Comparative Milling and Baking Quality of North Dakota Wheats[1]

By R. H. Harris[2], L. D. Sibbitt[3], G. M. Scott[4] and G. H. Bruner[5]

The introduction of new hard red spring wheats into the experimental plots at the different branch stations in North Dakota means that these must be carefully evaluated for milling and baking utilization. These hybrids have been bred and tested for agronomic and quality properties while grown in the plant breeding nursery and have shown promise as potential new varieties for North Dakota. They appear to offer some advantage over the varieties currently grown, such as rust resistance, higher yield, etc., and warrant further and more intensive testing.

This report summarizes the latest complete quality data obtained from several new wheats grown at six North Dakota stations during several crop seasons. Results from standard varieties which are satisfactory in quality are included to afford a comparison with the new wheats. Rushmore was developed at the South Dakota Experiment Station, while Lee was released by the Minnesota Experiment Station. Both possess some tolerance to the 15B stem rust complex. Selkirk is a Canadian variety and has substantially more resistance to 15B than the other two varieties. The other wheats discussed have been developed at the North Dakota Agricultural Experiment Station and have varying degrees of rust resistance. All wheats were grown under strictly comparable conditions in experimental plots.

The methods used in testing hard red spring wheats for quality are based on a large amount of experiment work in the cereal technology department and in other laboratories at experiment stations, the USDA and commercial flour mills. These methods have been shown to correctly evaluate wheat quality. They were described briefly by Harris, Sibbitt and Scott, "Quality of Some New Rust Resistant Bread .Wheat Hybrids," Bimonthly Bulletin, Vol. XVII, pp. 131-137, March-April, 1955, and will not be discussed here.

The tests fall roughly into three classes, namely, milling tests, baking tests and physical dough tests. The latter have become increasingly important in recent years with the general mechanization of the baking industry. These tests measure flour absorption, mixing time required to develop the dough, stability of the dough during mixing, and changes in dough properties such as resistance and extensibility while fermentation is taking place.

Results and Discussion

Table I shows the quality and milling data obtained from the wheats from the plots. Each value represents an average of 16 deter-

[1]This work was done under the provisions of H-10-2, entitled "Quality Investigations of Hard Red Spring Wheat Varieties."
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[4]Experimental Miller.
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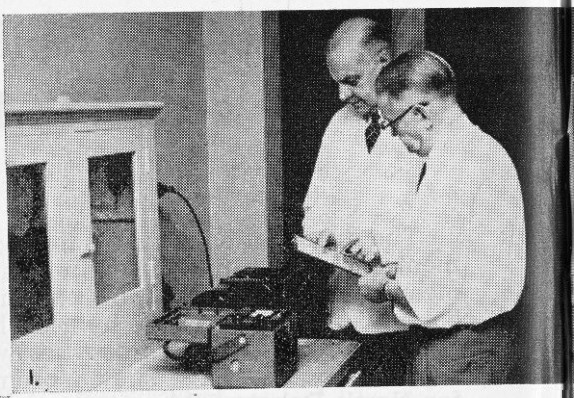
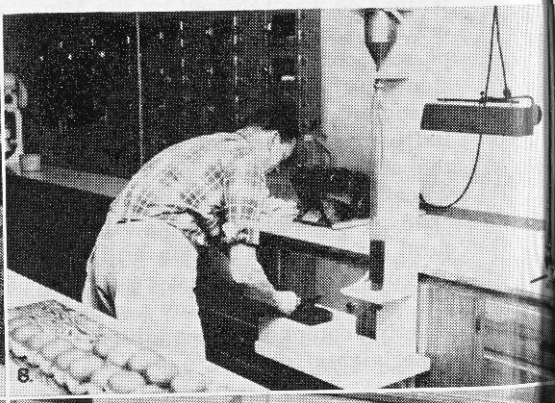
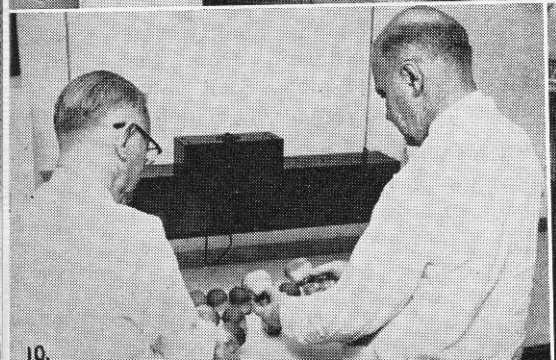
Trial for a New Wheat -- T

