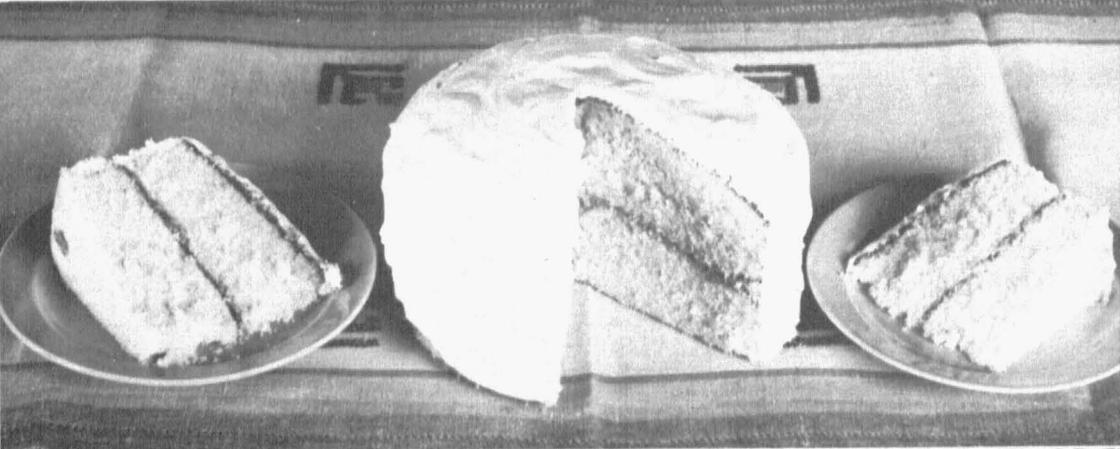


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# The Production of Quality In Missouri Soft Wheat

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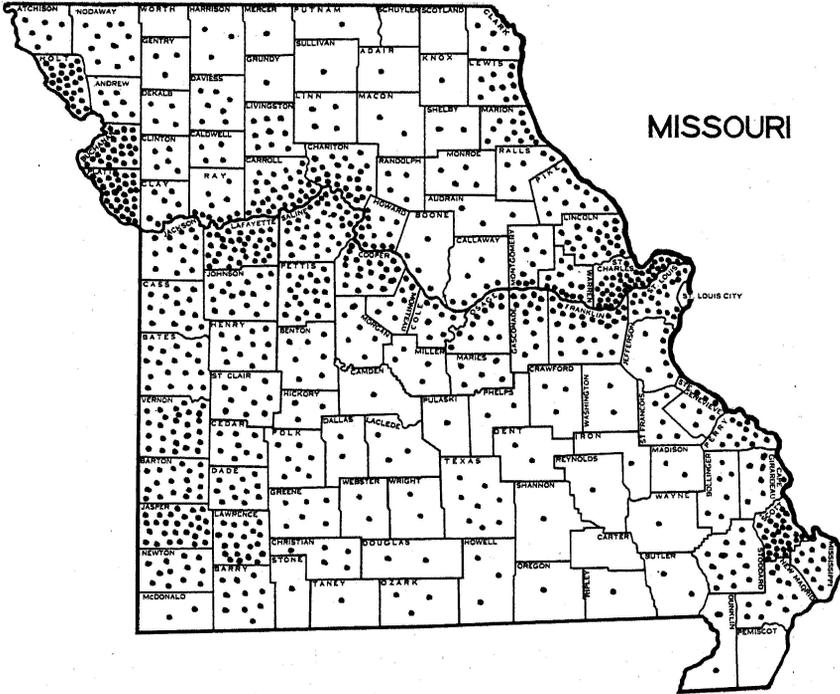


Fig. 1.—Where wheat is grown in Missouri. (Each dot represents 1,000 acres.) Over 90 per cent of the Missouri wheat acreage is normally planted to soft wheat varieties. The remaining acreage, planted to hard wheat varieties, is largely within a few counties in Northwest Missouri, and does not become mixed with soft wheat in market channels.

# The Production of Quality in Missouri Soft Wheat

J. M. POEHLMAN AND FERNE BOWMAN<sup>1</sup>

Quality in Missouri soft wheat is becoming primarily important. Recommendations of varieties are now made not only on the basis of high yields but consideration is also given to the quality of flour milled from these varieties and the quality of the product it will produce in the bakeshop. To the farmer who has been growing wheat for many years with little thought of its final utility, the emphasis on quality comes as a new idea. To the miller it has brought a realization that the sound development of his business on a quality product basis is closely related to the farmer's interest.

