QUALITY, DISTRIBUTION AND UTILIZATION OF THE 1946 KANSAS WHEAT CROP

by

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INTRODUCTION

Objective

The objective of this thesis was to analyze the production, quality, distribution and utilization of one crop of wheat grown within one state during a single crop year. The State of Kansas was chosen because of its preeminence as the chief wheat-producing state in this country. It seemed desirable to choose a crop year within this past decade. The crop year 1946 was chosen because it was not a war year. However, it was not a typical year, due to such factors as an overly large production of wheat and large exports of grain and flour. Two major considerations were studied; namely, the quality of the wheat crop and its utilization. The crop year, July 1, 1946 to June 30, 1947, was chosen as a basis for study of the quality and disappearance of the hard winter wheat harvested in Kansas. Data on the utilization of the crop were obtained throughout the year.

Literature

The reference material used in this study was obtained from various sources such as government publications, correspondence with officials located in the Departments of Agriculture and Commerce in Washington, Kansas City and Topeka, and correspondence with officials of the Kansas Wheat Improvement Association in Kansas City and Manhattan. Information was also obtained by correspondence and personal interviews with several leading executives and chemists in the milling industry.

Materials and Methods to Show Wheat Quality

All maps and graphs pertaining to wheat origin, baking quality, protein and test weight were made from data obtained from the milling industry. County outline maps procured from the Department of Agronomy at Kansas State College were used to show various aspects of the origin, distribution and quality of the 1946 crop. Yield and grade factors for the 1946 Kansas crop were obtained from various Department of Agriculture bulletins.

Materials and Methods to Show Crop Disappearance

The materials and methods used to show the disappearance of the crop necessitated considering separately the activities of all the mills in the State of Kansas and included also all mills in St. Joseph, and Kansas City, Missouri. The mills in the last two locations are known as the Missouri river mills.

Total inspected receipts for the year 1946 at all mills in Kansas and including St. Joseph and Kansas City, Missouri, mills were 306,732,600 bushels. The total Kansas production for 1946, including carryover, was 219,729,000 bushels. Assuming that the total production was shipped to the markets mentioned, which is a fair assumption, save for 20,000,000 bushels which went into feed, seed, and which was retained on farms, it was found that 72 per cent of the total inspected receipts at the designated markets represented wheat produced within the State of Kansas. The wheat raised in Kansas, in all probability, did go to the markets mentioned. The exceptions would be the St. Louis and Omaha markets whose yearly inspected receipts were small compared with those of the Kansas and Missouri River markets. Consequently, Kansas-raised wheat was assumed to have disappeared into internal Kansas markets, to Kansas City, Missouri, or to St. Joseph, Missouri. A further discussion of the situation will appear later in this paper.

GENERAL INFORMATION

Production

Total production of spring and winter wheat for the 1946 Kansas harvest was 216,768,000 bushels. Spring wheat amounted to 12,000 bushels in 1946 and winter wheat production totaled 216,756,000 bushels. In 1946, there were 581,832,000 bushels of hard winter wheat produced in the United States. Thus, in

1946 Kansas produced 37 per cent of all hard winter wheat.

The carry-over of Kansas wheat relevant to the 1946 crop may be analyzed as follows:

Table 1. Production and carry-over of wheat from the 1946 Kansas crop.

	Production	Bushels	Total bu.
			216,756,000
Add:	Off-farm total, July 1, 1946	5,007,000	
	On-farm total, July 1, 1946	4,159,000	
	Total carried into 1946 crop		9,166,000
	Total 1946 crop, plus carry-over		225,922,000
Sub-tract:	Off-farm total, July 1, 1947	4,025,000	
	On-farm total, July 1, 1947	2,168,000	
	Total carried out of 1946 crop		6,193,000
	Total 1946 production, including both carry-overs		219,729,000

The individual county production estimates for Kansas in 1946 are shown in Fig. 1. This was second to the record crop of 1931 at that time. The ten year (1935-1944) average was only 144,440,000 bushels; thus, the 1946 crop was considered a bumper crop. The increasing district or area production, increasing district and average yield, and the increasing district sown and harvested in acres for Kansas in 1946 are tabulated in Table 2. The totals for wheat sown and harvested in acres are also presented in the same table. Kansas was divided

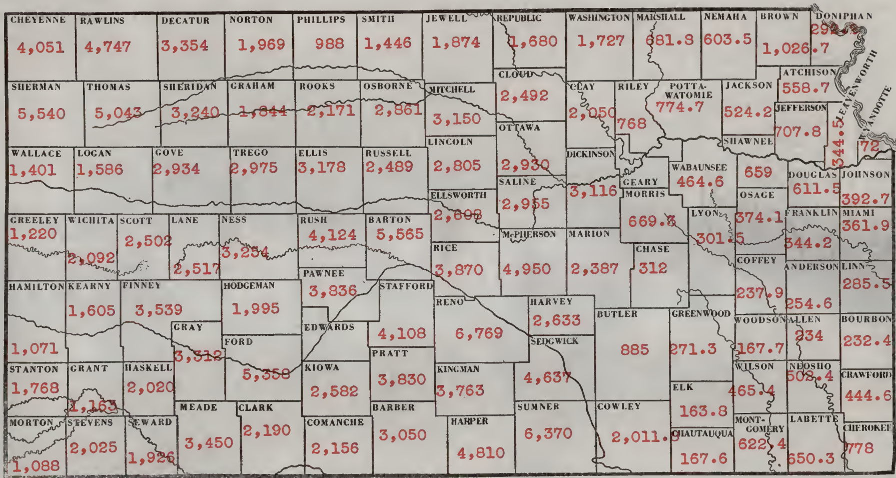

Fig. 1. Individual county production of wheat in Kansas in 1946. (Thousands of bushels).

into nine different areas to show where the majority of the wheat was raised within the state. In this study the eastern part of Kansas was disregarded because of the limited amount of wheat grown in this region. The first six production areas, as indicated in Table 2, are the major wheat-producing regions of Kansas. The average yield for the whole state was 16.5 bushels per acre. This was a considerably better yield than the ten year (1935-1944) average of 13.5 bushels per acre. The ten year (1935-1944) Kansas average for total wheat harvested in acres was 10,683,000. In 1946 the total wheat harvested was 13,381,000 acres; thus, the 1946 Kansas harvest was well above that of the ten year average. The low (13.1 bu. per acre) yield in the Southwest area of the State is worth noting because, as will be shown later, this low yield may well be substantiated by the high protein content in this same area.

Table 2. Increasing district production and yield in bushels, sown and harvested in acres, showing the average yield in bushels and the total sown and harvested in acres for wheat produced from the 1946 Kansas harvest.

District	Production, bu.	District	Yield, bu.
S. Central	51-756-000	N. W.	21.3
Central	38-047-000	N. E.	19.3
S. W.	32-570-000	S. Central	17.1
N. W.	29-788-000	Central	16.4
N. Central	23-369-000	E. Central	16.1
W. Central	20-481-000	W. Central	15.3
S. E.	7-596-800	N. Central	15.6
N. E.	7-354-400	S. E.	14.8
E. Central	5-865-800	S. W.	13.1
	216-768-000		16.5 = av. yield

District	Sown, acres	District	Harvested, acres
S. Central	3-116-000	S. Central	3-022-000
S. W.	2-737-000	S. W.	2-476-000
Central	2-375-000	Central	2-326-000
N. Central	1-633-000	N. Central	1-556-000
W. Central	1-512-000	N. W.	1-401-000
N. W.	1-487-000	W. Central	1-343-000
S. E.	530-400	S. E.	512-000
N. E.	385-000	N. E.	381-200
E. Central	372-600	E. Central	363-800
Total	14-147-000		13-381-000

Carry-Over

The carry-over of wheat both into the 1946 harvest and out of the 1946 crop year was extremely small; consequently, carry-over, if included in production figures, as shown previously, did not materially change the production estimate. Final analysis showed a three million bushel increase in production. This small carry-over resulted from the unusually large demand for wheat and wheat flour during the 1945 and 1946 crop years. The crop analysis presented shows that off-farm and on-farm stocks decreased from 1946 to 1947 from 5,007,000 to 4,025,000 bushels for off-farm stocks, and from 4,159,000 to 2,168,000 bushels for on-farm stocks, despite the bumper production of wheat for the 1946 crop.

