2009 RESEARCH REVIEW

USDA-ARS

SOFT WHEAT QUALITY

LABORATORY

United States Department Of Agriculture
Agricultural Research Service

2009
United States Department of Agriculture
Agricultural Research Service
Soft Wheat Quality Laboratory
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- ensure high-quality, safe food, and other agricultural products
- assess the nutritional needs of Americans
- sustain a competitive agricultural economy
- enhance the natural resource base and the environment, and
- provide economic opportunities for rural citizens, communities, and society as a whole.

New for the 2009 Report

Revised AACC Method 10-52 – Baking Quality of Cookie Flour, Micro Method. This method establishes a carefully controlled competition for water among the various components and ingredients, the results of which are manifest as differing cookie diameters.

Multi-year analysis of milling data from the Miag flour mill.

Forty Eastern soft wheats with resistance gene to Stem Rust through the *Sr36* gene.

Falling Number Presentation

Results from state trials of a collaborative study using an association mapping population of soft wheats grown in the eastern United States. The study's purpose is to use genetic mapping to identify important quality and agronomic traits for developing improved methods in marker assisted breeding.

Soft Wheat Quality Laboratory data from the Miag Multomat mill generated as part of the Soft Wheat Quality Laboratory's ongoing cooperation with the Overseas Varietal Analysis program of the U.S. Wheat Associates and the Quality Evaluation Council also are embedded in the 2009 report.

We will appreciate your comments and suggestions on the 2008 Report as we begin planning for 2010!

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Soft Wheat Quality Targets for Cultivars Developed for the Eastern US

The Soft Wheat Quality Laboratory (SWQL) has distributed over the years soft wheat quality targets as part of its industry reports. These reports have included the US Wheat Associates Overseas Varietal Analysis and the Wheat Quality Council SRW Report. The targets were meant as guidelines for interpretation of the quality generated by the SWQL. Two specific guidelines are used, one for pastry quality and a second for export and cracker products.

In the past we have listed quality targets for export shipments as identical to the cracker targets. Review of the results of the past 10 years of OVA trials confirms that international customers have a similar diversity of gluten requirements as domestic US millers and bakers. The current table reflects the diverse preferences of both the US and the export market.

Desired Ranges of Soft Wheat Quality Traits for Domestic and Export Customers

Category / Method	Pastry Flour Desirable Parameter Range	Cracker Flour Desirable Parameter Range
Test Weight / Grain Condition		
Test Weight	> 58 lb/bu	> 58 lb/bu
Shriveling Factor	< 15 %	< 15 %
1000 Kernel Weight	> 27 g	> 27 g
Wheat Density (g/cc)	> 1.31	> 1.31
SKCS Diameter (mm)	> 2.1	> 2.1
SKCS Weight (mg)	> 2.7	> 2.7
Field Sprouting		
Viscograph (Amylograph)	> 500 bu	> 500 bu
Alpha-Amylase Activity	< 0.08 abs	< 0.08 abs
Falling Number	> 350 sec	> 350 sec
Kernel Texture		
Milling, Allis-Chalmers Break Flour Yield	30 – 37 %	25 - 37 %
Milling, Miag-Multomat Break Flour Yield	24 – 35 %	21 - 35 %
Milling, Quadrumat Sr. Break Flour Yield	32 – 41 %	25 - 41 %
Milling, Quadrumat Jr. Softness Equivalent	53 – 64 %	45 - 64 %
SKCS Hardness Index	< 40.0	10.0 - 40.0
Milling Qualities		
Quadrumat Jr. Flour Yield	> 67.5 %	> 67.5 %
Quadrumat Sr. Flour Yield	> 62 %	> 62 %
Quadrumat Sr. Flour Ash	< 0.420 %	< 0.420 %
Allis-Chalmers Flour Yield	> 75.7 %	>75.7%
Allis-Chalmers Flour Ash	< 0.430 %	< 0.430 %
Allis-Chalmers E.S.I.	< 11.5 %	< 11.5 %
Allis-Chalmers Milling Score	> 52	> 52
Allis-Chalmers Friability	> 27.2 %	>27.2%
Miag-Multomat Flour Yield	> 71 %	> 71 %
Miag Damaged Starch	< 3.5 %	<3.5%
Miag Flour Ash	< 0.500 %	< 0.500 %
Agtron Color	> 50 Units	> 50 Units