All of this means that the consumers are demanding better quality in their bread, cake and pastry. The bakers hearing consumer demand pass it on to the flour dealers and millers, who at last carry the problem to its origin—the wheat grower.

What changes in recent years have brought the attention of farmers and millers alike to wheat quality? What is meant by wheat quality? How is it measured? Which varieties of soft wheat are good in quality? Why will the production of quality wheat be beneficial to Missouri farmers and millers alike? These questions are frequently met. They will be discussed in the following pages.

## How the Farmer Looks at Wheat Quality

Wheat produced as a cash crop by the Missouri farmer is usually delivered and sold to the local mill or elevator. The price received varies with the market grade of the grain delivered. Market grade in turn is determined by certain conditions of the grain, such as test-weight, relative freedom from damage, from foreign material, from mixtures with other wheat types (hard wheat), and the amount of moisture contained. On this basis of measuring quality, the variety of soft wheat affects market grade and price only insofar as it may also affect the factors that

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compose the market grade, as for example test weight. By such grading, any wheat that is sound and clean and plump is quality wheat. Most farmers know nothing more than that about the matter, and many of them know less. They are concerned only with a good yield, fair grading by the local buyer, and a good price.

### Wheat Quality from the Millers' View

The soft wheat miller is also interested in the qualities necessary for a high market grade. For unless the wheat is sound and clean and plump, he cannot mill a quality product. But certain other qualities in the wheat are necessary for the milling of flour to meet the requirements of the modern bake shop. These are the *milling and baking qualities*. They are not easily defined but they include kernel texture, protein and ash content, and the nature of the wheat gluten. Various chemical and physical tests are used to measure these properties but finally they are measured by the product from the baker's oven.

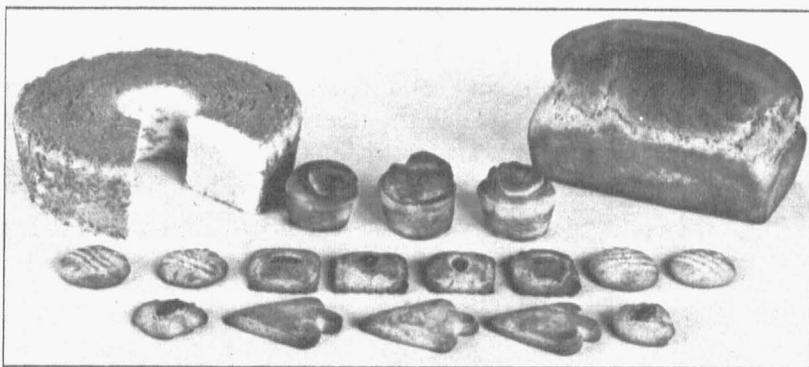


Fig. 2.—Soft wheat varieties have a low content of gluten, known to the flour trade as “weak,” and are used for milling cake, cooky, and cracker flours, but hard wheat varieties have a “strong” gluten and are used for milling bread flours.

The property that has made wheat so valuable as a bread grain is the gluten. The characteristics of wheat gluten—its amount and strength—are therefore of greatest importance to the miller in evaluating soft wheat quality. Gluten is a part of the total protein content of the wheat kernel and is influenced by the same conditions that affect the protein as a whole. The strength of the gluten largely determines how the flour milled from the wheat is to be used—whether for making bread or for making cakes, cookies, and crackers. In general, soft wheat

varieties have a low content of gluten, known to the flour trade as "weak", and are used for milling cake, cooky and cracker flours, but hard wheat varieties have a "strong" gluten and are used in milling bread flours. In turn, an individual soft wheat variety may have gluten properties that adapt it widely to the production of cake flour, cooky flour, cracker flour, or to family flour for general use.