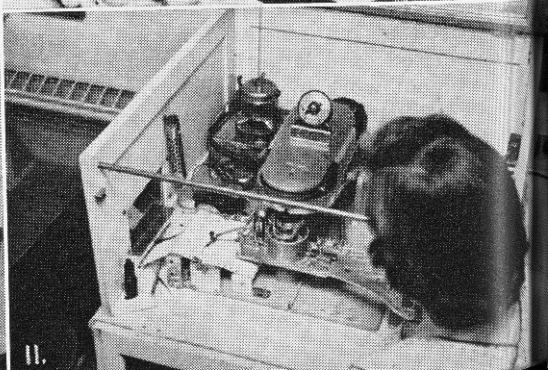
1. *Dr. R. H. Harris, head of cereal technology, (left) and George Scott, assistant, measure moisture content of wheat.*
2. *Protein content is determined by G. H. Bruner.*
3. *Flour for testing is milled by D. H. Classon, from wheat grown on experimental plots at NDAC's branch experimental stations.*



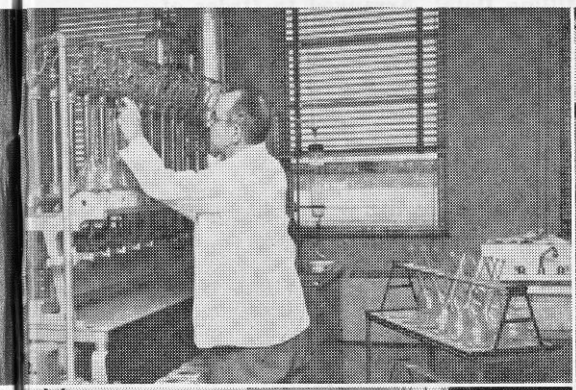
4. *Dough is removed from the mixer. Dough is mixed under a standard formula to determine baking quality by L. D. Sibbitt, assistant in cereal technology.*
5. *Dough is shaped into miniature loaves before being placed in baking pans. A dough sheeter, used to expel gas when punching dough, is in the foreground.*
6. *Loaf being removed from the fermentation cabinet is ready for the oven.*

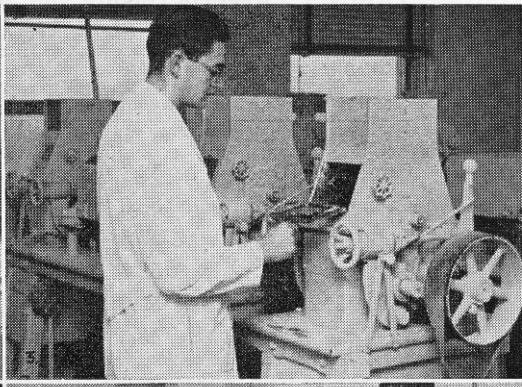


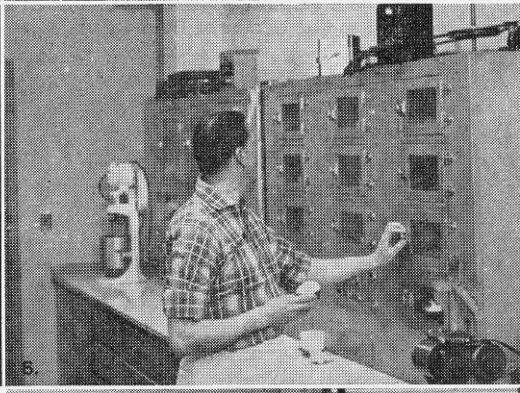




The Milling and Baking Tests







7. *After a 25-minute baking, bread is removed from oven.*

8. *Measuring device being used to determine loaf volume.*

9. *Myrth Weiser, student assistant, judges baked bread. Crumb texture and color are observed.*

