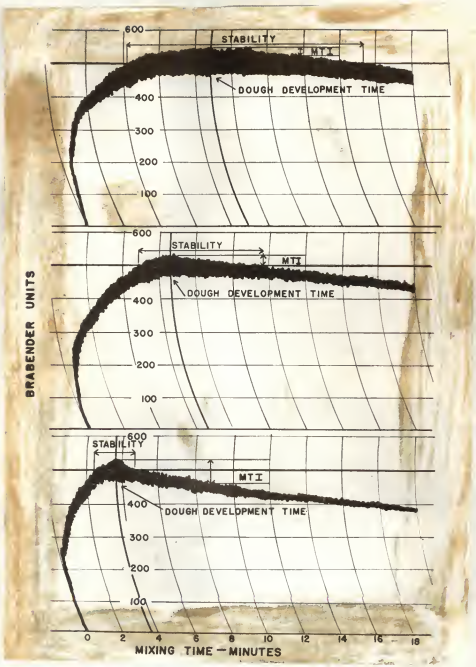

Fig. 3. Typical farinograms of flour samples with a long, medium, and short dough-development time, showing values for stability and mixing tolerance index (MTI).

Source: Miller, Byron S. and John A. Johnson, Testing Wheat for Quality.

Another measurement is the mixing tolerance index (MTI). It is the difference in Brabender units from the top of the curve at the peak to the top of the curve measured five minutes after the peak is reached.[1]

Certain wheat varieties which exhibit good stability to mixing are: Comanche, Ponca, Concho, Cheyenne, Tenmarq, Turkey and Nebred. However, other factors besides variety affect flour characteristics. As protein content increases the dough development time, absorption and stability also increase. But the mixing tolerance index decreases as protein content increases. Stability to mixing is the quality in greatest demand by commercial bakers. Along with this they would prefer a short dough development time. Unfortunately wheats with good stability are in short supply and usually they have a long dough development time.

Fig. 4 shows the method used by some flour millers in the state in evaluating wheat for quality. The figures given are the results of running the various tests on an actual wheat sample.

Baking Test. The quality of the baked bread is the final test of flour quality. In the baking test the percentage of absorption, loaf volume and external and internal characteristics are evaluated.[2]

Having defined quality and having explained the various methods and tests used to determine quality, the various factors which affect quality need to be examined. Shellenberger breaks these factors down into four general categories.[3]

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[1] Ibid., p. 4.
[2] Ibid., p. 7.
[3] Shellenberger, op. cit., p. 76.

Experimental Milling and Baking

Mill	A C	No.	X1338
Origin	Basic Blend #25		
Variety			
Bin No.		Moisture	10.85
Car No.			
Grade		Protein	14.25
Test Wt.		Ash	

Milling Data

Date	4-12-57	Yield	1.434
Total Feed	596	% Ext.	69.7
Total Flour	1370	Amt. Used	2000
Total Prod.	1965	Water Added	90

Flour Analysis		Faranograph Data	
Moisture	14.25	Absorption	61.7
Ash	.446	Consistency	510
Protein	12.70	Hydration	3¾
Color		Peak	7
Odor		Stability	10¼
Maltose	175	M.T.I.	40

Baking Data

Dough No.	5	Date	4-15-57
Flour Wt.	200	Volume (30)	30
Water	128	External (10)	8
Absorption	64.0	Grain (30)	23
Mixing Time	5½	Texture (30)	23
Volume (CC)	845	Total (100)	84
Cr. Color	97+	Rating	Good

Note: Flour Data Calculated to 14% Moisture Basis.

Fig. 4. Actual evaluation sheet used by some millers.