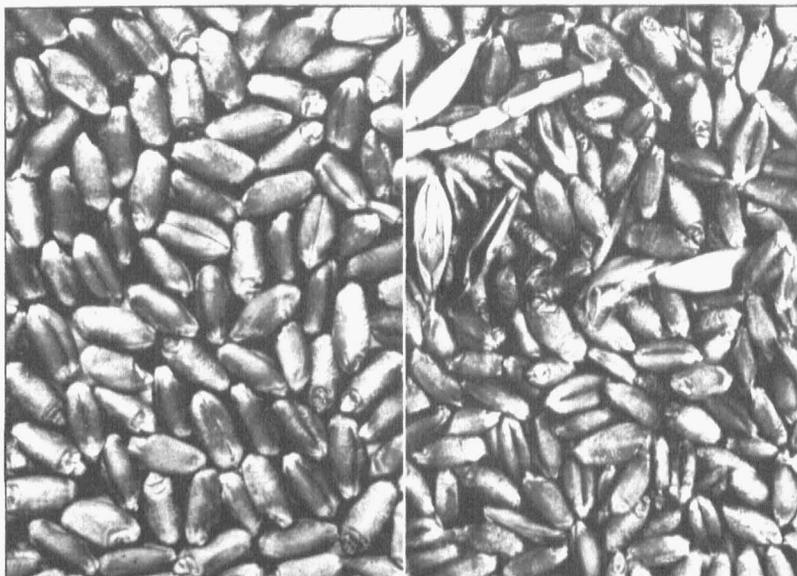


Fig. 3.—Present standards of grading soft wheat distinguish grain that is clean, sound, and plump, from grain that is unsound, dirty, or light. They do not distinguish soft wheat varieties good in gluten from those which are poor.

Thus gluten quality is definitely a variety characteristic of wheat. And the soft wheat miller who mills flour for a special trade therefore wants wheat that is not only sound and clean and plump, but he also wants the variety that will mill into flour which will satisfy the particular demand of his customers.

#### **Present Wheat Grading Standards Inadequate**

Present standards of grading will distinguish wheat that is sound and clean and plump from wheat that is unsound, dirty, mixed or light. But these standards do not distinguish soft wheat varieties good in gluten from those which are poor. Thus a variety of soft wheat may grade high in the market and yet be unsuited for milling a special kind of flour.

### Developments in Wheat Marketing

To avoid buying wheat of an unsuited variety, millers and grain dealers frequently buy on the basis of a sample of the grain to be delivered and tested rather than on the basis of market grade alone. Wheat of an undesirable variety, if recognized, will then be rejected. Difficulty in recognizing an undesirable variety in a mixture of varieties may result in the miller buying wheat unsuited to his need. To avoid this, millers sometimes explore the production areas before harvest, and then refuse to buy milling wheat from localities where undesirable varieties are grown. The entire production of wheat from these places must then be diverted to other market channels and hence loses the advantage of competitive bidding from the milling trade. It has been observed in Missouri that the general price level of wheat in a locality where an undesirable milling variety is grown may be several cents below the price level in an adjacent area where only good varieties are found. The reason for such a discrepancy is not always apparent to a farmer within the area where the lower prices are received. For on the basis of soundness, cleanness, and plumpness of the grain, he may be paid the highest market price in his community, regardless of the variety and its actual milling value.

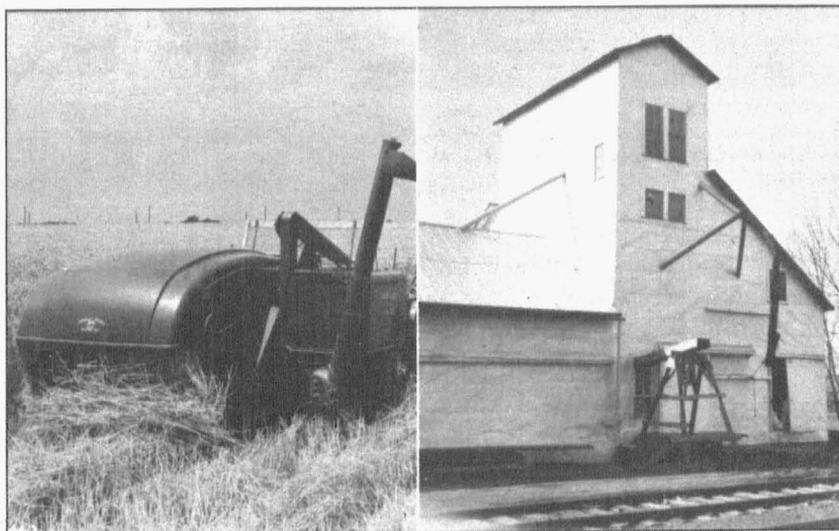


Fig. 4.—Wheat varieties become mixed in the custom combine and local elevator. If production in a community was of one variety, mixture through these sources would be avoided.