Soft Wheat Quality Targets

Category / Method	Pastry Flour Desirable Parameter Range	Cracker Flour Desirable Parameter Range
Protein Content		
Wheat Protein	9 - 11.5 %	10 - 15 %
Flour Protein	8 - 10 %	9 - 14 %
Protein Strength		
Mixograph Absorption	52 - 58 %	53 - 59 %
Mixograph Peak Time	> 2.0 min	> 2.5 min
Mixograph Peak Height	> 2.8 mu	> 3.0 mu
Alveograph Peak (Overpressure)	24 - 38 mm	> 30 mm
Alveograph Length (Abscissa)	106 -150 mm	> 150 mm
Alveograph Work (Deformation Energy)	70 – 127 Joules (x 10^{-4})	> 127 Joules (x 10^{-4})
Farinograph Stability/Tolerance	2 – 4 min	3 - 7 min
Farinograph Peak Time	> 0.75 min	> 1.0 min
Farinograph Absorption	51 - 55 %	52 - 56 %
Acidulated Flour Viscosity (MacMichael)	90-173 cps	150-300 cps
Solvent Retention Capacity		
50% Sucrose	<89%	<89%
5% Lactic Acid	>87%	>87%
5% Sodium Carbonate	<64%	<64%
Distilled Water	<51%	<51%
Baking Qualities		
Cookie, Wire-Cut Method 10-53 Width	62.9 - 66 cm	62.9- 66 cm
Cookie, Wire-Cut Method 10-53 Height	<8.4 cm	<8.4 cm
Cookie, Sugar-Snap Method 10-52 Width*	17.2 - 18.0 cm	17.2- 18.0 cm
Cookie, Sugar-Snap Method 10-52 Height*	< 1.65 cm	< 1.65 cm
Cookie, Sugar-Snap Method 10-50D Width	48.6 - 52.1 cm	48.6 - 52.1 cm
Cookie, Sugar-Snap Method 10-50D Height	< 5.7 cm	< 5.7 cm
Cookie Instrumental Hardness	< 26.6 kg	< 26.1 kg

*Based on 10-52 micro-sugar snap method prior to 2008 revision. Revised method generally results in larger cookie diameter. The minimum targets likely will be increased in one to two years as a new base of data is established.

New AACC Sugar Snap Method

AACCI Method 10-52
Baking Quality of Cookie Flour - Micro Method
First Approval December, 2008
Meera Kwan, Soft Wheat Quality Laboratory, Wooster, Ohio

Objective:

In North America, a “cookie” is a product similar to what is internationally known as a “biscuit”. Cookie quality of flour is determined by the interaction among endogenous components of the flour and the ingredients in the mix. This method establishes a carefully controlled competition for water among the various components and ingredients, the results of which are manifest as differing cookie diameters. Larger diameter cookies are preferred and an indicator of good pastry-making and specifically cookie-baking potential. The method is also useful to evaluate other flour types, various flour treatments and other factors, such as ingredients, that affect cookie geometry.

Apparatus
1. National cookie dough micromixer, with head speed of 172 rpm and special cookie dough bowl.
2. Electric mixer, with timer control (Hobart or Kitchen-Aide, with paddle attachment.
3. Aluminum cookie sheet. See note 1.
4. Rolling pin, 5.7 - 7 cm (2.25 - 2.75 in.) diameter. If wood, check for wear to edges from use and replace if necessary.
5. Cookie cutter, 60 mm inside diameter.
6. Small plastic spatula, ground flat at end, with notch cut to fit cookie dough bowl and mixing head pins.
7. Thermometer and humidity meter / hygrometer (see note 2).
8. Baking oven, reel or rotary, electrically heated and capable of maintaining temperature of 205ºC ± 2º (400ºF ± 4º). See note 3.
9. Measuring calipers (large enough to measure 22 cm)

AACCI Method 10-52
New Method - Baking Quality of Cookie Flour (cont'd.)

Reagents

1. Solution A. 0.95 M sodium bicarbonate (79.8 g dissolved in water to make 1L).
2. Solution B. 1.9 M ammonium chloride / 1.52 M sodium chloride (101.6 g and 88.8 g respectively, dissolved in water to make 1 L).
3. Sucrose. Any brand of "Baker's Special" sugar: sugar passing through a US No.30 sieve (595 µm openings) only. Particle size affects solubility.
4. Shortening. Non-trans fat, vegetable shortening not containing methyl silicone of medium consistency (e.g. Crisco non-trans fat shortening).
5. Nonfat dry milk. To pass through a US No. 30 sieve (595 µm openings).

Procedure

The total formulation amounts of each cookie pair are listed in Table I.