Wheat Varieties. The properties of seven different varieties are compared in Table 10. Table 11 shows a similar although less detailed analysis for four wheat varieties for a more recent year. From these figures it is possible to conclude that wheat varieties do affect quality. Flour millers have expressed the opinion that the quality of Kansas wheat has fallen from the high pedestal on which it once rested. This appears to be particularly true of wheat grown in southwestern Kansas. Some critics seem to feel that what is needed is a change in wheat varieties grown. The view appears to be based on the tremendous improvement brought about by the introduction of Turkey wheat in 1874. However, the dream that the introduction of a new variety would bring an end to quality problems is not too realistic. Today the qualities of wheats throughout the world are well known. The market for wheat has stabilized. Indications are that any future improvement in wheat varieties will be brought about by much research and hard work and that progress will be slow.[1]

Rainfall. Average annual rainfall in Kansas varies from 40 inches in eastern Kansas to about 16 inches in the western tier of counties. Too much or not enough rainfall at various stages in the growth of the wheat plant can have adverse affects on wheat quality.

Soil Nitrogen. Records of soil nitrogen depletion at the Fort Hays Branch Station show that in 45 years the soil nitrogen has been reduced by one-half.[2] At the present time over much of the wheat area it is not economical to add fertilizer to wheat to replace the depleted soil

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[1] Shellenberger, op. cit., p. 76.

[2] Myers, H. E., "Soil Quality and Wheat Quality," Milling Production, Vol. XI, No. 12, December 1946, p. 8.

Table 10. Composites of equal portions of same variety grown at 10 different stations in 1952.[3]

Variety[2]	Wheat Analyses[1]			Flour Analyses[1]				Baking Test, Straight Dough Method			
	Test Weight (pounds)	Protein (per-cent)	Ash (per-cent)	Protein (per-cent)	Ash (per-cent)	Farino-graph Absorp-tion (per-cent)	Valori-meter Value	Mixing Time (min-utes)	Loaf Volume (cc)	Grain (per-cent)	Texture (per-cent)
Comanche	59.0	12.8	1.60	11.8	.44	62	66	3.0	940	90	90
Kiowa	61.0	12.9	1.55	12.1	.41	63	58	3.0	945	86	86
Pawnee	60.0	12.6	1.51	11.2	.43	61	46	2.0	903	90	90
Ponca	59.6	12.0	1.61	11.2	.44	60	64	3.5	960	86	86
Red Chief	62.0	12.4	1.55	11.6	.46	63	56	3.0	930	86	85
Turkey	58.7	12.8	1.68	11.7	.45	61	74	3.0	960	88	88
Wichita	62.2	12.0	1.60	11.0	.43	61	54	2.5	933	90	90
Average	60.4	12.5	1.59	11.5	.44	62	60	2.9	940	88	88

[1] Results reported on 14 percent moisture basis.
[2] Varieties arranged in alphabetical order.
[3] Stations - Manhattan, Tribune, Kingman, Belleville, Hays, Hutchinson, Dodge City, Garden City and Mankato.

Source: Miller, Byron S. and John A. Johnson, Testing Wheat for Quality.

Table 11. Comparison of the properties of flour wheat varieties grown at 16 stations in Kansas in 1955.[1]

Variety	Protein (percent)	Protein Range (percent)	Valorimeter Reading	Farinograph Absorption (percent)	Sedimentation Value	Loaf Volume (cc)
Concho	13.6	9.2-17.2	55	69.9	43	806
Pawnee	13.9	9.4-17.1	50	69.0	40	805
Ponca	14.0	9.7-17.1	58	67.6	46	839
Turkey	13.6	9.4-15.8	55	66.4	45	819

[1] Values reported are the means from 16 samples.

Source: Shellenberger, J. A., The Story of Wheat Development in Kansas, Cereal Science Today, Vol. II, No. 4, April, 1957.

nitrogen. Improved wheat varieties have meant higher yields to the farmer but since the amount of available protein is partly fixed by environmental conditions, this has meant wheat with lower protein content.

Climate. The effects of climate on wheat quality are not too well known at the present time but is generally believed that the best conditions for wheat production are warm summers and subhumid or semiarid climates with rich deep black or brown soils. A combination of high temperatures and high humidities is extremely harmful to quality wheat production. It is for this reason that, although wheat can be grown in a wide range of climate and soil types, only a few areas regularly produce strong, high gluten wheats.[1]

[1] Shellenberger, op. cit., p. 77.