10. *Exterior characteristics of loaves are examined.*

11. *The mixing requirements of hard red spring wheat flours are determined.*

12. *Mixing curves obtained from new hard red spring wheat hybrids are examined.*

TABLE I.—**Average Quality and Milling Data[1]. Arranged In Order of Decreasing Flour Yield.**

Variety	Test weight	Vitreous kernels	Protein content	Flour yield	Flour ash	Specific flour volume[2]
	lbs./bu.	%	%	%	%	
Conley (ND 1)	58.4	88	15.3	72.9	0.42	2.16
Rushmore	58.6	88	14.6	72.8	0.42	2.20
Selkirk	57.5	87	14.8	72.6	0.42	2.17
ND 3	58.6	89	15.4	72.6	0.54	2.14
3880.227	59.6	89	15.3	71.0	0.43	2.16
Lee	58.6	87	15.2	70.5	0.42	2.22

[1]Protein and ash content are expressed on 13.5 percent moisture basis.
[2]Volume of 1 gram of flour measured under specified conditions.

minations. The test weights ranged between 57.5 and 59.6 pounds per bushel. Wheat 3880.227 was slightly higher than the others, while Selkirk was the lowest, although the individual differences were quite small. For vitreous kernel content there were no important differences. Rushmore and Selkirk were the only wheats below 15.2 percent in protein content, and the others were practically equal since the largest difference between them was only 0.2 percent. All were satisfactory in flour yield and milling quality, although Lee had the lowest yield. In flour ash content ND 3 was unusually high, and would be classed as undesirable on this account by many mills because millers prefer varieties which produce relatively low ash flour by usual milling methods. The other flours were rather uniform and satisfactory in ash content.

Specific flour volume is an indication of the extent of air spaces between the flour particles, or the "fluffiness" of the flour. A high flour volume generally indicates undesirable milling properties in a hard red spring wheat and would be found more generally in a soft winter variety. The wheats listed in table II were all uniformly satisfactory in flour volume and milling

TABLE II.—**Average Baking Data and Farinogram Patterns of Flour Milled From the Wheats. Arranged In Order of Decreasing Loaf Volume for Three Hours Fermentation.**

Variety	Absorption	Loaf volume 3-hour	Crumb color	Loaf volume 2-hour	Farinogram pattern
	%	cc.		cc.	
Selkirk	62.9	835	8.0	812	Med. Strong
Conley (ND 1)	66.5	822	8.4	834	Strong
3880.227	65.8	811[1]	8.0	832[1]	Med. Weak
ND 3	66.4	788[1]	7.8	802[1]	Med. Weak
Lee	65.2	765	7.9	814	Med. Strong
Rushmore	62.3	739	7.5	797	Med. Strong

[1]Dough characteristics at molding time were "soft with poor elasticity."

behavior. The only unfavorable property was the relatively high ash content for ND 3.

Table II provides information on the baking quality and dough mixing properties of the flours milled from the six wheats. As in table I, each value is the average of 16 tests. For flour absorption there was a range of 4.2 percent between the highest and lowest values. As the three new wheats were all higher than the standards, there is no doubt that they would be satisfactory in water absorption in commercial bakeries. Loaf volumes also were satisfactory for both the 3-hour and 2-hour fermentations, but the doughs for 3880.227 and ND 3 slacked off and became soft with poor elasticity after the fermentation period. This is undesirable because it leads to inferior molding and panning performance. The crumb color of the baked loaves tended to be best for Conley, while that of Rushmore and ND 3 was the poorest.