Seeding, Growing and Harvesting Conditions

Total wheat acreage in Kansas for 1945 was 14,147,000 acres. The need for greater world production of wheat and the generally favorable weather at seeding time accounted for this large acreage sown. Table 2 shows the south central, southwest and central areas far above the other regions of Kansas in acreage sown. The same areas are also well above in acres harvested. The year 1946 was not good for favorable crop production, the period July 1, 1945 to May 30, 1946 being one of the driest on record. Only a high general rainfall the last of May, 1946 saved a crop considered practically lost. Total rainfall for the year was 26.48 inches. Temperature was definitely moderate throughout the crop growth. The early winter months of 1946 were mild; there was very little zero or sub-zero temperature during the winter of 1945-1946. The spring weather in February and March advanced the wheat prematurely, making it more susceptible to a later delayed frost damage. There were three setbacks retarding crop growth, beginning with a freeze on May 11, 1946, causing sterility in the growing plant. On May 30, 1946, a severe hail storm damaged the winter wheat by approximately 15-30 per cent. Lastly, a summer drought followed which further retarded proper crop growth for suitable harvesting. The harvest months of June, July and August, 1946 were all under normal, due to the lack of sufficient moisture. Viewed as a whole, the 1946 crop out of Kansas did not have good or even fair growing conditions, regardless of the bumper production figure for the year. That these poor growing conditions were in part responsible for the inferior baking quality of the wheat cannot be denied, but other factors, such as varietal selection, also played an important role in the baking quality aspect of the wheat.

QUALITY CHARACTERISTICS

In this study the dough quality of the 1946 Kansas wheat crop was determined mainly by the analysis of dough development curves. Quality, as derived from these curves, was judged as either desirable, average, or undesirable. When available, protein and test weight were considered as separate quality factors for wheat originating in a particular area within Kansas.

Determination by Mixing Curves

The material used consisted of some three hundred mixing curves obtained from Shellabargers, Inc. in Salina, the William Kelly Milling Company in Hutchinson, and the Kansas Milling Company in Wichita. No mixing curves were available at Dodge City mills. The mixing curves were used to judge wheat flour quality and were of two types. Those curves obtained from the Kansas Milling Company in Wichita were run on the Brabender Farinogram. Those obtained from Hutchinson and Salina were made on the National Recording Dough Mixer. This equipment produces a curve called a Mixograph. Some of these latter curves were made from wheat meal. However, both type curves are indicative of mixing quality. The set of curves used were hand picked; and, though only covering a few cars of wheat in comparison with the total Kansas production, may well be considered a typical representation of the wheat grown in the various wheat-producing regions of Kansas in 1946. All the curves were graded desirable, average, or undesirable as to mixing quality on the basis of that particular mill's determination from whence they came as to what constituted a desirable and an undesirable wheat for quality purposes.

Relationship of Mixing Curve to Quality

Both mixograph and farinogram mixing curves were used in this study. Johnson and Swanson (1942) observed that curves obtained from sifted wheat meals, as run on the mixograph, are closely correlated to those of flour, as run on the farinogram, in the various characteristics of height, dough development time, and the angles made by the up and down slopes of the curve. Harris (1943) stated that the value of the mixograph as a supplementary device in the testing of wheat qualities is generally becoming recognized. The estimation of dough properties from recording-dough mixer curves has received marked attention in relation to the prediction of baking strength according to Harris, Sibbitt and Banasick in 1943. In 1942, Johnson, Swanson and Bayfield critically examined mixing curves and their properties in relation to varietal quality of Kansas wheats.

Larmour, Working and Ofelt (1939) stated:

> The greatest value of these mixing curves, protein content being known, is to identify the type to which a flour belongs. The curves tend to establish qualitative differences between flours that were or were not different in baking quality.

This would assume that mixing curves are indicative of baking quality only on the past experience and application of the curve in predicting quality. Past experience assumes an actual bake; however, the mixing curve has been developed today to the extent that it may be used as a predetermination of whether a flour will or will not be desirable for baking. Bayfield, Working and Harris (1941) showed that pattern differences between wheat varieties were greater than within a variety as observed on the mixing curve. They found that the pattern within a certain variety tended to be more or less characteristic. This is significant because many wheat varieties may be judged either desirable or undesirable for quality purposes largely on the basis of these mixing curve patterns, provided the flour representing these curves had once been baked for actual results. Bayfield, Working and Harris (1941) stated that the question of desirability or non-desirability depends on the market use of the flour. The curves used in this thesis were all hard winter wheat curves and it can be assumed safely that these curves were chosen to indicate bakery flour quality. An example of a wheat variety working into the desirable class in Kansas would be Turkey. It seems to be favored in Kansas mills and therefore flours whose curves have Turkey characteristics are readily acceptable as bakery type flour. In other words, this flour would not require the actual bake; it would be accepted on the basis of its mixing curve characteristics. It is in such a way that the mixing curve may be used commercially as a predetermination of baking quality. Indeed, many commercial bakers today will go so far as to accept or reject a car of flour solely on the basis of the mixing curve. "The curve provides a pictorial expression of some dough-handling properties of a flour; it provides data about a flour hitherto lacking," according to Bayfield, Working and Harris in 1941. These dough-handling properties of a flour are more important to the commercial baker than they are to the laboratory technician.

Johnson, Swanson and Bayfield (1943) proved that there was a positive correlation between the mixing curves of Tenmarq, Turkey, Comanche, Kawvale, Pawnee, Nebred and Blackhull varieties and grain and texture of the finished loaf of bread. They also found the flour baked from those curves representing Chiefkan, Cheyenne and Early Blackhull varieties resulted in a loaf of bread with open grain or heavy cell walls. Tenmarq exceeded all other samples observed in crumb color.

Mention was made above of mixing curve characteristics. Geddes, Aitken and Fisher (1940), in studying the relationship between the farinogram and the baking strength of some western Canadian wheat varieties, observed several definite characteristics of the mixing curve. First was the dough development time or the mixing time required to produce a dough of maximum consistency. This mixing time was found to decrease with increments of protein up to 12 per cent and then tended to increase as protein content became greater. Johnson, Swanson and Bayfield (1943) used loaf volume as the chief criterion of baking quality and observed that mixogram characteristics tended to reflect baking strength of a flour mainly because of the high correlation between loaf volume and protein content on the one hand, and between protein content and mixogram characteristics on the other. This means then that the evaluation of baking strength by means of the mixing curve invariably brings the factor of protein content into the picture, at least when referring to loaf volume as a criterion of baking strength.

The second curve characteristic may be observed as a group. Johnson, Swanson and Bayfield (1943) studied the curve characteristics of height, width and weakening angle of the mixogram and failed to establish any significant correlation between these curve characteristics and loaf volume independent of protein content. Again the association established was between loaf volume and protein content on the one hand, and between protein content and mixing curve characteristics on the other. Consequently, protein content must be known before any real estimate of baking quality may be made. It is recognized generally today that the majority of flours representing curves of either the mixogram or the farinogram have already been analyzed for protein content.

In what is generally recognized as the best article on the relationship of mixograms to baking quality, Johnson, Swanson and Bayfield (1943) concluded:

> The most important use of the mixogram appears to be that of furnishing information that supplements baking data. It gives information regarding mixing requirements, mixing tolerance and varietal pattern. The varietal pattern tends to establish qualitative differences between flours that may or may not have different baking qualities. In this way flours of known inferior baking qualities may be readily distinguished and discarded as unsuitable for bread making.

D. W. Kent-Jones and A. J. Amos (1947) wrote concerning the farinogram.

> It must not be thought that the farinogram invariably gives results which check up with baking knowledge and experience, but it has the advantage of being a well constructed machine, capable of being operated by comparatively unskilled workers and which gives, with all other workers, the same results for a given flour. General opinion is that the machine is substantially helpful in diagnosing flour strength and potentialities. The farinograph is particularly helpful in recording the dough characteristics of a flour found to be useful for a certain special purpose, as other flours intended for this particular purpose should give similar farinograms.

Johnson, Swanson and Bayfield claimed that the varietal pattern tends to establish qualitative differences between flours that may or may not have different baking qualities. An explanation of the term baking quality seems proper. Any flour of good baking quality is one which could be placed in any one of a number of bakeshops; and, under the varied conditions of each of these shops, would produce a good loaf of bread. Factors such as good color, adequate protein to retain the gas produced during fermentation, and above all, tolerance to both mixing and fermentation are assumed in a good baking quality flour. The mixograph curve does not measure fermentation time or fermentation tolerance in any way. Thus, it does not measure taking quality directly. It does measure mixing time, dough elasticity, steepness of the ascending slope, characteristics of the curve peak, whether sharp or rounded, general width and height of the curve and the rapidity with which any flour might break down after severe mechanical treatment. These factors are closely related to baking phenomena. It also established qualitative differences between wheat varieties to a reasonably accurate degree. The curves of the varieties in each class are usually similar to each other, all having the same type curve which permits differentiating one class from the other. Therefore, any particular curve may be classified as either "good" or "poor" and in this way flours of known inferior baking qualities may be recognized and discarded as unsatisfactory for bread baking. It should be restated that the curves are only indicative of baking quality on the experience of previous actual bakes. Once a flour has been classified as "poor" for baking on this basis, then the mixing curve representing that "poor" flour may be applied as an indicator of what that flour will do in the future under other baking tests. This would, to a certain degree, eliminate the baking test for a flour whose mixing curve was known to classify as "poor".