Next to quality, price is the most important factor influencing purchases. However, actual prices paid for wheat may not be as important as it might seem. Other factors which influence prices are basic freight rates, transit privileges and final destination of flour.

Because Kansas City is the price basing point for Kansas, freight rates to Kansas City are an important factor in determining wheat prices at various local points in Kansas. Therefore, as long as local rates are an accurate reflection of freight rates, interior mills can draw wheat from any area and as long as the railroads will grant transit privileges, the cost of the wheat in the form of flour will be the same at the final destination of the flour. Usually as long as the movement of wheat and flour is in the same general direction transit privileges are allowed; however, in one instance found in the survey a mill located in south central Kansas reported that because not enough local wheat was available the most logical source of their supply was southeast Kansas, but because most of their flour was shipped to Memphis the railroads refused to grant back-haul privileges. Thus, they were forced to purchase the bulk of their wheat in northwestern Kansas and southwestern Nebraska.

One mill owner reported that because local wheat was usually of excellent quality a premium was usually paid for it and because of this, plus transit privileges, it was possible to ship in wheat and send the flour out to its final destination at a lower price than flour milled from local wheat. Flour millers are also reluctant to purchase wheat which must be shipped in by truck because basic rates will have to be paid on rail shipments of flour milled from trucked-in wheat.

Another factor which influences the source of supply is the type of flour milled. Family type flour does not need as high a protein content as bakery type flour; consequently, those mills producing predominantly family type flour will either purchase their wheat direct from local farmers or else from terminal elevators. On the other hand, mills producing mainly baking flour are much more discriminating not only as to the amount of protein, but also all the other factors affecting quality which were discussed earlier. Wheat used for bakery flour may originate in central and northwest Kansas, western Nebraska, Wyoming and eastern Colorado. Mills located in the northeastern part of the state also use hard spring wheat to blend with the hard winter wheat.

Size of operation also enters into the picture. Two small mills, milling only family type flour made all of their purchases locally. However, even here, wheats were blended by using wheat grown on different soil types and in different years.

Many mills in the state have a limited amount of storage space. This means that in order to keep their plant operating throughout the year they need to have a constant flow of wheat coming in. In eastern Kansas almost all wheat moves to market at or shortly after harvest. Therefore, mills in eastern Kansas with limited storage space must purchase the bulk of their wheat either from terminals, western Kansas or out of state. Some mills with sufficient storage space purchase as much local wheat as possible, providing it is of reasonably good quality, and then purchase outside wheat to blend with the local wheat to produce the desired grade of flour. Mills with ample storage space will even carry

over wheat from one year to the next, if it is found to possess the desired characteristics.

The particular policies of the individual mill also influence the source of supply. One policy found, which has already been noted in another connection, is to buy all local wheat available. One owner pointed out that they were there to provide a market for the farmer's grain and that by blending different wheats they were able to utilize almost all wheat purchased locally, except an occasional lot which was either sent on to a terminal market or diverted to feed use.

In some plants, the policy was to purchase all wheat through grain merchants. This meant that any wheat that was purchased locally first moved through a country elevator and the grain merchant. The bulk of these firms' purchases were made through the board of trade and moved through terminal elevators. The reason given by one firm for this type of operation was that they believed that the other fellow, meaning the grain merchant, also needed to make a living.

Personal habits of the individual grain buyer will also affect source of supply. Buyers, after finding that a certain locality produces the type of wheat which they desire, will continue to purchase wheat from that area even though grain of similar quality is more readily available elsewhere. In the survey, one buyer pointed to a three or four county area on the map of Kansas and indicated that the bulk of all purchases were made in that area and that no wheat was purchased west of a line running down the center of Kansas. This was interesting in view of the fact that another firm interviewed in the same town, milling the same type of flour, indicated that they purchased a large share of their

wheat from western Kansas. It is possible that this particular buyer stressed certain tests of quality to the exclusion of others. In this case it was apparent in talking to the buyer that he considered ash content to be of great importance.