The farinogram patterns indicated that 3880.227 and ND 3 were lacking in the dough strength of the other varieties and differed from them in mixing requirements. These two wheats would probably not be as acceptable for industrial baking purposes. Figure 1 shows representative mixing curves or farinograms obtained from the flours when mixed with distilled water at correct absorption. The absorption used both

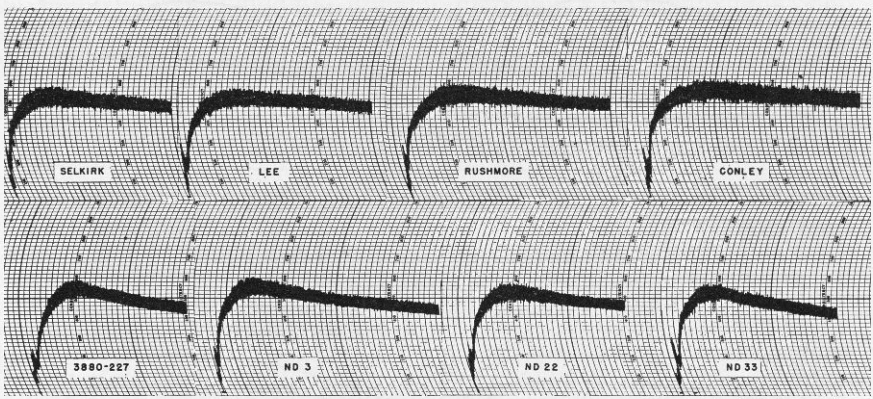


FIGURE 1.—*Representative farinograms obtained from mixing the flours milled from four named varieties and four hybrids under test. The doughs were mixed from flour and distilled water.*

for baking and for the dough mixing test was determined from the farinogram. In addition to farinograms from the six wheats already discussed, representative curves of the two wheats ND 22 and ND 33 which were grown less extensively in the plots have been included. These new hybrids possess certain agronomic advantages which have led to their insertion in the experimental plots for more detailed observation and testing.

The four upper curves represent satisfactory mixing properties of four varieties and show what is expected from hard red spring wheats by the milling and baking industries. Good dough stability during mixing is especially important. This property is represented by the length of line which remains

straight and horizontal after the curve reaches maximum height and before a decrease in height becomes apparent. Examples of poor stability are seen in ND 33 and to a lesser degree in the other three unnamed wheats where a marked decline in the curve occurred very shortly after the peak was attained. Of these four hybrids ND 22 had the least objectionable mixing pattern. Poor dough stability usually means that the dough would not handle properly in dividing and molding equip-