1. Sift dry ingredients (sucrose, nonfat dry milk, dry sodium bicarbonate; Table II for sufficient creamed mass for different batch sizes, 21-46 cookie pairs; 37.60 g for each pair) together until well-mixed. Cream these ingredients together with shortening using Hobart or Kitchen-Aide mixer, using a paddle attachment, on low speed 1 min, then scrape bowl and paddle; on medium speed 1 min, then scrape; on high speed 30 sec, then scrape; and on high speed 30 sec. Weigh 37.60 g portions of this creamed mass for each cookie-pair to be baked.
2. Scrape measured creamed mass into cookie dough mixing bowl (National cookie dough micro-mixer, using a cookie dough bowl; head speed 172 rpm). Add water as shown in Tables I and III: add 4.0 mL solution A, 2.0 mL solution B, and additional water (use water amount in Table III for appropriate flour moisture; 8.7 mL total water per cookie pair). Mix 3 min (stopping mixer and scraping after first few sec if shortening is stuck on side of bowl) and scrape with small spatula.
3. Add 40 g flour (14% mb, weight per Table III) to mixing bowl. Mix a total of 25 sec. as follows: Mix for the first 10 sec while tapping side of bowl. Scrape dough from mixer and bowl pins; scrape outer edge and bottom of bowl, pushing dough between pins several times. Mix 5 sec and scrape as just described. Mix 5 sec and scrape. Mix 5 sec and scrape mixer pins.
4. Gently scrape dough from bowl, gently form into a single dough mass and cut with spatula into two equal portions. Transfer to a room-temperature cookie sheet with gauge strips. Roll to thickness with one forward and one backward stroke of rolling pin Cut dough with cookie cutter, discard excess dough, and remove cutter.

New Method - Baking Quality of Cookie Flour (cont'd.)

5. Immediately place in oven and bake for 10 min. Remove sheet from oven. Cool 5 min and remove cookies from baking sheet.
6. After cookies have cooled to room temperature (at least 30 min), measure cookie diameter using calipers, or image analysis. Lay two cookies edge-to-edge and measure width. Rotate one cookie 90º, the other 45º. Measure again. Rotate both cookies 90º and measure again. Repeat. Average the four readings and divide by two to obtain average diameter of one cookie.

Notes

1. Aluminum cookie sheets made of 3003-H14 aluminum alloy, 2.0 mm (0.08 in) thick, 30.5 X 40.6 cm (12 X 16 in) or 25.4 X 33.0 cm (10 X 13 in), or other sizes required to accommodate oven doors and shelves. Cookie sheets should be manufactured with gauge strips fastened to the long edges of the sheets (gauge strips made of the same alloy as the sheets, 7 mm (0.275 in) thick and the length of the baking sheets). New sheets should be conditioned by lightly greasing and placing in hot oven for 15 min, cooling, and repeating the process two or three times. Cookie sheets should have excess grease wiped off after each cookie pair is baked. Cookie sheets should be washed while warm in water (without use of soap or detergent) and wiped dry after each bake.
2. Dough consistency, stickiness and cookie spread are affected by temperature and humidity. Room and ingredient temperature and humidity should be maintained at constant level among bakes (21ºC ± 1º (70ºF ± 2º) and 30 - 50% are recommended, respectively). Consistent environmental conditions are more important in a lab than adherence to a particular level, within reason.
3. Oven should have a hearth consisting of ceramic-fiber-reinforced structural alumina refractory product (6.4 mm (0.25 in)) thick as shelf liner cut to dimensions of and placed on the steel baking shelf. Oven shelves consisting of wire mesh baking surface are also suitable and may not need shelf liner (to prevent excessive bottom browning).
4. For relatively consistent mixing action, recommended cream mass batch size is 21 - 46 units. Obtain amounts of sugar, nonfat dry milk, sodium bicarbonate and shortening from Table I.
5. Oven should be heated to temperature with oven shelves turning. Bake "dummy" cookies out of scrap dough or extra flour to condition the oven before beginning a test bake, at the beginning of a baking series, or if the oven has not been used for 15 min or longer.

New Method - Baking Quality of Cookie Flour (cont'd.)

Table 1. AACCI Method 10-52 Ingredient amounts per cookie pair

Ingredient	Amount
Flour (14% mb)	40 g
Sucrose	24 g
Nonfat dry milk	1.2 g
$NaHCO_3$	0.40 g
$NaHCO_3$ (in Soln A)	0.32 g (in 4 mL)
NH_4Cl (in Soln A)	0.20 g (in 2 mL)
NaCl (in Soln B)	0.18 g
Shortening	12.0 g
Added Water[1]	2.7 mL

[1]Based on moisture of flour, adjusted water was added (see table 3)

Table 2. AACCI Method 10-52 Ingredient weights for batch preparation.