On the other hand, the commercial baker could advantageously use the data on a "good" mixing curve and be assured that the flour would perform satisfactorily in the bakeshop. Johnson, Swanson and Bayfield (1943) showed that overmixing decreased loaf volume. Consequently, a "good" mixing curve should have a reasonably long mixing time in which the dough would be properly developed. Any flour necessitating too long a mixing time would not be acceptable as bakery type flour because of the time involved in mixing and the decrease in the quality of the finished loaf. The mixing curves indicate, in the time required to reach the peak of the curve, the relative amount of mixing any flour will need in taking if an optimum mix is to be used. Thus the curves indicate mixing quality, a direct criterion of baking quality.

As for some of the other characteristics of mixing curves such as height, width, breakdown after reaching the peak and steepness of the ascending slope, they are not directly related to baking quality. They are pattern differences established by previous research on the mixing curve which today allow the baker to classify flour as either "good" or "poor" for baking purposes. That flour is judged by these curves cannot be denied; they will probably never be substituted for the actual baking test, but they do provide accessory information indirectly related to baking quality. The mixing curve to some extent has revolutionized the judging of flour quality in the milling industry.

It is possible to make a good loaf of bread from poor variety wheats if the flour is handled properly from the standpoint of mixing time, fermentation time and other factors. However, many poor variety wheats, often characterized by a short mixing time, do not have sufficient mixing and fermentation tolerance to justify their use in numerous bakeshops all over the country where conditions are always different. Thus, to meet the varied conditions existing in different bakeshops, the flour representing the "good" variety mixogram may be identified as possessing the uniformity of strength and mixing tolerance necessary in all type bakeshops. The first and second curves of Plate I show unfavorable and favorable dough development curves, respectively. The first curve would be unsatisfactory for baking quality because it is a "poor" variety wheat showing little or no mixing tolerance as the curve rises and falls suddenly. The favorable dough development curve would be satisfactory for baking quality as it falls into the "good" variety curve class having the mixing tolerance and other pattern requisites conducive to good baking quality. It will be noted that a peak was maintained for some length of time, then gradually fell off.

The following data show one system by which the farinogram curves were graded. Other systems may be used for grading these mixing curves, but the objective is the same; namely, to determine mixing quality. The action of the farinogram is similar in theory and results to the mixogram; the former has a gentle kneading action on the dough, the latter a rigorous mixing action.

Mixing time (M)		Index (W)	
Blend	7 & over (min.)	Blend	Under 80
Good	5 - 7 "	Good	80 - 90
Fair	4 - 5 "	Fair	90 - 110
Poor	4 & under "	Poor	110 & over

The above figures were taken from curves used in this thesis. Farinogram curves are indicative of baking quality in that absorption, mixing time, mixing tolerance, dough elasticity and point of breakdown during severe mechanical treatment are readily observed. The question of varieties does not play so important a part as it does in dough development curves. Farinogram curves may test flour blends rather than wheat meal and the flour may already have lost its identity as to variety of the wheat used. The factors "M", mixing time, and "W", mixing tolerance, are used mainly in determining whether or not each curve could be judged as favorable or unfavorable as to baking quality. Again, as in dough development curves, the curves were classified into "good" or "poor" categories. The letter "W" may be considered as a reasonably fair index showing mixing tolerance and ultimately the strength of the flour under consideration.

The third and fourth curves on Plate I show unfavorable and favorable farinogram curves, respectively. The third curve has an "M" of 3, a "W" of 120, and would be considered a poor flour for baking purposes. The fourth curve shows an "M" of 4-3/4, a "W" of 80 and is considered for all practical purposes as desirable for baking quality purposes. In other words, the flour represented in the fourth curve should stand up well when mixed and baked. This mixing time, "M", and mixing tolerance, "W", data are presented as examples whereby any particular farinogram curve may be judged as either favorable or unfavorable for baking quality. The flour of a curve in the "poor" category would probably not be regarded as

EXPLANATION OF PLATE I

Curve #1 - An example of an undesirable dough development curve showing little or no mixing tolerance.

Curve #2 - A desirable dough development curve showing greater mixing tolerance than curve #1. The gradual descent of the curve from its peak in curve #2 should be compared with curve #1.

Curve #3 - An undesirable mixing curve as run on the Brabender Farinogram.

Curve #4 - A desirable farinogram curve. As in the dough development curves, the fairly abrupt descent or gradual tapering of the curve from its peak is important in determining mixing tolerance and ultimately an indication of the baking strength of the particular wheat or flour under study.

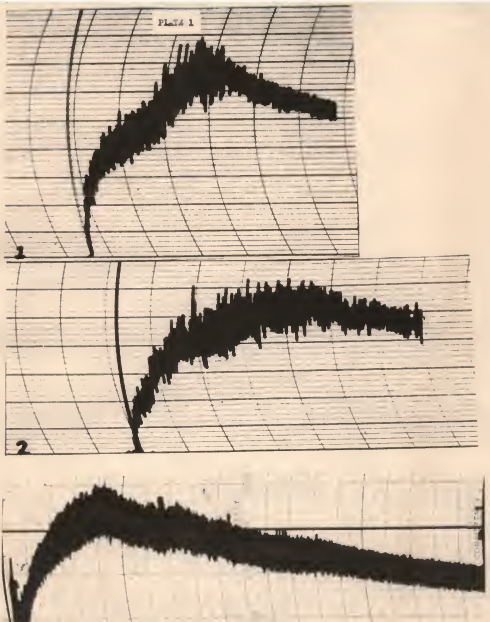
PLATE 1

adaptable to baking. The fermentation tolerance would generally not be satisfactory for use in the majority of bakeshops across the country. Though many large shops prefer short mixing time flours as time saving factors, the same flour, above all, must have proper mixing and fermentation tolerance. But generally speaking, the "good" and "blend" classes of curves represent flours which, all other factors being satisfactory, would show good tolerance to mixing and fermentation. If a flour can classify as "good" on a mixing curve, then it is reasonably safe to assume that the same flour will show proper fermentation tolerance in all types of bakeshops where conditions are most varied and mechanical punishment would seldom, if ever, be the same. By way of explanation, the wheat from a "blend" curve will often be blended with that from a "poor" curve, obtaining a satisfactory blend which may satisfy requirements for a particular bakeshop. The mixing curve thus enables the miller to utilize to some extent his inferior quality wheat by blending it with his superior quality wheat.

The question of over-tolerance deserves attention and it should be remembered that over-tolerance, usually observed in a long and flat curve, may be as detrimental as under-tolerance, usually seen in a short and abruptly descending curve. The farinogram curves were all graded with this in mind. If a flour required 15-20 minutes mixing time, it would obviously outlive its own usefulness for most commercial purposes.

Other Quality Factors Used

Baking quality was judged mainly by the classification; i.e., favorable or unfavorable, into which each mixing curve fell. If a curve was judged "good", then the wheat representing that curve was considered satisfactory for the desired objective -- a good loaf of bread. However, test weight and protein factors were obtained and such data were used as important quality factors in conjunction with the information submitted on "good" or "poor" mixing curves to determine baking quality. Test weight and protein data were not available on every curve from the three Kansas markets, but this omission should not materially affect the basic conclusions drawn as to quality. Two diagrams are later presented to show how these test weight and protein factors were used as measures of wheat quality. In most cases, each curve represented one car of wheat, but in some cases as many as 20 cars, though this was exceptional.

Terminal Markets Chosen for Study of Inspected Graded Receipts

The major terminal markets chosen for a study of the yearly inspected receipts into those markets were Kansas City, Missouri, St. Joseph, Missouri and all internal Kansas markets. Wheat entering these markets was not all Kansas wheat, but these three markets were used as a logical destination for the majority of Kansas wheat. Statistics presented showed that approximately 72 per cent of the wheat received at the three designated markets was Kansas-raised wheat. Laboratory mixing curves were not obtained from the above markets; they were procured from the three internal Kansas markets of Salina, Hutchinson and Wichita, because the origin of the wheat on the mixing curves was definitely known to be within Kansas, whereas some wheat into Kansas City and St. Joseph may have originated in other states.

Data on yearly inspected receipts into internal Kansas markets, Kansas City, Missouri and St. Joseph, Missouri are presented to show a breakdown of the numerical and special grades of wheat received at these markets during the crop year 1946. The same markets will later be used to show the disappearance of the 1946 Kansas crop. St. Louis, Missouri might have been included; but, upon observation, the receipt figures for winter wheat at St. Louis were small compared with those of the other markets. Thus, St. Louis was omitted from any discussion mainly on the basis that most of the wheat entering St. Louis was soft wheat.