Another development in local grain marketing is the practice of a mill or elevator in discounting the price of an undesirable variety (if the variety is recognized) when the wheat is delivered to the mill or elevator. Kawvale<sup>1</sup>, for example, is frequently discounted in Missouri. Such a practice, based entirely on recognition when the grain is delivered, is unsound, unless the variety can be recognized with invariable accuracy. Failure to evaluate accurately its milling and baking qualities may result in the discounting of a new variety, even though it possesses satisfactory gluten properties. The Clarkan<sup>2</sup> variety has sometimes been discounted in Missouri without apparent justification.

A more desirable practice is that of paying a premium for a variety excelling in milling and baking qualities. Some Missouri millers have in this way encouraged the production of quality wheat in their production areas. This practice, based on the supposition that a reward is more effective than a penalty, has stimulated the production of superior varieties and led to an increase in their acreage. When the millers' economy permits, this is a practice to be encouraged.

### One Variety Communities

Because the mixing of good and poor milling varieties in the local elevators is likely to result in a generally lower price level for the whole locality, the single-variety production of wheat by the whole area is increasing. This idea is practiced in the wheat areas of other states, and it has been developed with remarkable success by the cotton growers in Southeast Missouri to increase the uniformity and quality of their product. Several Missouri mills and elevators are encouraging the practice by making available to local farmers the pure seed of a desirable variety. The production of a single variety, high in yield and satisfactory in quality, will make more money for farmers and millers alike. To promote the adoption of the single-variety idea, the Missouri Agricultural Experiment Station is now recommending only two varieties—*Clarkan* and *Early Premium*—for the whole State.

### Wheat Variety Changes in Missouri and Their Relation to Wheat Quality

For many years Missouri soft wheat reached and held a high standard of quality among soft wheat millers, and the flour

<sup>1</sup>Kawvale is a semi-hard variety of wheat developed at the Kansas Agricultural Experiment Station. Although it is graded as soft wheat on the market, its milling and baking properties approach those of hard wheat.

<sup>2</sup>Clarkan is a variety of soft wheat developed by a private plant breeder in Kansas.

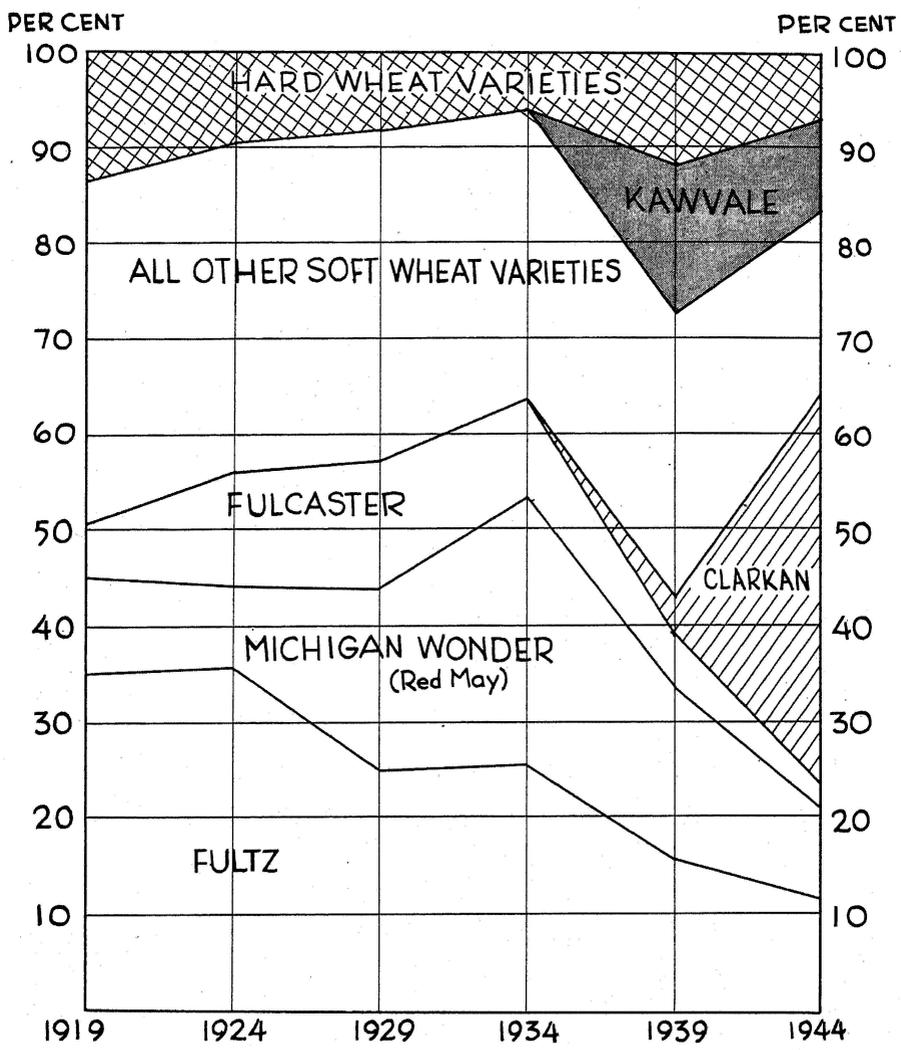
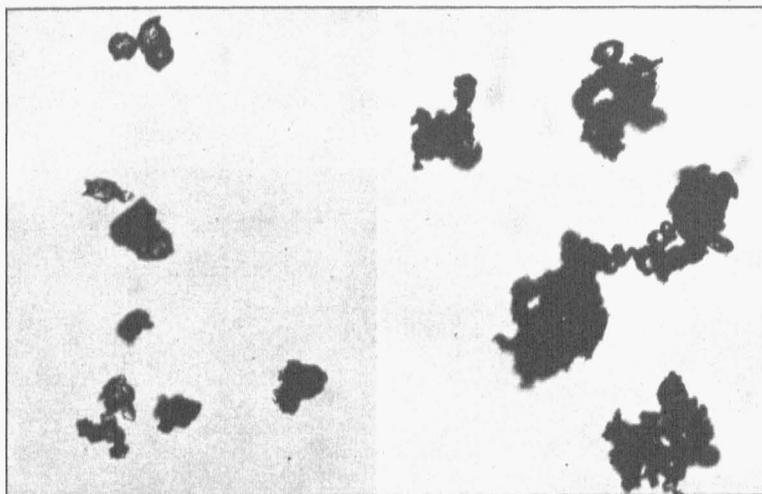