Ingredient weights (g) for preparing creamed mass for different batch sizes

Ingredient	20	25	30	35	40	45
Sucrose[1]	504.0	624.0	744.0	864.0	984.0	1104.0
Nonfat dry milk	25.2	31.2	37.2	43.2	49.2	55.2
Sodium bicarbonate	8.4	10.4	12.4	14.4	16.4	18.4
Shortening	252.0	312.0	372.0	432.0	492.0	552.0

Table 3. AACCI Method 10-52 Calculated amounts of flour and added water for cookie test formula.

Flour moisture (%)	Added Water (g or mL)	Flour (g)	Flour moisture (%)	Added Water (g or mL)	Flour (g)
9.1	4.9	37.8	12.1	3.6	39.1
9.2	4.9	37.8	12.2	3.5	39.2
9.3	4.8	37.9	12.3	3.5	39.2
9.4	4.7	38.0	12.4	3.4	39.3
9.5	4.7	38.0	12.5	3.4	39.3
9.6	4.6	38.1	12.6	3.3	39.4
9.7	4.6	38.1	12.7	3.3	39.4
9.8	4.6	38.1	12.8	3.3	39.4
9.9	4.5	38.2	12.9	3.2	39.5
10.0	4.5	38.2	13.0	3.2	39.5
10.1	4.4	38.3	13.1	3.1	39.6
10.2	4.4	38.3	13.2	3.1	39.6
10.3	4.3	38.4	13.3	3.0	39.7
10.4	4.3	38.4	13.4	3.0	39.7
10.5	4.3	38.4	13.5	2.9	39.8
10.6	4.2	38.5	13.6	2.9	39.8
10.7	4.2	38.5	13.7	2.8	39.9
10.8	4.1	38.6	13.8	2.8	39.9
10.9	4.1	38.6	13.9	2.7	40.0
11.0	4.0	38.7	14.0	2.7	40.0
11.1	4.0	38.7	14.1	2.7	40.0
11.2	4.0	38.7	14.2	2.6	40.1
11.3	3.9	38.8	14.3	2.6	40.1
11.4	3.9	38.8	14.4	2.5	40.2
11.5	3.8	38.9	14.5	2.5	40.2
11.6	3.8	38.9	14.6	2.4	40.3
11.7	3.7	39.0	14.7	2.4	40.3
11.8	3.7	39.0	14.8	2.3	40.4
11.9	3.7	39.0	14.9	2.3	40.4
12.0	3.6	39.1	15.0	2.2	40.5

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2. Finney, K.F., Yamazaki, W.T., and Morris, V.H. 1950. Effects of varying quantities of sugar, shortening and ammonium bicarbonate on the spreading and top grain of sugar-snap cookies. Cereal Chem. 27:30.
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Multi-Year Analysis of Miag Flour Mill Evaluation

Prediction of Wire-cut Cookie Quality in Long-flow Milled Flour Samples

Purposes of study

1) Measure the reproducibility of industry panel evaluations of new wheat varieties.
2) Illustrate relationships among wheat quality measures.
3) Identify the most valid tests for predicting wire-cut cookie quality.

Summary

Differences among samples in the OVA study for water absorption characteristics (including Solvent Retention Capacity measures), cookie baking quality, and Alveograph P values have large genetic components and reflect differences among varieties as well as the different growing environments in which the varieties were grown. Flour protein, Alpha-amylase activity (falling number), Farinograph stability, Alveograph P and P/L ratio appear almost no genetic variation in the OVA studies. Differences among the OVA samples are due almost entirely to the production environment where the sample was produced. In this set of samples, Alveograph parameters, flour protein concentration, and solvent retention capacity tests provide complementary information to the prediction of baked product quality. The best prediction models for cookie quality used flour protein concentration, Alveograph measures and solvent retention capacity tests in combination. Flour samples with lower protein levels, smaller Alveograph P and L values, and smaller water and sucrose SRC values produced larger and tenderer cookies.