Table 3 shows inspected receipts of hard red winter wheat at the listed markets within Kansas, at Kansas City, Missouri and St. Joseph, Missouri from July 1, 1946 to June 30, 1947, carloads only. Assuming 110,000 pounds of wheat to a carload and dividing by 60, 1833 bushels would equal one carload of wheat. Therefore, it was assumed that each carload contained 1800 bushels of wheat.

Analysis of Table 3 showed that over 85 per cent of the total inspected receipts at Kansas markets graded No. 1 or No. 2 wheat. The wheat into Kansas City, Missouri and St. Joseph, Missouri was predominantly No. 1 and No. 2. These two grades accounted for about 80 per cent of the total. Thus, the wheat of the 1946 crop in general was not graded down heavily because of low test-weight, excess damage or foreign material. Sample grade wheat into Kansas markets was 5.3 per cent of the total receipts, which is fairly normal. Special grades were receipts shown in addition to the numerical grades and therefore must be added to the latter to obtain total inspected receipts at the designated markets. Total tough, light smutty, smutty and weevily percentages were calculated on the basis of special grades received at the markets given. Total numerical and sample grade percentages were calculated on the basis of total numerical grades received. Table 3 shows that 19 per cent of the special grades received at Kansas markets was classified as "tough" wheat. This means that almost 20 per cent of all special grade wheat into Kansas markets contained over 14.5 per cent moisture.

Table 4 is a summary of Table 3 converted to bushels. Summary figures were obtained by multiplying the total number of cars received at each of the three stations (the Kansas stations being considered a single station for this purpose) by 1800 to

Table 3. Hard red winter wheat, inspected receipts at Kansas markets, Kansas City, Missouri, and St. Joseph, Missouri July 1, 1946 to June 30, 1947, carloads only.

Markets	Grades							Special grades				
	No. 1	No. 2	No. 3	No. 4	No. 5	Sample	Total	Tough	L. Smut	Smutty	Weevily	Total
Kansas												
Kansas City	18,549	12,367	3,061	709	254	2,587	37,527	1,244	843	892	2,071	5,050
Atchison	1,632	1,296	262	21	6	68	3,285	99	16	24	48	187
Arkansas City	2,750	228	29	3	2	4	3,016	35	6	2	182	225
Coffeyville	168	11	5	-	-	4	188	6	-	1	6	13
Dodge City	2,804	1,331	165	32	10	109	4,451	45	10	3	762	820
Great Bend	1,451	244	60	13	5	27	1,800	10	10	4	175	199
Hutchinson	18,146	5,342	1,621	474	123	1,227	26,933	367	317	268	3,067	4,019
Salina	4,307	6,616	1,571	379	120	771	13,764	460	187	205	731	1,583
Topeka	1,919	2,749	574	103	34	294	5,673	219	59	42	319	639
Wellington	1,482	97	30	17	5	119	1,750	100	24	37	126	287
Wichita	10,291	2,460	602	219	94	750	14,416	423	370	330	1,671	2,794
Total Kansas markets	63,499	32,741	7,980	1,970	653	5,960	112,803	3,008	1,842	1,808	9,158	15,816
Per cent	56.3	29.0	7.1	1.7	.6	5.3	100	19.0	12.0	11.0	58.0	100
Missouri												
Kansas City	11,118	12,847	4,374	533	167	1,543	30,582	775	376	339	637	2,127
St. Joseph	2,982	3,967	1,065	157	66	246	8,483	275	73	48	200	596
Total K.S. & St. Jos. Mkts.	14,100	16,814	5,439	690	233	1,789	39,065	1,050	449	387	837	2,723
Per cent	36.0	43.0	14.0	1.7	.6	4.6	100	38.6	16.4	14.2	30.7	100

Table 4. Summary of inspected receipts at all internal Kansas markets, Kansas City, Missouri and St. Joseph, Missouri.

Markets	Receipts (bushels)
Numerical grades	
Total Kansas	203,045,400
Kansas City, Missouri	55,047,600
St. Joseph, Missouri	15,269,400
Total	273,362,400
Special grades	
Total Kansas	28,468,800
Kansas City, Missouri	3,828,600
St. Joseph, Missouri	1,072,800
Total	33,370,200
Total, both grades	306,732,600

obtain inspection figures in bushels. Again, it should be emphasized that 306,732,600 bushels did not all represent Kansas-raised wheat, but it is reasonably accurate to state that 72 per cent of this figure represented wheat raised within the State of Kansas.

Estimation of Baking Quality

The baking quality of the 1946 Kansas wheat crop was estimated by analyzing a series of mixing curves from Salina, Hutchinson and Wichita. First, some 300 cars of wheat were plotted according to county origin on the basis of desirable, average and undesirable wheat, using dough development curves and farinogram curves. It was observed that certain areas seemed to produce wheat of a desirable nature, while other more numerous areas seemed to produce wheat of an undesirable classification. Figure 2 shows the general area separation of desirable, average and undesirable wheat on the basis of the mixing curves studied. The major terminal market of Dodge City was omitted because of inaccessible records. Salina, Hutchinson and Wichita were chosen because they represented three markets which milled wheat from all of the major wheat-producing areas of Kansas. The data presented on quality, while not complete for the whole Kansas crop of 1946, were, nevertheless, adequate information to reach a conclusion on the quality in general of the 1946 Kansas crop.

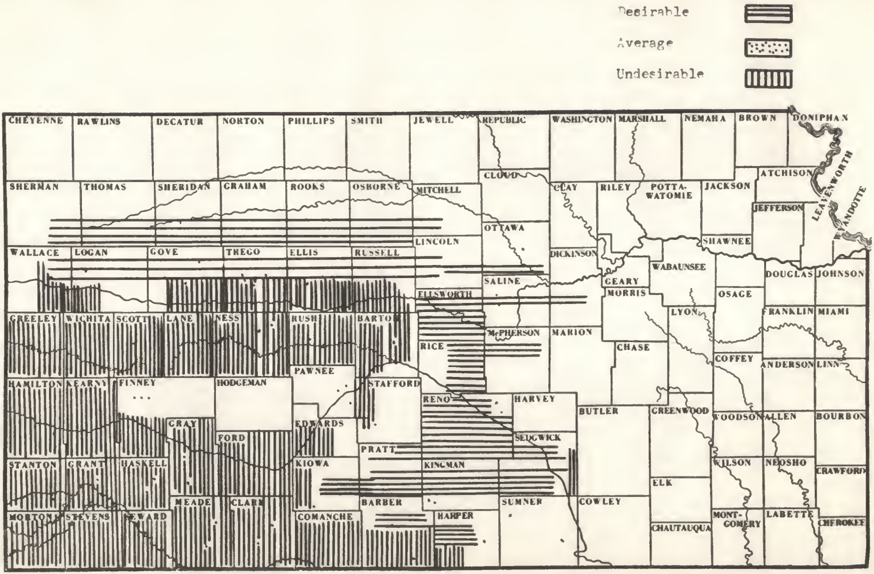

Figure 2.

General area separation of desirable, average and undersirable wheats on basis of mixing curves from three internal Kansas terminal markets.

All car origins used as preliminary data in making Fig. 2 were specific in that the town originating the car(s) of wheat was given on each mixing curve. One exception was the case of 41 cars into Lawrence, Kansas for the Kansas Milling Company of Wichita. Exact wheat origin lacking in this instance, the cars were plotted generally near the Union Pacific tracks in western Kansas, assuming that the wheat was tracked into Lawrence by the Union Pacific Railroad.

The desirable and undesirable wheat areas in Fig. 2 are well outlined in that a certain locality could be generally regarded as producing either good or poor wheat as far as baking quality was concerned. The average wheat appeared to spread all over the map. Some counties were omitted, in that the mixing curves used did not show wheat originating in these particular counties. It was attempted to isolate areas, not counties, and therefore some overlapping was inevitable.