Fig. 5.—Percentage of Missouri wheat acreage planted to leading varieties from the years 1919 to 1944. Increase in acreage of hard wheat and Kawvale from 1934 to 1939 was primarily responsible for the decline in soft wheat quality during that period. Since 1939, acreages of these wheats have been reduced and Clarkan has become the most extensively grown variety in Missouri.

was sold at a premium everywhere. In recent years, however, the quality has declined until serious loss in our soft wheat milling industry has been predicted unless this trend is checked. Much of the wheat marketed in Missouri during the period 1934 to 1939 was not up to the previous high standards of quality.

Difficulties met by millers in milling the quality of product needed for their trade are evidence of this fact.

What have been the causes of this decrease in production of Missouri quality wheat? Increase in acreage of undesirable varieties and deterioration in soil fertility are considered as the dominant causes though lesser factors have also played a part.



Early Premium

Kawvale

Fig. 6.—Flour particles experimentally milled from pure seed of Early Premium and Kawvale varieties (magnified 150 X). Flour milled from Early Premium is fine and fluffy; flour milled from Kawvale, coarse and granular.

In 1934 more than 94 per cent of the Missouri wheat acreage was planted to soft wheat varieties of acceptable milling quality—varieties such as Fultz, Michigan Wonder, Fulcaster, Poole, Mediterranean and Dunbar—upon which the previous high reputation of Missouri soft wheat had been built. Only about five per cent of the State wheat acreage was planted to hard varieties, and this part was found mostly in a few counties of Northwest Missouri where it did not become mixed with soft wheat in market channels. But in 1939 only 72 per cent of the Missouri wheat acreage was planted to good soft wheat varieties, while over 27 per cent was planted to hard wheats or to Kawvale, a semi-hard variety not satisfactory for soft wheat milling. Furthermore, the increase in acreage of Kawvale was widely scattered over West and North Missouri, there mixing Kawvale with the acceptable soft wheats in normal trade channels, so that much more than 27 per cent of the crop was lost to the soft wheat miller for milling into quality flour.