TRUCK SHIPMENTS OF WHEAT

Although the bulk of all wheat processed by Kansas flour mills is shipped by rail, it is nevertheless true that a considerable volume of it does move by motor carrier. Table 12 gives an indication of the amount of wheat which moves by truck. Included in these figures are all the purchases made directly from local farmers as well as wheat which moves in from a distance. In Table 13 the amounts purchased directly from farmers has been excluded. This leaves only a small fraction of total wheat shipments actually moving any great distance by truck.

Since 1955, railroad freight rates have been rising steadily. For instance, prior to July 1, 1955 the charge from Salina to Kansas City was 25½ cents per cwt. By February 15, 1958 this had risen to 33½ cents per cwt. During this same period rates from Goodland to Kansas City rose from 38½ cents to 45½ cents per cwt.[1]

It would be supposed that with these increases in railway freight rates there would be a definite trend toward truck shipments. However, this has not been the case as indicated by the trend line in Fig. 6. The value obtained for b, the slope of the line, 47.7 is non-significant beyond the 20 percent level. This indicates that during the last five

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[1] Personal correspondence from J. A. Lynch, Transportation Assistant, Kansas City Board of Trade, March 10, 1958.

Table 12. Total amount of trucked-in wheat.

Year	Bushels (thousands)	Percent of Total Purchases
1952	6,712	26.2
1953	5,237	21.6
1954	6,263	24.3
1955	4,646	18.5
1956	6,045	23.6

Table 13. Amount of trucked-in wheat, other than local purchases.

Year	A (thousand bu.)	B (thousand bu.)	C (thousand bu.)	Total (thousand bu.)
1952	339	935	225	1,499
1953	184	736	81	1,001
1954	458	947	127	1,532
1955	362	636	124	1,122
1956	957	521	199	1,677

years no discernable trend toward truck transportation has taken place. One of the reasons for this is the previously mentioned transit privileges granted by the railroads to processors of agricultural products. Another reason that might be given is that rates charged by truckers have also increased somewhat.

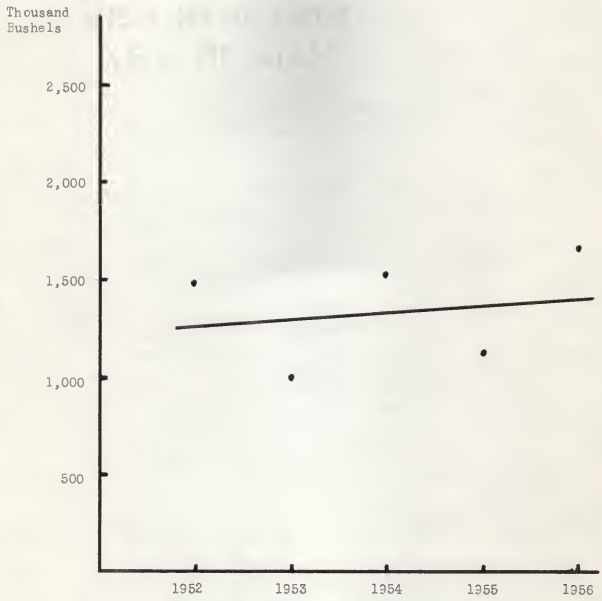

Fig. 4. Total amount of wheat shipped in by truck excluding local wheat purchased directly from farmer.

DESTINATION OF KANSAS MILLED FLOUR

Most of the flour milled in Kansas moves out of state to be consumed elsewhere. Obviously with a yearly production of approximately 31,000,000 sacks this must be true.

In general it can be said that the flour moves to the population centers of the East and Southeast. Those mills which enjoy a large export trade move their flour to the gulf ports. Usually mills located in the northeastern part of the state will ship their flour into Chicago and points east. Mills located farther south and west will tend to ship to Memphis and the gulf. However, not all flour moves south or east. One mill reported small, but regular shipments to Arizona. Another firm indicated that they had just made their first shipment of flour to the west coast and that they planned to make additional shipments in the future.