Figure 3 shows the protein quantity by counties of wheat received at Salina and Hutchinson. Careful analysis of Figs. 2 and 3 gave two findings: First, the best quality wheat raised in Kansas started in the upper western tier of counties of Thomas and Sheridan, and extended eastward to the upper east central portion of the state. From the east central region the high quality wheat abruptly dropped into the south central area. The poorest quality wheat raised in Kansas was definitely in the southwestern counties where few, if any, desirable

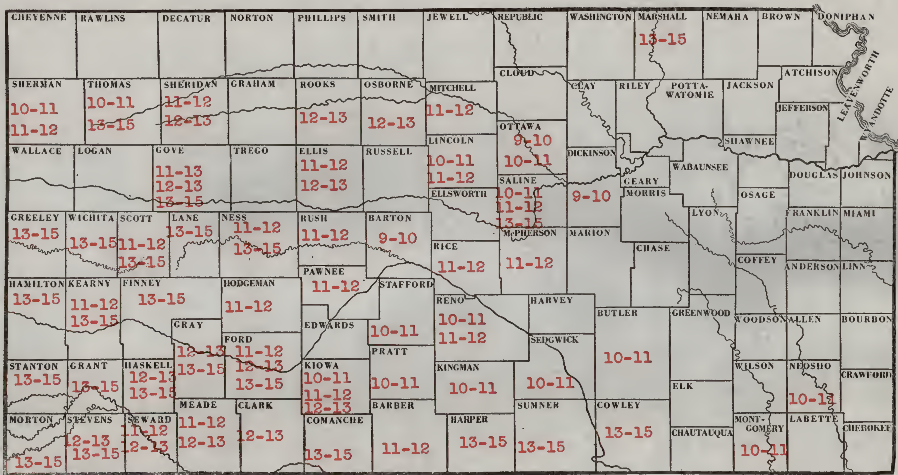

Fig. 3. Protein quantity by county origin of wheats received at the two internal Kansas terminal markets of Salina and Hutchinson.

wheats originated in 1946. These wheats were judged on the basis of mixing curves, examples of which are shown in Plate I. Secondly, combining protein with wheat quality, the desirable wheats had a lower protein content than the undesirable wheats. This means that wheats from southwest Kansas in 1946 contained high protein quantity, but inferior wheat quality. This is significant in that high protein wheats generally tend to bake well.

Figure 4 showed the relationship of decreasing protein quantity to counties giving the number of incoming cars at Salina and Hutchinson, and the desirability or nondesirability of these cars on the basis of mixing curves. Each 1" bar represents at least one car of wheat and often more, because one mixing curve was sometimes run on two or more cars of similar protein content. When cars of wheat were predominantly favorable or unfavorable from one county, one bar was used. Otherwise, favorable, average and unfavorable wheats may all have been plotted from the same county. In most cases, only one protein content appeared on the mixing curve. The peak of each 1" bar represents the protein range into which each car(s) of wheat would fall from that particular county. For example, Stevens County shows one car in the 13-15 protein range, another car in the 12-13 range. If a bar is not shown in any particular case, as in the 12-13 range of Kearny County, there was no sample observed falling into that range from Kearny County. Figure 4 is a further segregation of desirable, average and undesirable wheat areas on the basis of decreasing protein content and county origin. Practically all of the desirable wheat fell into a lower protein range than the undesirable wheat. The latter was mostly in the 13-15 protein range. Furthermore, this 13-15 per cent protein range generally covered those counties of the southwest area of Kansas. The more desirable wheat fell into the 9-12 per cent protein range which generally included the upper east central tier of counties, extending into the mid-southern area of the state. Figure 4 was thus well correlated with Fig. 3. It showed the number of desirable, average and undesirable cars from various counties that fell into the various ranges of protein content. The number of these cars was then plotted against protein content in Fig. 5 on the basis of desirable, average and undesirable mixing curves.

Figure shows in graphical form the relationship between protein content and estimated baking quality for the 1946 Kansas wheat crop. The majority of cars classified as undesirable for baking quality came from the high protein range of from 13 to 15 per cent. The greatest number of cars classified as desirable were in the 10 to 12 per cent protein range. Reference to Figs. 3 and 4 show that the high protein wheat, which was mostly undesirable, predominated in the southwestern counties, while the lower protein wheat of more desirable quality originated in the upper west central and central counties.

In general, the dough development curves classified as

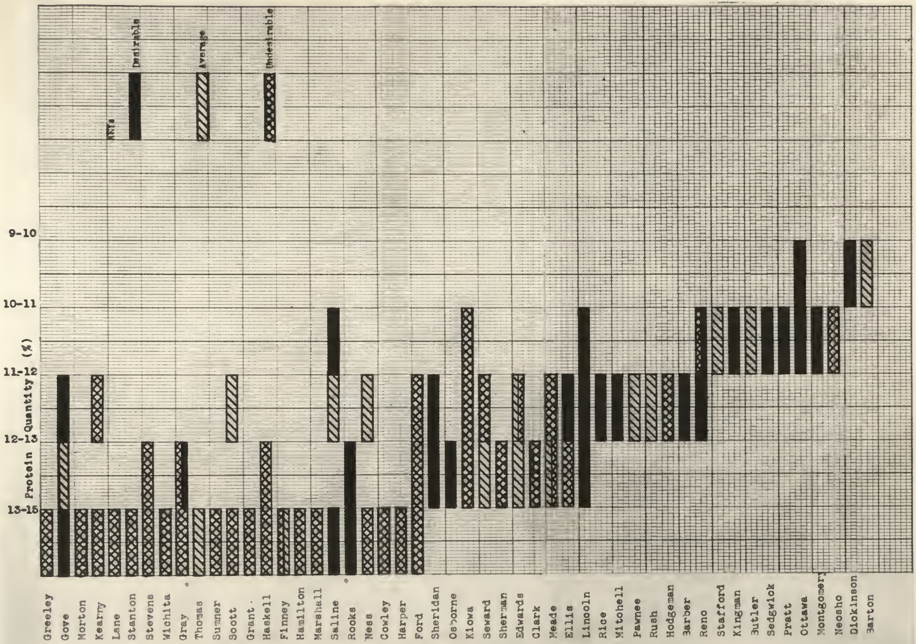

Figure 4

The relationship of decreasing protein quantity (%) to counties of a number of incoming cars at Salina and Hutchinson and the desirability or non-desirability of the same cars on the basis of mixing curves. (Each 1" bar represents at least one car of wheat.)

average seemed to follow the group of curves judged desirable as plotted in Fig. 5. Since a majority of these average curves representing cars of wheat fell into the lower and more desirable protein range, it would be reasonably safe to assume that these curves, while not representing wheat varieties of an absolutely desirable nature, could be regarded as desirable varieties for baking for all practical purposes. If the protein quality of the more desirable curves was not sufficient to produce proper tolerance in the bakeshop, it was found necessary in 1946 to obtain Spring wheats from Montana and blend them with the desirable and average varieties grown in Kansas during that year. By doing this, the superior lower protein wheats of Kansas were sufficiently strengthened in protein to produce the proper baking characteristics. The best dough development curves obtainable showed the wheat originating in Dickinson and Ottawa counties, (ref. Fig. 4) and having a protein content well under 10 per cent. The wheat of the poorest curves obtained originated in Grant and Haskell counties with a protein content of from 13 to 15 per cent. Naturally, these two curves represented extremes of all curves procured, but they do substantiate the fact shown elsewhere in this study that the high protein wheats of the 1946 Kansas crop, as judged by mixing curves, were not conducive to desirable baking quality. Nor could these varieties be properly blended in large quantities without causing severe setbacks in the baking process. This was especially true of wheats from the Southwest, and to a certain extent, from the lower west-central regions of Kansas. Evidence exists today showing that poor varieties of wheat were planted which resulted in a high protein, a high test-weight, but a very undesirable dough development curve.

The test-weight of 71 cars into Salina was plotted on the basis of dough development curves in Fig. 6. Despite the small number of cars observed, the graph in Fig. 6 showed a definite trend. More cars of desirable wheat from a baking quality standpoint fell within the test-weight range of 58-60 and more cars of undesirable wheat from the same standpoint fell within the test-weight range of 60-63 pounds per bushel. In other words, more wheat, classified as desirable varieties on the basis of dough development curves, came into Salina at a lower test-weight (58-60) than at a higher test-weight (above 60 pounds per bushel). There seemed to be little, if any, correlation between high test-weight and desirable baking quality for wheat brought into Salina from the 1946 Kansas crop. There was a positive correlation between low test-weight (58-60) and desirable baking quality in that the desirable curve in Fig. 6 starts to rise in number of cars received at 57-58 pounds per bushel, reaching a peak of 11 cars at 59-60 pounds. At any test-weight above 60 pounds, this desirable curve tends to decline in number of cars received, reaching 0 at 62-63 pounds per bushel. The correlation between

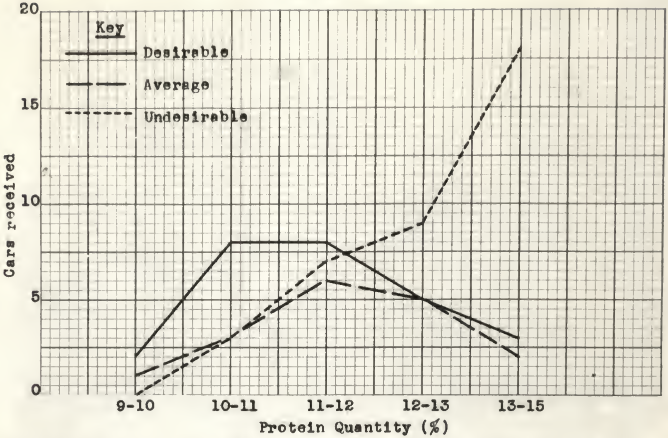

Fig. 5.The correlation between increasing protein quantity and a representative number of incoming cars at Salina and Hutchinson based on mixing curves for the same cars of wheat.