Coincident with the reduction in acreage of good quality wheat was the increasing need of milling the flour to meet the requirements of a more exacting trade. In the past a large portion of Missouri wheat had been utilized in the production of family flour for home baking. But with the decline in home baking more of our soft wheat was being used in the production of cake flours for commercial bakers. And the modern bake shop with its standardized formulas and procedures demands a flour more uniform in quality than does the home baking trade. While Kawvale flour might be acceptable for general home use, it could not meet the high standard set by the commercial bake shop.

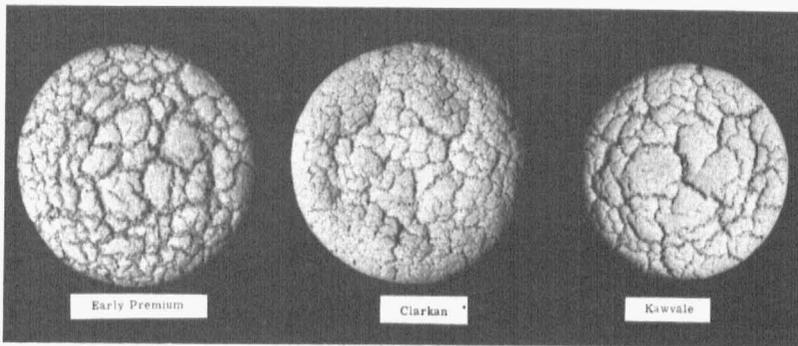


Fig. 7.—Cookie baking tests are used to measure gluten properties of wheat varieties. The large spread of cookies made from Early Premium and Clarkan varieties indicates a “weak” gluten. The smaller spread of cookies made from Kawvale indicates a “strong” gluten, undesirable to the soft wheat flour trade.

The effect of soil fertility in this change in wheat quality is not easily distinguished. That a general deterioration in soil fertility has contributed to the decline is not proved by available evidence. For among the reports received from millers were many showing the presence of high protein and high ash—both being undesirable—in their soft wheat flours. But these conditions are more readily attributed to the increasing uses of legumes and fertilizers during this period than to a general decline of soil fertility. It is possible that with the increased use of soil amendments, wheat varieties containing “weaker” gluten than those now recommended will need to be developed. From the fact that old and accepted varieties of high quality, such as Fultz, have continued to produce wheat of excellent milling properties wherever grown, it appears that any general decline in total wheat quality in Missouri may be attributed more

fully to a reduction in acreages of these good milling varieties than to changes in soil fertility.

### Why the Change in Wheat Varieties?

Several abnormal conditions during the years 1934 to 1939 contributed to the decrease in the relative acreage of good soft wheats in Missouri and to the increases in hard wheats and Kawvale. Among these were the drought years, 1934 and 1936, the heavy epidemic of stem rust in Western Missouri in 1937, and the severe winter killing in Western and Northern Missouri in 1938.

The stem rust epidemic in 1937 was of such proportions that much of the wheat acreage in Western Missouri was abandoned. The good soft wheats grown in this area were highly susceptible to rust and were severely injured, whereas the hard wheats and Kawvale possessed either tolerance or some resistance to stem rust and produced relatively good yields. Winter injury the following season also was more severe in the soft wheats than in the more winter-hardy Kawvale variety or the hard wheat varieties. Yields of Michigan Wonder and Fulcaster at Maryville in 1938 scarcely exceeded one bushel per acre, while Kawvale produced a yield of 15 bushels. Under these conditions growers in Western Missouri readily turned to these hardy types to replace their soft wheat varieties. These changes were reaching also into Central and Eastern Missouri. It was during this period that a decline in wheat quality became most apparent.

### Can Kawvale Acreage Be Reduced?

At this time it became evident to those interested in the continued production of quality wheat that unless the spread of the Kawvale variety was checked and its acreage reduced, Missouri soft wheat would not regain its previous high standards. The discounting of the price paid for Kawvale, as previously described, was resorted to by many millers to discourage its further production. But with the increased need and use of wheat as a feed grain in Missouri, and the high grain yields of Kawvale, farmers could profitably continue to grow Kawvale even though its price was discounted. Reduction in the acreage of Kawvale necessitated its replacement by other varieties. That farmers in Western Missouri could not be expected to replace Kawvale with the old varieties previously grown is evident from the high yields of Kawvale, as compared to yields of Michigan Wonder and Fulcaster. Twelve yield trials at Lathrop, Grain

Valley and Maryville, Missouri, during the years 1937-1944 are summarized here:

Michigan Wonder	.....21.8 bu. per acre
Fulcaster	.....21.1 bu. per acre
Kawvale	.....29.3 bu. per acre

The only practical solution of the problem was the replacement of Kawvale with a variety equally high in yield and acceptable in quality. The Clarkan variety appeared best suited for this purpose.