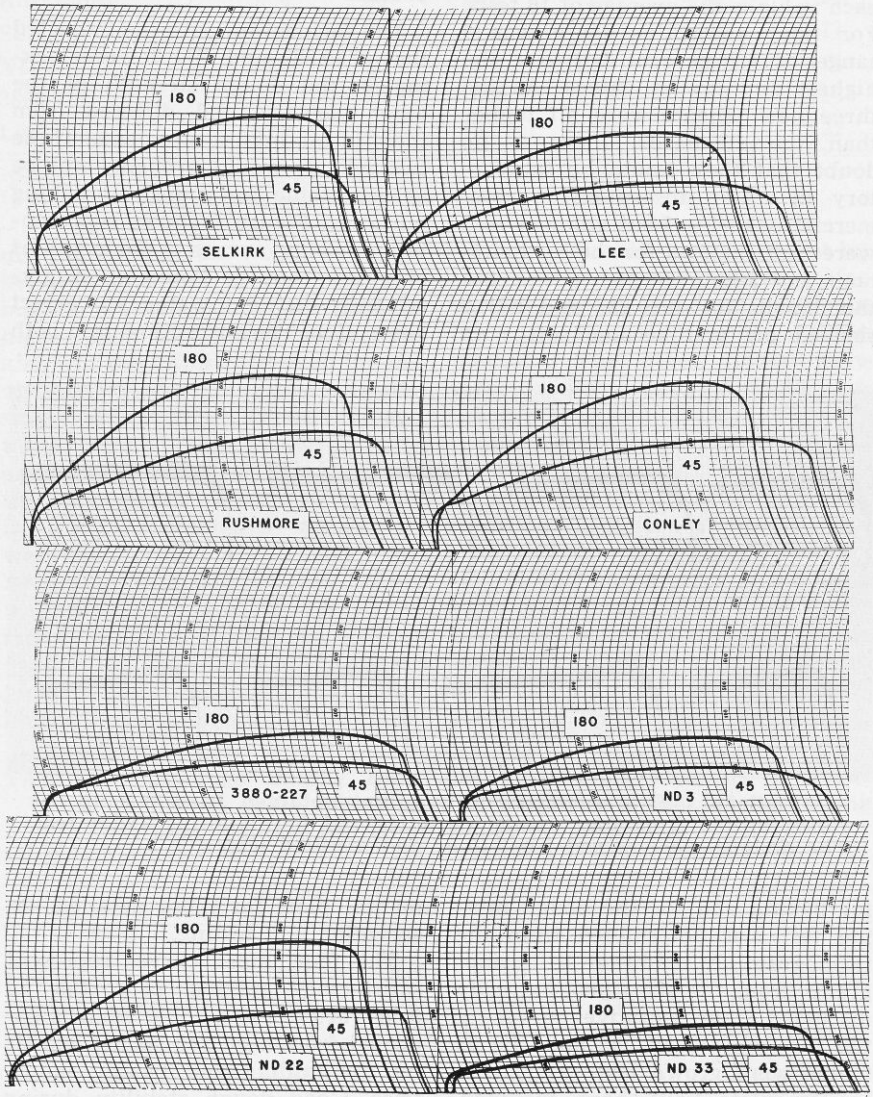


FIGURE 2.—*Representative extensograms obtained from the flours from the four standard and the four wheats under test. These doughs were mixed with flour, distilled water, 1 percent salt and a very small percentage of an oxidizing agent.*

ment, resulting in the production of inferior loaves and decreased production.

Figure 2 represents the extensogram patterns of the same eight wheats. Curve height measures the resistance of the dough while being stretched. Curve length shows the extensibility during stretching. The 45 and 180 values denote the length of time in minutes which elapsed between mixing and stretching the doughs. The difference in height between the two curves is generally thought to indicate the reaction to be expected from the flour when bleached in a commercial flour mill. Since it measures response to an oxidizing agent such as potassium bromate, the greater the difference between the curves the more improvement would be obtained by proper bleaching treatment. There was little difference in resistance among the four standard wheats although the general shape for Selkirk and Rushmore seemed to differ slightly from that of Lee and Conley. This was caused by slightly less extensibility for the first two. These four varieties have satisfactory and acceptable extensogram patterns. Of the remaining four, ND 22 would be classed as on the borderline of acceptability as the curve height was below the acceptable wheats. The three wheats 3880.227, ND 3 and ND 33 had low resistance to stretching and little response to oxidation. The low resistance indicated by the height of both 45 and 180-minute curves is characteristic of a soft dough. This is not desirable for hard red spring wheat flours.