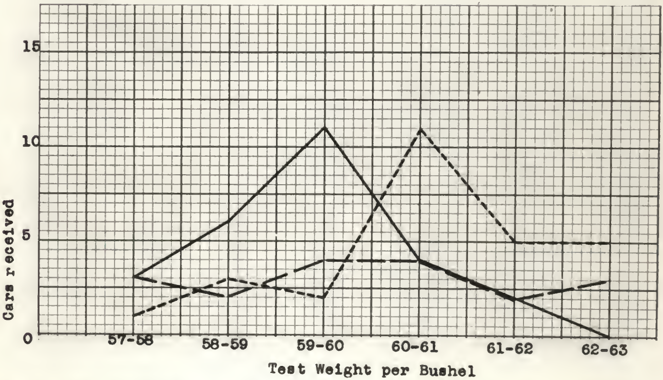

Fig. 6. The correlation between test weight per bushel and a representative number of incoming cars at Salina based on mixing curves for the same cars of wheat.

high test-weight (above 60) and undesirable baking quality is also observed in that there were only six cars received of undesirable wheat at the test-weight range of 57-60, while there were 21 cars received classified as undesirable at any test-weight over 60 pounds. The undesirable curve reached its peak of 11 cars at 60-61 pounds per bushel. Thus the higher test-weight varieties, which generally contained greater protein quantity, were not considered satisfactory, on the whole, for baking.

Other Quality Determinations

Figure 7 points out further interesting data on the relationship between the protein received at the internal Kansas markets and that received at Kansas City, Missouri, during the crop year 1946. First of all, the wheat received at Salina and Hutchinson was known to be all Kansas wheat. The wheat at Kansas City, Missouri was mostly Kansas wheat, but also consisted of some Texas, Nebraska, Oklahoma and Colorado wheat. Kansas City, Missouri wheat represented well over 15,000 cars of wheat received throughout the 1946 crop year; Salina and Hutchinson wheat represented only some 200 cars received at these markets throughout the crop year 1946. While by no means the total receipts at Salina and Hutchinson for the crop year, it was stated previously that these 200 cars were well representative of wheat received at these two internal Kansas markets. The graph (Fig. 7) showed that the protein level received at Kansas City, Missouri was definitely lower than that received at Salina and Hutchinson. This was probably a favorable result in that the Kansas City protein, while not so high, must have had better baking quality on the whole than the Salina and Hutchinson wheat. The high protein wheat received at the latter markets has been proved to be of an inferior baking quality. The lower protein wheat at Kansas City represented a large part of the whole United States 1946 crop. Therefore, it was logical to assume that the Kansas City wheat of lower protein must have had generally average to desirable baking quality. If the wheat marketed at Kansas City was not used eventually for baking purposes, a large supply of the 1946 crop would have been classified undesirable for baking, which was not the case. Remembering that the Kansas City wheat also came from the other hard red winter wheat producing states, it should be stated that their wheat must have been somewhat superior to the southwestern area wheat of Kansas for the year 1946. The accurate baking quality of the many cars received at Kansas City was not obtained, but since it represented Kansas City's total wheat for the year, and since it showed a comparatively low protein, then again the point should be emphasized that low protein wheat (11-12 per cent) gave the best results for desirable baking quality in 1946. If the receipts at Kansas City were analyzed on a baking quality basis

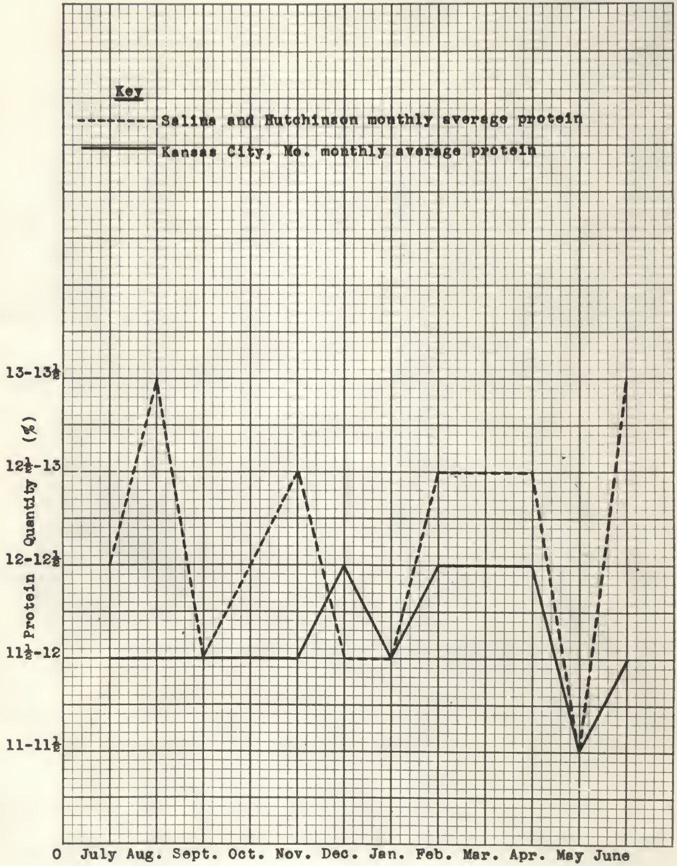

Fig. 7. A comparison of the monthly average protein quantity received at Salina and Hutchinson with that received at Kansas City, Missouri during the 1946 crop.

and found to be undesirable, then practically the whole hard winter wheat crop would have been undesirable, which was not the case. It was observed from this study that there definitely was an area in Kansas from whence came an undesirable wheat for baking. This area was the southwest and lower west central regions of Kansas, even extending into the south central area. This wheat nearly always carried a high protein content.

Another possible reason for the wheats into Salina and Hutchinson carrying a higher protein than the wheat into Kansas City was that the former may have come from dry lands where the moisture would have been less and consequently the protein greater. The wheat into Kansas City may have contained more moisture and thus less protein. Another reason was that the wheat into Salina and Hutchinson was of a variety which gave a high protein but an inferior baking quality.

Figure 7 showed an upward trend in the protein content of wheat received at Kansas City during the period November through March. There are two explanations for this rise in protein content of cars received as the crop year progressed.

First, the farmers and country elevators stored their high protein wheat realizing that it probably would sell at a premium later in the year. It generally is true in the milling industry that all of the wheat harvested in one crop year does not reach the terminal markets right at harvest time. As the need for higher protein wheat progresses through the year, the farmer will store some of his better wheat hoping that the protein premiums for this wheat will rise somewhat thus allowing the farmer a greater remuneration for his better wheat as the year progresses. This does not mean there would be no market for high protein wheat at harvest time; there is always a market for wheat containing desirable quality characteristics. But the market for it would no doubt be greater as the year passed than at harvest time.

Secondly, barring any severe abnormalities of moist weather, wheat which has been stored properly and turned for some months usually will dry out or decrease in moisture. Any comparison of increasing or decreasing protein content of wheat or flour always should be made on a uniform moisture basis. This has been set at 14 per cent moisture by the American Association of Cereal Chemists. There is an inverse ratio between the moisture content of wheat or flour and the protein content of the same. A decrease of one per cent in the moisture content of wheat under storage conditions would show an increase of about two-tenths per cent in protein. This would account for the higher protein wheat at the Kansas City market toward the end of the crop year. However, the wheat having been sold on the commodity market on this protein basis direct from country storage, and at some moisture content under 14 per cent, would later on decrease in protein content when corrected to the uniform moisture basis. This would not come about until the wheat reached the laboratory for flour analysis.

The sudden decrease in protein during the month of April in Fig. 7 probably was due to the fact that the remainder of the old crop was coming to market before the new crop was harvested. In May, the protein started to rise again as it was influenced by the new 1947 crop.

The monthly variation in protein for wheat into the Salina and Hutchinson markets throughout the crop year was so irregular that it was difficult to make any observations concerning its variation. About the only observation that can be made is that it was consistently higher in protein than the wheat going into Kansas City for the crop year.