General description of the dataset

We evaluated 142 samples of soft red and white winter wheat for the US Wheat Associates Overseas Varietal Analysis (OVA) and the Wheat Quality Evaluation Councils (QEC), from 2001 to 2007. Samples were provided from a variety of sources typically from commercial grain samples. In each year samples often came from multiple fields and locations. All samples were milled on the Miag Multomat. Straight grade flour was evaluated at the USDA Soft Wheat Quality Laboratory using AACC methods. In addition for the Wheat QEC samples, Alveograph data was provided by Kraft Foods Corporation and Farinograph data by the Mennel Milling Company. For the OVA samples Alveograph and Farinograph data was provided by US Wheat Associates.

Questions often arise about the interpretation results of the long-flow milling for the US Wheat Associates. One set of questions focus on customer preferences. The discussion within each country is intended to shed light onto the preferences of each customer. A second set of questions concern the reliability of the data and the inter-relationships of the quality measures. This study was intended to address the second set of questions. Rather than presenting the results in a narrative, the results are summarized in response to common questions that are asked about the OVA results and soft wheat quality in general.

Question #1. What is the level of reproducibility for a variety's quality when evaluated in quality councils?

How reproducible are flour quality measures that are evaluated in long-flow evaluations such as the Overseas Varietal Analysis (OVA)? The differences between the lines include both genetic differences, differences due to location, and the particular growing year. When comparing samples, it is easiest to simply acknowledge that the samples are different and interpret how the cooperators respond or score the differences. Yet, varieties that appear in the OVA often are recognizable and reflect differences that were apparent in replicated testing conducted with smaller flour mills. To test which flour measure differences are likely due to genetic difference and which largely reflect the environment, we analyzed a subset of the varieties included in the analysis. Examining only the varieties that were repeated in the analysis we could measure what the variance and the precision was for single observations of quality. The varieties and trials in which they were repeated are given in Table 1. The analysis of variance in Table 2 quantifies the portion of the differences between samples that is due to true genetic differences between varieties and the proportion of the differences that are due to environment or error in measuring the quality.

Discussion of repeatability

In Table 2, the mean square terms for flour measures that are followed by stars indicate that the differences between samples have significant genetic basis. Environment and error also contributes to the differences in varieties, but the genetic difference between samples is greater than these background effects. Differences among varieties for wire-cut cookie diameter and SRC measures are characteristic of the variety. They have the largest variance attributed to genetics relative to the background effects of environment, years, and random error. Recommendations for changes to the soft red winter wheat class for these flour traits with a genetic basis can be readily addressed through breeding and genetics.

In contrast to water absorption characteristics, some traits have no obvious genetic component of variation in the samples evaluated by the OVA and QEC programs. Examples of these are Alveograph L and P/L ratios, which are important measures of flour quality for many soft wheat product manufacturers. Selecting varieties for Alveograph L may be of limited value, the range in variation for L or P/L that are needed for different soft wheat products will likely derive from the range in environmental differences in the places where soft wheat is produced. Genetic variation may occur for some of the traits that do not have significant variety effects in this test. Grain hardness is a good example of this. Once hard wheats have been excluded from a sample of varieties, genetic differences in grain hardness are difficult to quantify. Traits like flour yield and break flour yield were controlled by both environment and genetics, with only moderate amounts of variation attributed to variety.

Table 4. Varieties repeated in the analysis of soft red wheat using long-flow milling.

Cultivar	replicates	Trials where the variety was tested
Armor 3035	4	2001 OVA, 2002 OVA, 2003 OVA, 2005 OVA
Armor 4045	3	2001 OVA, 2002 OVA, 2003 OVA
AGS 2000	3	2005 OVA, 2006 QEC, 2007 QEC
Beretta	2	2005 OVA, 2006 QEC
Bravo	2	2003 QEC, 2006 OVA
Caldwell	4	2001 QEC, 2002 QEC, 2003 QEC
Coker 9184	3	2002 OVA, 2004 OVA, 2004 QEC
Coker 9553	2	2006 OVA, 2007 OVA
Coker 9663	5	2001 OVA (2 samples), 2002 OVA, 2004 OVA, 2005 OVA
Dominion	2	2004 QEC, 2006 OVA
Featherstone 176	2	2004 QEC, 2006 QEC
Hopewell	2	2006 OVA, 2007 OVA
Magnolia	2	2006 QEC, 2007 OVA
McCormick	2	2001 QEC, 2007 OVA
Natchez	4	2002 OVA, 2003 OVA, 2005 OVA, 2006 OVA
NC Neuse	2	2006 OVA, 2007 OVA
Pioneer 25R47	3	2002 QEC, 2003 QEC, 2007 OVA
Pioneer 26R12	2	2002 QEC, 2004 OVA
Pioneer 26R15	2	2003 QEC, 2005 OVA
Pioneer 26R24	4	2001 OVA, 2002 OVA, 2003 OVA, 2004 OVA
Pioneer 26R58	2	2002 QEC, 2005 OVA
Panola	2	2005 OVA, 2006 OVA
Patterson	2	2004 QEC, 2006 QEC
Roane	2	2001 OVA, 2004 OVA
Sisson	2	2002 OVA (2 Samples)
Tribute	2	2002 OVA, 2007 OVA
USG 3209	5	2001 OVA, 2002 OVA, 2004 OVA, 2006 QEC, 2007 QEC