Final destination of flour is influenced by the policies of the particular railroad serving the area with regard to transit privileges and origin of the wheat. It was stated earlier that the destination of flour was an important factor in determining where wheat purchases would be made. This is true when the particular mill has an existing outlet for their flour. However, where it is consistently advantageous to purchase wheat in a given area the particular mill will attempt to develop a market such that it will be possible to take advantage of proportional rates, backhaul and transit privileges. While some would probably argue that there is a cause and effect relationship, it would probably be more correct to say that there is interaction between the two.

TRUCK SHIPMENTS OF FLOUR

The previous discussion indicated that flour shipment generally moves by rail. That this is true is shown by Table 14. The 366,000 sacks of flour shipped by truck in 1956 by the mills included in the sample is only a very small proportion of their total output. In fact, with a few exceptions, most of the flour shipped by truck during the years which were included in the survey was destined for local consumption or possibly to an adjacent community.

It should, however, be noted that, although the total amount shipped by truck is small, each year has seen an increase over the preceding year. This is shown more clearly when the totals are plotted on a scatter diagram as in Fig. 6. In testing to see if the slope of the line differed significantly from zero, it was found that the value computed for b, 23.2, was significant at the five percent level, thus indicating a definite trend in the direction of truck shipments.

As a further indication of this trend, a number of mills have during 1957 made arrangements to haul flour in bulk trucks. Therefore, had the survey included 1957, the trend toward truck shipments quite likely would have been even more pronounced.

The reason cited for this change in the direction of truck shipments is the sharp increase in railway freight rates in recent years and the ease in handling bulk flour as compared to sacks.

Table 14. Amount of flour shipped out by truck.

Year	A (thousand bu.)	B (thousand bu.)	C (thousand bu.)	Total (thousand bu.)
1952	208	48	23	279
1953	227	46	24	297
1954	264	43	24	331
1955	287	42	26	355
1956	298	41	27	366

FUTURE OF KANSAS FLOUR MILLING INDUSTRY WITH REGARD TO SOURCE OF SUPPLY AND TYPE OF TRANSPORTATION USED

The statistical analysis presented earlier in the study showed that the trend lines for purchases from terminal and country elevators had a positive slope and that for purchases direct from farmers it had a negative slope. In each case the slope of the trend line was not great enough to cause us to reject the hypothesis that it did not differ significantly from zero. Having concluded that no significant trends have occurred in the past five years, can we assume that the existing situation will continue in the future? All flour millers interviewed stated that they expected to make no major changes in their purchasing procedure. However, two points were brought out which might bring about some change. Two millers pointed out that because of certain standards imposed by the food and drugs law they were reluctant to buy wheat from farmers late in the marketing season. Therefore, they thought that in the future they would probably purchase somewhat less wheat directly from farmers. One

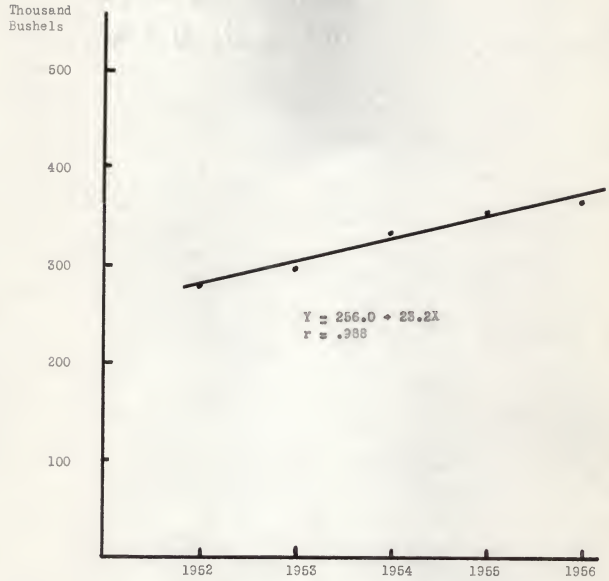

Fig. 5. Truck shipments of flour 1952-1956.

other factor which was brought out was that millers who rely heavily on locally produced wheat are at a severe disadvantage in certain years when for some reason, the locally produced wheat does not measure up to the quality standards demanded.