### Early Premium and Clarkan Have Set Standards of Quality and Production

Since 1939 two varieties of wheat have received increasing attention in Missouri. They are *Early Premium* and *Clarkan*.

**Early Premium**<sup>1</sup> ripens extremely early, is fair in yield, short in straw, and has excellent milling and baking properties. While its acreage is not extensive, especially where grain yields are of first importance to the farmer, Early Premium is a fine nurse crop and has set the standard in Missouri for soft wheat quality and market price.

**Clarkan** is high in yield, winter hardy, stands well without shattering, and produces a plump heavy berry, but is susceptible to loose smut. Its milling and baking qualities are acceptable to soft wheat millers, although it has a heavy bran and may produce a low yield of flour. Grain yields and winter hardiness of Clarkan equal or exceed those of Kawvale.

Comparisons of Early Premium, Clarkan, and Kawvale in yield and test weight are summarized from the years 1937-44 as follows:

	Yield*	Test Weight**
	Bu. per A.	Lbs. per bu.
Early Premium	.....24.2	58.3
Clarkan	.....28.1	60.8
Kawvale	.....28.0	58.2

\*83 comparisons at Columbia, Sikeston, Lathrop, Bethany, Maryville, Grain Valley and Elsberry.

\*\*15 comparisons at Columbia, Sikeston, Lathrop, Bethany, Maryville, Grain Valley and Elsberry.

Thus the farmer who grows Clarkan instead of Kawvale accepts no loss in yield of grain and gains the advantage of the higher test weight and the added value of marketing a quality

<sup>1</sup>Early Premium is an early variety of soft wheat developed at the Missouri Agricultural Experiment Station.

product. The latter may not be readily measured with our present marketing standards, but its value becomes apparent in the long view.

Since 1939 the acreage of Clarkan has spread rapidly. It now occupies a larger part of the wheat acreage in Missouri than has been occupied by any other single variety in the last twenty-five years. Further increase in its acreage may be expected. Its faults such as susceptibility to loose smut and heavy bran can perhaps be overcome but only by an intensive breeding program of long duration.

### Quality Comparisons of Early Premium, Clarkan, and Kawvale

The influence of the variety upon the quality of wheat and flour was a problem new to the Missouri farmer and the Missouri miller. Information on the comparative milling and baking qualities of wheat varieties grown in Missouri was not available. To obtain this information studies of wheat quality were begun at the Missouri Agricultural Experiment Station. Interested in them were many Missouri millers and a soft wheat laboratory at Wooster, Ohio, newly established by the U. S. Department of Agriculture. These studies include chemical analyses of the wheat and flour, baking tests to compare the quality of cakes and cookies made from the flour, and various supplementary tests which measure additional wheat gluten properties.

Chemical analyses most informative in wheat quality studies are those that measure the protein and ash in the wheat and flour. A summary of the protein and ash content of wheat and flour experimentally milled from Early Premium, Clarkan and Kawvale is reported below:

	Wheat protein	Wheat ash	Flour protein	Flour ash
	%	%	%	%
Early Premium . . . .	10.51	2.05	8.67	0.38
Clarkan . . . . .	10.87	2.23	9.30	0.43
Kawvale . . . . .	10.80	1.98	9.10	0.48

Average analyses of variety samples grown at Columbia in 1941, 1943 and 1944; and at Sikeston in 1942 and 1944. All analyses corrected to a 13.5 per cent moisture basis.

Although the protein of wheat and flour is a useful figure to the miller and baker in evaluating wheat and flour strength, it proved to be of little use in comparing these wheat varieties grown under similar conditions of soil fertility and climate.