Table 5. Wheat quality traits analysis of variance and distribution of variety means for varieties that appeared repeatedly in Overseas Varietal Analysis and Wheat Quality Council, 2001 to 2007.

		Mean square terms			Distribution			
Trait	samples	Variety		Error	Average	Max.	Min.	Units
Grain hardness	57	116.1		80.8	23.5	46.1	10.4	0 to 100
Flour protein	72	1.056		0.658	8.38	10.04	7.21	g 100 g^{-1}
Flour yield	72	3.62	*	1.87	73.4	75.7	71.3	g 100 g^{-1}
Break flour yield	72	46.3	*	26.0	32.6	42.2	24.1	g 100 g^{-1}
Flour ash	72	0.00316	*	0.00152	0.395	0.474	0.346	g 100 g^{-1}
Falling Number	72	3870		2410	392	469	325	Sec
Alpha amylase	65	0.00186		0.00641	0.112	0.199	0.089	absorp.
Starch damage	72	1.502	***	0.507	2.84	3.93	1.30	%
RVA Peak	72	641000		865000	3629	4690	2814	cP
RVA Final	72	641000		688000	3755	4441	2863	cP
Lactic Acid SRC	72	280.8	***	80.8	101.1	116.2	79.8	g 100 g^{-1}
Sucrose SRC	72	58.67	***	20.37	90.2	101.0	82.6	g 100 g^{-1}
Sodium Carb. SRC	72	38.67	***	11.32	71.0	79.7	64.2	g 100 g^{-1}
Water SRC	72	13.03	***	4.61	53.4	60.2	50.7	g 100 g^{-1}
Farinograph absorp.	63	6.50	**	2.41	52.7	58.1	50.5	g 100 g^{-1}
Farinograph stability	63	2.39		3.50	2.8	7.1	1.2	Min
Alveograph P	72	222.22	**	88.22	38	60	24	Mm
Alveograph L	72	1520		1030	102	151	46	Mm
Alveograph W	72	1492	*	817	107	163	52	($x10^{-4}$J)
Alveograph P/L	72	0.148		0.160	0.500	1.008	0.190	
Cookie diameter	72	0.674	***	0.225	15.73	16.95	14.72	Cm
Cookie height	72	3.215	***	0.978	21.4	23.7	18.7	Mm
Shape factor	72	0.01002	***	0.00277	0.740	0.911	0.648	
Snapping force	72	113200	*	62800	2390	2807	1995	G
Force/diameter	72	2640	**	1040	305	366	244	g cm^{-1}

*, **, *** F-test for variety is significant at the 95%, 99%, and the 99.9% confidence interval, respectively.

Question #2. If a wire-cut cookie is the standard for soft wheat baked products, what quality measures of grain and flour are correlated to wire-cut cookie measurements?

Among the samples in the OVA and QEC studies were a wide range of flour types, large enough to produce good correlation studies of what flour traits are correlated to cookie quality. For our analysis we excluded samples that would normally not be shipped into export channels. Samples with less than 300 sec FN were excluded from the correlation (12 samples were excluded). Correlations from the 2001 to 2007 OVA and QEC panels are based on 130 samples with Falling Number values greater than 300 sec.

Discussion of Correlations

The measures with the least effect were flour ash, damaged starch, and Alveograph P/L ratios. These measures can be significantly related to cookie quality but were not in this due to the sampling and flour milling methods. Flour ash and damage starch variation were minimal because the same streams were combined for each flour sample. Differences in flour ash likely had more to do with whole grain ash concentration that degree of inclusion of aleurone layers into the flour.