However, the fact remains that wheat is purchased on the basis of quality, price and freight costs. Included in the term freight cost are such things as proportional rates and backhaul and transit privileges. Therefore, assuming that the bulk of the wheat and flour shipments will continue to be made by rail and also that the principal quality wheat producing areas will continue as they are today, it is reasonable to assume that subject to the two conditions listed earlier, Kansas flour millers will continue to purchase their wheat from the same marketing agencies in about the same proportions as they are doing today.

Having previously detected a trend toward truck shipments of flour there may be some question about the validity of the above assumption. However, because truck shipments of flour represent only a small percentage of total shipments and because it was concluded that there was no significant trend with regard to truck shipments of wheat, the assumption appears to be valid for the next few years.

The flour millers themselves appear to be in agreement in feeling that if railway freight rates continue to increase a definite trend toward truck transportation will occur. A number of them felt that they would not personally be affected but that for the industry as a whole, truck shipments would increase. The shift which is occurring in the area of flour shipments can be expected to spread toward wheat shipments whenever truck shipments of flour become a substantial part

of the whole. This is because as truck shipments increase flour millers will no longer be as concerned with proportional rates and transit privileges and truck operators will be better able to compete with the railroads. The extent of this shift will, of course, be determined by the disparity in rates between the two types of transportation. Shipments which are made in a direct line from point of origin of the wheat to mill to final destination of flour, will in all probability continue to be made by rail.

It would be impossible to tell what effect this will have on wheat purchases from the different agencies without additional study. However, a number of possibilities exist. First of all, a change to truck transportation may have no effect at all. Wheat will continue to be purchased on the basis of quality and millers will purchase their wheat wherever quality wheat is available. Also, truck lines may work out some arrangement of proportional rates as the railways have. Another possibility which might occur is that mills will purchase the bulk of their wheat from country elevators wherever quality wheat is available regardless of present freight arrangements. Where the particular mill has plenty of storage space it might be to its advantage to have wheat trucked in from areas where quality wheat is being produced at harvest time. Here the wheat might be purchased directly from farmers.

SUMMARY AND CONCLUSIONS

Kansas continues to be the leading flour milling state in the nation despite a large decrease in the number of mills in operation. During the past five years output has been relatively constant. However, a sharp decrease in activity did occur following the years immediately

following World War II. Purchases of wheat from the various marketing agencies have also remained fairly constant during the period included in this study. In general flour millers themselves feel that no significant changes will take place in the amounts purchased from the various agencies. One exception noted was that a few millers indicated that they planned to purchase less wheat directly from farmers in the future. Evidence was cited that this may already be happening in a few instances.

While the amount of wheat shipped in by truck has also remained constant, the amount of flour shipped out by truck is definitely increasing. Furthermore, there is every indication that the amount of flour so shipped will continue to increase. However, at the present time this type of shipment is only a very small percentage of the total. As truck shipments of flour increase, shipments of wheat by truck will also increase. Depending upon the extent to which this trend develops, this could have considerable influence on purchases from the various marketing agencies.

Kansas flour millers purchase wheat, first of all, on the basis of quality. Furthermore they are willing to pay a premium in order to get the type of wheat needed. The type needed will depend on several factors, one of which is the type of flour produced. Family flour does not require as high a protein content; thus the miller manufacturing only this type or even a large portion of family flour is not likely to pay a premium for high protein content flour. In fact, he may even discount it because of its high ash content.

Those firms milling predominantly bakery flour are usually anxious to get high protein wheat, but in years when this type of wheat is plentiful they will not pay a premium for it.

From this it is possible to conclude that it would pay the farmer to produce wheat of desired quality, because even if he does not get a premium for quality wheat he is being penalized for producing wheat of inferior quality in the form of actual price discounts and lost markets. At present, this is being modified by the government loan storage program.