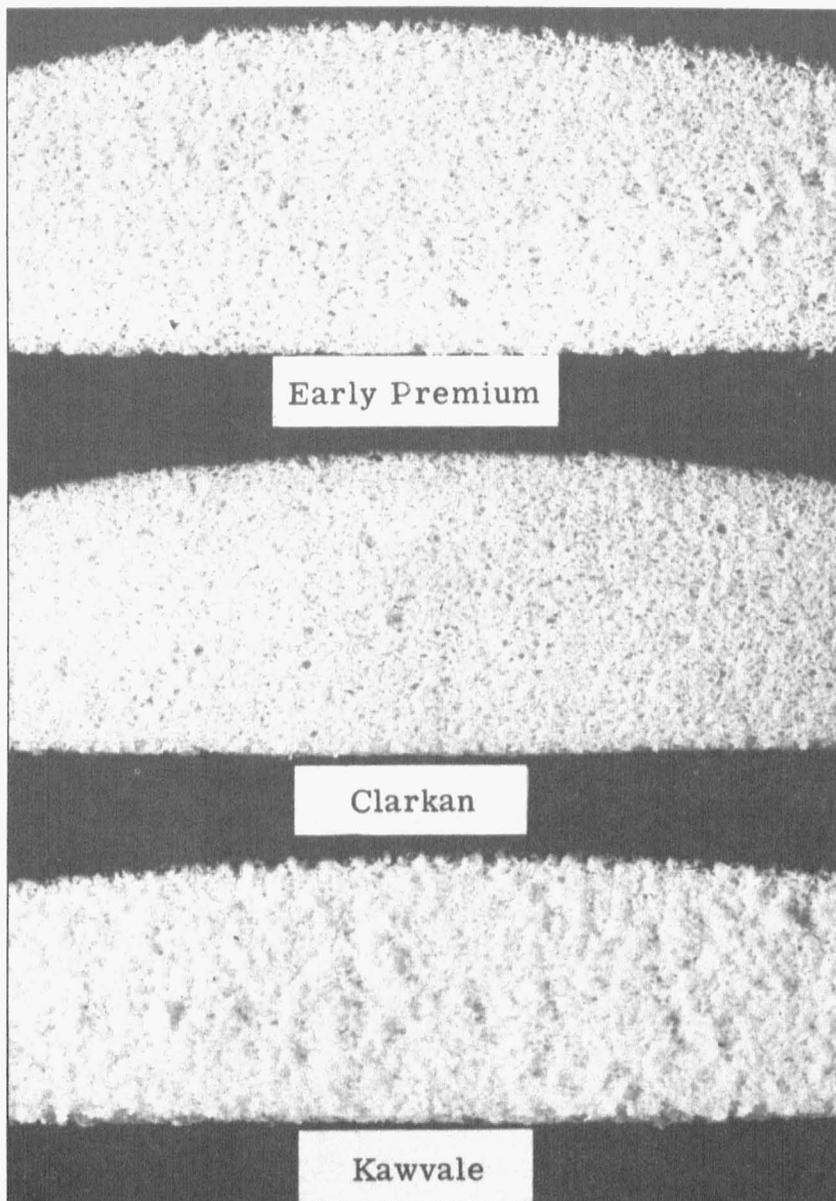


Fig. 8.— White cakes baked from Early Premium and Clarkan are light, tender and large in volume. Cakes baked from Kawvale are heavy and low in volume.

But the higher ash in the flour from Kawvale is truly indicative of the poorer milling qualities of that variety.

Of much greater use in comparisons of quality are the baked products from the flours. One of the most important commercial outlets of Missouri soft wheat is the milling of cake flour. And through their cake baking performance we can best compare the values of the varieties for that purpose. Comparative volume and scores of white cakes baked from experimentally milled flours of the varieties are as follows:

	Comparative volume	Total Baking score
Early Premium .....	100	92
Clarkan .....	98	87
Kawvale .....	92	77

Average of bakings with flour experimentally milled from wheat varieties grown at Columbia in 1941, 1943 and 1944; and at Sikeston in 1942 and 1944. Approximately 5 bakings were made on each flour sample.

A close relation between the volume and lightness of the cake and the total score for "eating quality" was found. Flours from Early Premium and Clarkan always held their maximum volume until baked. Cakes from these varieties were light, tender, and velvety. Early Premium and Clarkan were therefore rated as desirable for making cake flours. But cake made from Kawvale flour did not hold its maximum volume during the baking process. It would shrink and when finished would be heavy and low in volume. Kawvale was thus rated as unsatisfactory for making cake flour. Baking tests with cookies emphasized these results.

Supplementary tests to study additional characteristics of the varieties—especially texture and gluten properties—were also made. These include such tests as pearling, time fermentation test on wheat meal, viscosity and mixogram area on flour. But mostly these tests are technical in their operation and limited in their meaning. They are only supplementary to the pointed results obtained from the baking tests with cakes and cookies.

#### Acknowledgments

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