Many of the measures of wheat quality are correlated to one or more of the measures of cookie quality. The best predictor of cookie shape (diameter, height, and shape factor) was water SRC with negative correlation coefficients of greater than -0.5 to each cookie measure ($p<0.01$). Farinograph absorption, a more common measure of flour water absorption than water SRC, had smaller correlation coefficients but also was significantly correlated to cookie shape. The best predictors of cookie texture were sucrose SRC, final Rapid Visco-Analyzer viscosity, flour protein and measures of gluten strength (lactic acid SRC, Alveograph W, and Farinograph measures). Previous work suggests that many of the flour quality measures also are inter-correlated with each other and may predict the same underlying factors of the flour quality, for example, water SRC and Farinograph absorption measure similar characteristics of the flour. When there is a choice of tests to use, which is better and which should be used together in combination for the best prediction of flour functionality?

Table 6. Correlation wire-cut cookie quality with grain and flour characteristics measured on 130 samples of wheat evaluated in the OVA and QEC, 2001 to 2007

	Cookie diameter	Cookie height	Shape factor	Snapping force	Force/ Diameter
Grain hardness	-0.39**	0.21*	-0.30**	0.10	0.21*
Flour protein	-0.01	0.12	-0.09	0.26**	0.24*
Straight grade flour	0.11	-0.12	0.11	-0.19*	-0.21*
Break flour yield	0.53**	-0.16	0.32**	-0.02	-0.17
Damage starch	-0.08	0.14	-0.11	0.07	0.09
Flour ash	0.05	0.22*	-0.12	0.15	0.12
Falling number	-0.28**	0.21*	-0.25**	0.11	0.18*
Alpha amylase	-0.01	-0.03	0.02	0.00	0.00
RVA Peak viscosity	0.40**	0.00	0.16	0.33**	0.18*
RVA Final viscosity	0.16	0.13	-0.02	0.35**	0.27**
Ratio of Peak to Final	0.46**	-0.21*	0.31**	0.10	-0.04
Lactic acid SRC	-0.21*	0.24*	-0.25**	0.30**	0.32**
Sucrose SRC	-0.40**	0.39**	-0.42**	0.40**	0.48**
Sodium Carbonate SRC	-0.42**	0.55**	-0.53**	0.19*	0.29**
Water SRC	-0.50**	0.51**	-0.53**	0.06	0.20*
Alveograph P	-0.50**	0.40**	-0.46**	0.24*	0.36**
Alveograph L	-0.12	-0.02	-0.03	-0.10	-0.06
Alveograph W	-0.41**	0.22*	-0.31**	0.12	0.22*
Alveograph P/L ratio	-0.09	0.09	-0.11	0.04	0.06
Farinograph absorption	-0.36**	0.37**	-0.39**	0.10	0.20*
Farinograph stability	-0.24**	0.15	-0.20*	0.18	0.23**

*, ** F-test for variety is significant at the 95% and 99% confidence interval, respectively

Question 3. Are there prediction models based on simple measurements that can predict cookie diameter?

In this set, simple measures are considered to be grain hardness, flour protein, flour ash, falling number. These are simple analyses that may be performed at grain receiving. They also are part of tender offers for international grain shipments. This dataset uses 111 samples, excluding samples with less than 300 sec. falling number. This analysis is different from the correlation analysis listed above because we can have more than one predictor of cookie quality. In reality this is closer to most specification used in industry where multiple quality measures are used in the purchase and sale of grain and flour. We used step-wise addition of following variables: hardness, protein, falling number, ash.

Discussion of simple predictions

The strength of the prediction model in this analysis is measured by the R^2 value in Table 4. The number is the percent of variation in cookie characteristic that is predicted by the best combination of the simple measures of grain hardness, protein, and falling number, and flour ash. So for cookie diameter, 20% of the variation in the diameter of cookies can be predicted by the combination of grain hardness and falling number. In this model lower values of grain hardness (increasingly soft grain) and lower falling number values resulted in larger (better) cookies.

The reduction in falling number values may be an important point. Below 300 seconds differences in falling number values for samples is largely due to alpha amylase activity and these samples were excluded from the analysis. However, differences above 300 seconds also occur. They are likely due to particle size and non-gluten networks within the grain such as arabinoxylans. Very high falling number values may be a sign of large particle size and increased arabinoxylans concentration, which may be undesirable for cookies.

The other prediction models were poorer than the model for diameter (R^2 values of less than 20%). Flour ash appears a second variable in several of the models. Flour protein in combinations with other variables predicts the texture parameters of the cookies, with greater protein concentration associated with increasing force to snap the cookie. Can the prediction of cookies be improved by adding more complex flour measurements?