Wheat quality is determined by the weather, soil fertility and wheat variety. Over the first factor man has little control, and the application of commercial fertilizers in many areas may not be economically practical. Therefore, about the only influence which the farmer has in producing quality wheat lies in his selection of the variety which he plants.

Many people believe that wheat varieties with a long dough development time should comprise from 50 to 75 percent of the total wheat grown. From 1952 to 1956 Kansas acreage devoted to these varieties comprised from 17 to 32.9 percent of total acreage. In these same years the percentage planted to these varieties in Nebraska made up from 51 to 61.7 percent of the total.[1] This is undoubtedly one of the reasons for the large amount of wheat shipped into Kansas from Nebraska.

Given a plentiful supply of quality wheat the next most important factor in determining source of supply is price. In considering price the miller takes into consideration not only the price he must pay per bushel, but also freight rates and transit privileges that apply when shipping the grain from the source to his mill and on to the final destination of the flour.

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[1] Miller and Johnson, op. cit., pp. 9-12.

The remaining reasons given can be classed as one general type in that they are peculiar to the individual mill because of its size, location, type of flour milled, policies of the management or prejudices of the grain buyer.

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WHEAT PURCHASES BY KANSAS FLOUR MILLS AND TYPE OF CARRIER USED IN TRANSPORTING WHEAT AND FLOUR

by

RICHARD DALE REIMER

A. B., Bethel College, 1957

AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

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For many years Kansas has been the leading milling state in the nation, despite the fact that Kansas has no large flour milling centers like Kansas City, Missouri or Minneapolis, Minnesota. Important changes have been taking place in the flour milling industry in Kansas since World War II. Inasmuch as these mills have the capacity to mill approximately one-half of the wheat grown in Kansas, any changes made by these flour millers with regard to wheat purchases and type of transportation used is of tremendous importance not only to the wheat growers of the state, but also to the wheat marketing and transportation facilities which have developed through the years.

Therefore one of the purposes of this study was to determine the marketing channels through which the wheat used by Kansas flour millers moves and the type of transportation used. It was also the purpose of this study to determine the extent of the changes, if any, which have occurred with regard to purchases and type of transportation used in the last five years.

The entire population of 38 Kansas flour mills was stratified into three size groups on the basis of rated daily milling capacity. Group A included those mills with rated daily milling capacity of 4,400 sacks and over. Group B included those mills between 2,200 and 4,399 sacks per day. Group C was made up of mills with rated capacity of 2,199 sacks per day and under. From this population a random sample of one-third of the mills was drawn from each strata.

Each mill in the sample was visited personally. Flour millers were questioned about the size of their operation and agencies from whom purchases were made. Additional questions asked dealt with the type of transportation used in shipping wheat and flour, the final destination

of flour and criteria used in determining source of supply.

Purchases of wheat from the various marketing agencies have remained relatively stable during the past five years. When total purchases of wheat from the various agencies were plotted on scatter diagrams and trend lines drawn, statistical analysis indicated that the slope of the lines did not differ from zero at the ten percent level. In general flour millers themselves felt that no significant changes in purchasing habits would take place in the future. One exception to this was that a few millers indicated that they would probably purchase less wheat directly from farmers in the future.

The amount of wheat shipped in by truck has also remained relatively constant while the amount of flour shipped out by truck is definitely increasing. While the amount of flour shipped by truck at the present time is very small there is every indication that this trend will continue. Furthermore as truck shipments of flour increase, truck shipments of wheat will also increase.

Flour millers purchase wheat first of all on the basis of quality. The exact type of wheat required will be determined by the type of flour milled. Quality itself is determined by weather, soil fertility and wheat variety.

Given a plentiful supply of quality wheat the next most important factor in a determining source of supply is price. In considering price the miller takes into consideration not only the price he must pay, but also freight rates and transit privileges which apply when shipping the grain from the source to his mill and on to the final destination of the flour.

The remaining reasons cited by the millers can be classed as one general type in that they are peculiar to the individual mill because of its particular size, location, type of flour milled, policies of the management or prejudices of the grain buyer.