Quality in General

After analysis of the mixing curves, protein, and test-weight, and study of the inspected receipts from internal Kansas, Kansas City, Missouri and St. Joseph, Missouri markets, as well as the average monthly protein received at Kansas City, Missouri throughout the crop year 1946, it is possible to reach several conclusions regarding the quality of the 1946 Kansas wheat crop. The crop, taken as a whole, was poorer than average from a baking quality standpoint. Figure 2 showed the desirable and undesirable area of Kansas as far as baking quality was concerned. There was some good wheat produced in 1946, but there was too much inferior wheat raised to call the crop satisfactory. The yield was above average; protein and test weight were above average in many areas, but in these same regions the baking quality was poor. Production or bushels harvested was excellent, but this did not give a desirable wheat for baking. The wheat practically all graded No. 1 or No. 2 and the number of cars of special grade was not large. The high protein-high test weight wheat from the lower west central, southwest and south central regions of Kansas was not conducive to desirable baking quality. The lower protein-lower test weight wheat from the east and upper west central area of Kansas was more conducive to desirable baking quality. This desirable region also extended somewhat into the south central area of the state, Fig. 2.

DISTRIBUTION

The quality of the 1946 Kansas crop was the most important aspect observed in this study from a milling point of view. However, economically speaking, the distribution and utilization of the same crop should not be ignored for the complete picture. The background of the wheat crop of 1946 should be mentioned in that the demand for wheat was abnormally high in both the domestic, and especially, in the foreign markets. The government played a large role in exporting wheat and flour through the Commodity Credit Corporation and the Production and Marketing Administration. It will be shown later that this export figure for Kansas wheat was unobtainable, and consequently had to be left as an unknown factor in showing the distribution of the crop. The total supply of wheat in the United States, including carry-over for 1946, was 1,255,800,000 bushels. Total exports, including shipments of flour made only from domestic wheat, military exports for European relief and exports by the Department of Agriculture were 400,000,000 bushels. These figures are given to show the tremendous exports of the 1946 crop. The wheat disappearance in 1946-1947 was the third largest on record and exports were then at an all time high.

Disappearance

The distribution of the 1946 Kansas wheat crop was estimated by a process of elimination. Method 1 of Table 5 shows disappearance by subtracting grind, feed and seed figures from total Kansas production leaving the unaccountable wheat merchandised outside of Kansas to mills manufacturing Kansas hard wheat flour plus export. Method 2 of Table 5 involves the use of apopulation and per capita consumption figure. By subtracting the flour used in Kansas from the total Kansas grind in method 2, the flour shipped from Kansas is obtained. However, this latter figure is still a part of the

Table 5. Methods showing the distribution of the 1946 Kansas wheat crop.

	Method 1		bu.
	Total Kansas production - 1946 (including carry-over, Table 1)		219,729,000
Less:	Wheat ground into flour by internal Kansas mills and Missouri river mills	114,136,460 25,706,808	
Less:	Wheat used for animal and poultry feed	6,503,000	
Less:	Wheat used for seed	14,994,000	
			161,340,268
	Wheat merchandised outside of Kansas to mills manufacturing Kansas hard wheat flour + export		58,388,732
	Method 2		
	Total Kansas production - 1946		219,729,000
Less:	Feed	6,503,000	
	Seed	14,994,000	
	Farm use	21,497,000	
	Total Kansas grind	114,136,460	
Less:	Flour used in Kansas[1]	6,544,490	
	Flour shipped from Kansas	107,591,970	
	Total accounted for		
	Farm use	21,497,000	
	Kansas grind	114,136,460	
	Missouri river mill grind	25,706,808	
			161,340,268
	Wheat merchandised outside of Kansas to mills manufacturing Kansas hard wheat flour + export		58,388,732

[1] Based on January 1, 1947 population of Kansas and 1946-1947 U. S. per capita consumption in bushels. The figure assumes that the flour was all ground within the state, which was not the case.

total grind. Both methods gave the same results as to total wheat accounted for and were used to show possible methods of the distribution of the 1946 Kansas crop. All data were calculated for the crop year 1946, which was July, 1946 through June, 1947.

Analysis of these two methods necessitated leaving the two unknown factors at the end. Out of a production of 219,729,000 bushels of wheat in Kansas in 1946, all but 58,388,732 bushels have been specifically accounted for. The remaining 58,388,732 bushels were divided between wheat merchandised outside of Kansas to mills manufacturing Kansas hard wheat flour and to the export market. This must have been the case, because there was no place else for the wheat to move. Small as it would have been anyway, the industrial use of making alcohol from wheat was prohibited by the government during that year. An attempt was made to find the amount of Kansas wheat exported during 1946, but records were not available from the Department of Agriculture, flour mills, or the Commodity Credit Corporation. The Commodity Credit Corporation purchased the export wheat for the government, but neither the Washington nor the Kansas City office could supply this data by states. The same problem was met in attempting to acquire specific figures of Kansas wheat merchandised outside of Kansas to mills manufacturing Kansas hard wheat flour. Consequently, it was decided to show the disappearance of the crop in so far as specific figures were available, and to leave the balance of the wheat in the two unaccounted for categories previously mentioned.

Terminal Markets Chosen as Grinding Centers for Kansas Wheat

The markets chosen for grinding figures were (1) all internal Kansas mills, and (2) the Missouri River mills of Kansas City and St. Joseph. These were the same markets chosen for the study of inspected receipts at designated markets. It will be remembered that 72 per cent of these inspected receipts was considered Kansas wheat. Since all of the wheat ground in the Missouri River mills could not have been Kansas wheat, it was decided to use this 72 per cent figure and thus assume that approximately 72 per cent of the wheat ground in the Missouri River mills was Kansas wheat. Estimates from men in the milling field concerning this figure ran from 70 to 80 per cent.

The figure for wheat ground into flour by internal Kansas mills through the crop year 1946 was 114,136,460 bushels. This quite possibly may have been too high, as some of it was definitely not Kansas wheat. Estimates on this ranged around 10 per cent. In other words, 10 per cent of the total wheat ground in internal Kansas mills during the crop year 1946 was not Kansas wheat. It was known that wheat from other areas came into Kansas but the exact amount was difficult to determine. The grinding figure for internal Kansas mills was complete in that there are 70 mills in Kansas and 69 of them reported their total grind every month of the year to the Bureau of the Census.

UTILIZATION

Table 5 showed the disappearance of the 1946 Kansas wheat crop; the utilization of this same crop as to where the wheat flour actually was marketed was also undertaken. The information presented will give the reader an idea of just what happened to the wheat of the nation's largest wheat-producing state during the crop year 1946. The total number of bushels ground into flour by internal Kansas mills was 114,136,460. Using a conversion factor of 2.26 bushels of wheat to make a hundred-weight of flour, the total flour sales for the year ending May 31, 1947 (note that June was omitted) were 38,546,540 sacks x 2.26 = 87,115,180 bushels. This figure was obtained from the Associated Millers of Kansas Wheat, whose membership constitutes around 95 per cent of all Kansas mills. The relationship of these total flour sales for the year ending May 31, 1947 to the total Kansas grind figure ending June 30, 1947 was 76 per cent. If the month of June had been included in the above sales figure, the percentage of sales to total grind would have been even greater. This percentage figure was by no means calculated to show the sales of all Kansas wheat and flour in 1946, but only to show a typical figure of sales during that year. Table 6 was compiled to show the destination of sales to points both within and outside the United States, and also to show the actual usage of the flour, such as bakery, family, etc. It must be remembered that the figures presented in Table 6 were included within the grind figure, and may not be considered in addition to it. They were used as typical figures of destination and flour usage of Kansas ground wheat, most of which was grown within Kansas. The totals of Table 6 were compiled in Table 7.

This table showed more than 77 per cent of the flour went into bakery flour and export. It again must not be overlooked that this was based on 38,546,540 sacks which, when converted to bushels at 2.26 bushels per sack, gave 27,115,180 bushels. This latter figure, in turn, represented 76 per cent of the Kansas grind which was sold as flour. In other words, the picture, while not totally complete, was sufficient to show the disposition of more than three-quarters of that flour ground in the crop year 1946 by internal Kansas mills.

The export figure in Table 7 channelled 30 per cent of the flour sales into the export market. This was the only specific mention of export in terms of wheat or flour obtainable. This export of 11,565,630 sacks, when converted to bushels by the conversion factor of 2.26, gave 26,138,323 bushels or 23 per cent of the total Kansas grind going to

Table 6. Destination and usage of most of the 1946 Kansas wheat grindings, sacks.

Zone	District	Bakery	Family	Clear	Farina	Total sacks	% of total
1	Greater N.Y., Newark, Jersey City, Philadelphia	1,852,257	37,300	250,974	8,400	2,148,931	5.6
2	N. Y. State, New England	692,880	7,314	25,500	600	726,294	1.9
3	Eastern Penna., N.J., Md., Del., Dist. of Col.	865,524	50,531	4,500	-	920,555	2.4
4	Pittsburgh, Western Penna., W.Va., Va.	746,880	214,849	29,400	-	991,129	2.6
5	Detroit, Cleveland, Cincinnati	913,692	16,625	89,400	1,000	1,020,717	2.6
6	Ohio, Indiana, Lower Michigan	1,498,687	86,868	150,038	41,059	1,776,652	4.6
7	Chicago	572,566	14,900	277,187	8,660	873,313	2.2
8	Ill., Iowa, N. Dak., S. Dak.	640,642	85,783	50,771	16,810	794,106	2.1
9	Minnesota, Wisconsin, Northern Michigan	729,156	13,047	52,292	156,290	950,785	2.5
10	Kansas, Nebraska	572,462	88,268	65,560	6,500	732,790	1.9
11	New Orleans	51,194	61,594	200	-	112,988	0.3
12	Okla, Arkansas, Louisiana, Miss.	249,187	860,915	15,950	-	1,126,052	2.9

Table 6. (concl.).