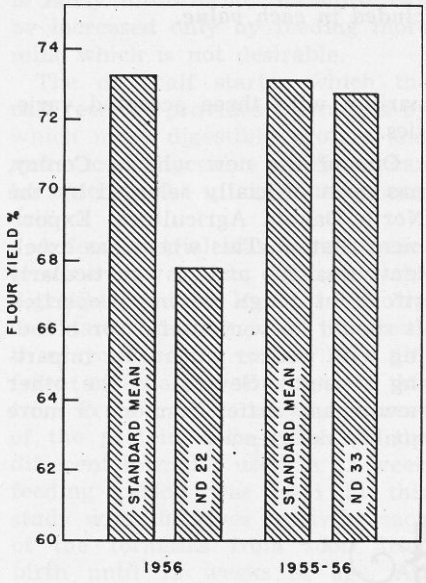


FIGURE 3.—*Average flour yield of the three standard wheats compared with the average yield of ND 22 and ND 33. Both comparisons include six replicates.*

Figure 3 compares the flour yield of ND 22 and ND 33 with that of the average for the three standards—Selkirk, Lee and Rushmore—when grown comparably in the same plot. The graph shows clearly that ND 22 yielded approximately 5.7 percent less flour than the standard wheats in 1956. For ND 33 the difference was barely significant. From these comparisons ND 22 would be ranked as unsatisfactory for milling, while ND 33 would be acceptable.

Further evidence of the poor milling quality of ND 22 is found in fig. 4 which shows the flour volume of this variety in comparison with seven others of satisfactory milling properties. As pointed out earlier, flour volume indicates the amount of air spaces surrounding and between the flour particles. An abnormally high value, as shown for ND 22, usually denotes unsatisfactory milling quality as a true hard red spring wheat type.

Figure 5 represents comparisons for loaf volume between the means of the standard varieties and the new wheats. As for flour yield, ND

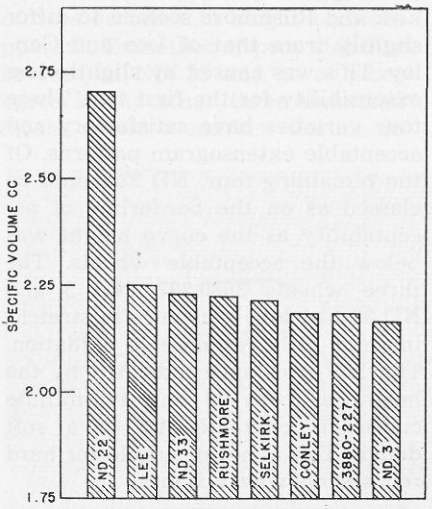


FIGURE 4. — *Specific flour volume of four named wheats and four hybrids under test. All values except those for ND 22 are normal and differ little between wheats. Each value represents six replicates.*

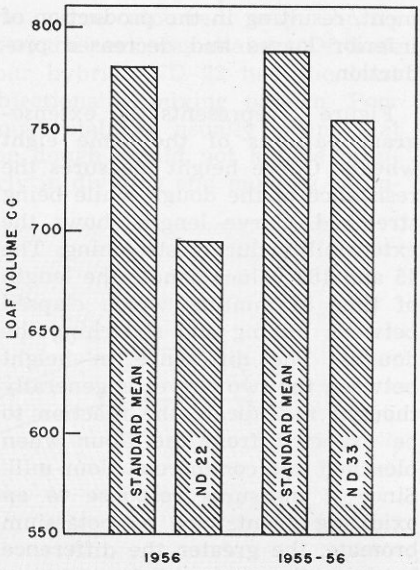


FIGURE 5.—*Average loaf volume of the flours milled from ND 22 and ND 33 compared to that from the three standard wheats. As before, there were six determinations included in each value.*

22 is definitely below the standard mean and unsatisfactory in loaf volume. For ND 33 the difference is not nearly so large and would not necessarily prevent approval of this hybrid.

Summary

This report summarizes several years' investigations on the milling, baking and physical dough properties of several new hybrids in comparison with three accepted varieties.

One of the new wheats, Conley, has been officially released by the North Dakota Agricultural Experiment Station. This wheat has excellent quality and is particularly strong in dough mixing properties. It should be very useful for blending with weaker wheats for imparting strength. Several of the other new wheats suffer from one or more quality deficiencies.