Zone	District	Bakery	Family	Clear	Farina	Total sacks	% of total
13	Southeastern Territory	1,365,945	1,251,357	22,392	-	2,639,694	6.8
14	Texas, New Mexico, Western States	110,025	70,605	12,148	800	193,578	0.5
15	Missouri	636,520	254,868	165,672	600	1,057,660	2.7
	General Bakery	6,769,299	-	-	-	6,769,299	17.6
	Export	-	-	-	-	11,565,630	30.0
	LCL (Local Delivery)	-	-	-	-	1,139,477	3.0
	Government	-	-	-	-	3,006,890	7.8

export. The difference was accountable in that the export data, like the total sales data, only included 11 months (June was omitted) and the information was obtained from the Associated Millers of Kansas Wheat, which represents only 95 per cent of the Kansas mills. Had this export figure been obtained from the Bureau of the Census on a 12-month basis, as was the total grind figure, it undoubtedly would have been greater. Nevertheless, a partial picture of the export market was observed in showing that at least 23 per cent of the total Kansas grind in 1946 went to export. When it was considered that the grind only represented some 50 per cent of the Kansas crop, there must have been considerable wheat remaining, as was shown in Table 5, to move into export. The export figure of 30 per cent of total flour sales made in sacks may be considered also when estimating exports of 1946. Regarding exports of wheat from Kansas during the crop year 1946, this thesis had no specific data to offer, other than the figures presented above. Specific data were obtainable on total United States exports, but such information pertaining to a single state was unobtainable.

Table 7. Totals of Table 6 showing trade usages and other purposes for which Kansas flour was used in 1946.

Usage	Total sacks (cwt.)	Per cent of total sales
Bakery	18,267,016	47.4
Family	3,114,824	8.1
Clear	1,211,984	3.1
Farina	240,719	0.6
Export	11,565,630	30.0
Local delivery	1,139,477	3.0
Government	3,006,890	7.8
Grand total	38,546,540	100.0

SUMMARY

It has been the objective of this thesis to make a study of the quality of the 1946 wheat crop produced in Kansas. The word "quality" as used in the milling field covers a multitude of meanings. Consequently, it was decided to obtain data from various mills, insofar as possible, indicating baking quality of Kansas-grown wheat, along with protein and test weight determinations on the same wheat. It was felt that mixing curves from various mills would be the most practical commercial indicators by which to judge the quality of the

crop. At times, such as considering Kansas City protein receipts and total Kansas, Kansas City and St. Joseph, Missouri grade receipts, it was necessary to consider wheat which did not come from Kansas. Nevertheless, such data still had a very direct bearing on the Kansas crop itself because the heavy majority of this wheat was Kansas wheat. The flow of wheat may be likened to that of water in that it passes interstate boundaries and no one actually can keep track of it. This was the main reason why certain basic assumptions were made in writing this paper. There were no assumptions made pertaining to quality factors, but there were some involved in attempting to show distribution and utilization of the crop. However, such assumptions were backed up by the best authority in the country on such problems.

The two unknown factors on which specific data were not available were (1) the amount of wheat merchandised outside of Kansas to mills manufacturing Kansas hard wheat flour for the crop year 1946; and (2) that amount of Kansas-grown wheat that went into export from the crop of 1946. Data on these two factors never will be available until more adequate records are maintained by both the government and the various milling companies. It is hoped that this paper may have at least brought out the nonexistent figures which must be obtained before the complete disappearance of any crop from any one state may be analyzed.

The quality in general of the 1946 Kansas wheat crop was variable, as many wheat crops are. Any consideration of the quality aspect of the crop was entirely relative -- depending on which parts or regions of the state were under consideration. Certain conclusions were reached in this study showing that the southwest region of the state raised wheat which was entirely undesirable from the bakers' point of view. So undesirable was some of this wheat that spring wheat had to be brought in from the north to give a satisfactory mixing curve. Consequently, the ultimate objective of raising wheat -- to bake well -- was not attained when considering the Kansas crop raised in 1946 in the southwest part of the state. On the other hand, the counties farther north toward the center of Kansas produced a good crop as judged by mixing curves as pre-determinants of baking quality. That all of the wheat raised in Kansas in 1946 was used to greatest advantage cannot be denied; this was because of the extraordinary demand for wheat and wheat flour during that postwar year. However, the same crop of wheat raised in Kansas today would have a difficult time finding its way to market with satisfactory returns to the farmer, the elevator operator, the miller and the baker. While the protein and test weight of the crop produced in the southwest were both high, the wheat was inferior if mixing curves are any judge of baking quality. Quoting from a letter from the Dodge City Flour Mills:

> The quality of the wheat in the southwestern area of Kansas has deteriorated during the past several years due to the fact that a large percentage of inferior quality wheat has been planted. This wheat is of the Red Chief and Chiefkan varieties. However, recently, due to the heavy discount on these varieties, farmers have decided to plant wheat that is more suitable to the making of flour for the bakery trade.

By discount on these varieties is meant that such varieties are simply not readily sold or accepted on the commodity market. This directly affects the demand for the farmer's wheat.

The following data in Table 8 give a brief summary of comparative baking tests of six different varieties of wheat from the 1946 Kansas crop. The tests were run at the Fort Hays Experiment Station and are shown as supplemental information pertaining to baking quality.

All of the samples were short mixing time and rather sensitive to over-mixing. The Delux Red Chief was inferior in most all characteristics. Comanche was superior in most respects. The remaining samples were considered acceptable by the Station although all showed a weakness toward mechanical treatment during the mixing. This would indicate that the protein was not of the proper quality or the gluten not of sufficient strength to permit full development of the dough during mixing. Protein quantity was observed, but not protein quality.

After studying the distribution of the wheat grown within

Table 8. Summary of comparative baking tests of six different wheat varieties from the 1946 Kansas crop.

	Protein	Absorption	Mixing time	Loaf vol.	Grain & texture	Crumb color	Bread and shred	Handling characteristics at pan
	per cent	per cent	min.	cc	per cent	per cent		
Blackhull x Cheyenne	13.1	63	2.0	769	86	87 ay	Fair	Very good
Cheyenne x Early Blackhull	14.5	65	1.2	788	85	87 ay	Fair	Very good
Pawnee[1]	15.3	66	1.2	789	86	85 ay	Poor	Sticky & soft
Delux Red Chief[1]	14.2	64	1.5	665	80	85 ay	Poor	Sticky & soft
Comanche[1]	15.5	66	1.3	855	87	86 ay	Poor	Very good
Triumph[1]	14.2	64	1.5	846	87	88 ay	Good	Very good

[1] Only varieties being grown at Ft. Hays Station today.

one state during one crop year, the need was found as mentioned before, for more available and accurate statistics on disappearance factors, such as wheat into export and wheat merchandised outside of the state. This information would not be necessary for minor wheat-producing states, but it should be available for the major wheat states, and especially for Kansas. With more information of this type at hand the question, "Where, exactly, does all the wheat raised in Kansas go?" would no longer be an enigma, as it certainly is today.

Such data could readily be made available in monthly reports of mills and elevators to the Department of Commerce, Bureau of the Census.

The method herein described of obtaining mixing curves and then analyzing these curves for wheat origin and baking quality potential is also set forth as an accurate method whereby areas in Kansas may be isolated because of producing wheats of inferior baking quality. If not isolated, such areas could at least be studied to better the wheat raised in those particular localities.

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Shellabarger's Inc., Salina, Kansas

The Kansas Milling Company, Wichita, Kansas

The Wm. Kelly Milling Company, Hutchinson, Kansas

The Dodge City Flour Mills, c/o The Colorado Milling
Milling & Elevator Company, Dodge City, Kansas

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The Wm. Kelly Milling Co., Hutchinson, Kansas

The Kansas Milling Co., Wichita, Kansas

The above mentioned curves were all chosen for wheat produced in Kansas from the 1946 harvest and originating, at some time during the crop year, 1946, (July 1, 1946 to and through June 30, 1947) at various stations within Kansas.

Maps showing location of specific towns in various Kansas counties originating Kansas wheat: Gallup Map and Stationary Company, Kansas City, Missour,