Table 7. Simple quality measures that predict wire-cut cookies

Cookie characteristic	Prediction model	R^2
Diameter	17.7 – 0.0232 Hardness – 0.0035 Falling Number	0.20
Height	17.7 + 0.0304 Hardness + 7.38 Flour ash	0.09
Shape factor	0.937 – 0.00203 Hardness – 0.000367 Falling Number	0.13
Snapping force	1106 + 84.9 Flour protein + 1456 Flour ash	0.11
Force/Diameter	142.9 + 9.11 Flour protein + 0.217 Falling Number	0.09

Question 4. Traditional instruments to measure cookie quality are the farinograph and alveograph. What are their relationships to cookie quality?
We fit the models for predicting cookie using flour protein and then adding in the flour quality measures from either the Farinograph (Table 4) or Alveograph (Table 5). In these models we will continue to use flour protein in the models as cookie formulas make adjustments for protein. Terms such as flour protein or water absorption were retained in the multiple regression models only if they were significant predictors in of cookie quality. As with the multiple regression models of Question 3, we used for this question and all subsequent questions the Stepwise addition of variables to the model using the statistical program PROC REG in SAS.

Discussion of Traditional Flour Measures
Water absorption as measured by the Farinograph was a predictive variable for cookie diameter, height, and shape factor (Table 4). The R^2 for models with the Farinograph were similar to the values using just simple measures described in the above section (Table 3). For the height and shape factor measures, water absorption was the only variable that was retained in the model. All other variables were non-significant after water absorption was included in the model. The lower water absorption of a flour sample, the larger and flatter the cookie. As in the previous model (Table 3), flour protein was the best predictor of snapping force to break a cookie; adding Farinograph measures to the model did not improve the prediction of cookie snapping force. When snapping force was standardized by dividing it by the diameter of the cookie, Farinograph stability was the best predictor of cookie texture. As stability increased so did the force to snap the cookie.

Alveograph P was a significant predictor variable for all regression models, predicting all of the cookie quality measures. The regression models were for Alveograph were generally more significant than the Farinograph models with the R^2 for cookie diameter predicting 36% of the variation in diameter. Flour samples with smaller Alveograph P values produced cookies that were larger in diameter, thinner and tenderer. Alveograph L and W were included in the multiple regression models for cookie diameter and shape factor although these measures were less significant to the total model than Alveograph P. Flour protein was still the most important predictor of cookie texture, with smaller concentrations of flour protein producing more tender cookies.

Alveograph was a better predictor of cookie quality than Farinograph in this study. Can other flour quality measurements improve the prediction of cookie quality?

Table 8. Prediction of cookie quality based on flour protein and Farinograph measures.

Cookie characteristic	Prediction model	R^2
Diameter	21.5 + 0.207 Flour protein – 0.135 Absorption – 0.115 Stability	0.23
Height	6.81 + 0.276 Absorption	0.13
Shape factor	1.57 – 0.0157 Absorption	0.15
Snapping force	1812 + 69.2 Flour protein	0.11
Force/Diameter	289 + 4.66 Stability	0.06

Table 9. Prediction of cookie quality based on flour protein and Alveograph measures.

Cookie characteristic	Prediction model	R^2
Diameter	18.0 - 0.0482 P - 0.00936 L + 0.00484 W	0.36
Height	19.4 + 0.0522 P	0.16
Shape factor	0.972 – 0.00556 P – 0.000931 L + 0.0007 W	0.29
Snapping force	1429 + 85.2 Flour protein + 6.99 P	0.13
Force/Diameter	155 + 11.4 Flour protein + 1.44 P	0.19

Question 5. What are the relationships of solvent retention capacity (SRC) tests to other quality measures?

Solvent retention capacity tests are based on certain assumptions of flour functionality. The water SRC is a measure of global water absorption of the flour in much the same way as farinograph absorption measures flour absorption. Sodium carbonate SRC is a measure of starch damage. Sucrose SRC is a measure of arabinoxylans. Lactic acid SRC is a measure of gluten strength. We did not have a single measure of arabinoxylans in this study. That is conducted in a separate smaller study. However arabinoxylans contribute to the magnitude of the Alveograph P. Similarly, we do not have a single measure of gluten strength. However, greater flour protein concentration can increase gluten strength. Increased alveograph W and farinograph stability measures are considered to measures that increase as gluten strength increases. Do these assumptions of the solvent retention capacity test hold when looking at a set of varieties milled on a long-flow flour mill? Again flour protein is included in each of these models as a potential covariate and fit in a stepwise forward model.

Discussion of Solvent Retention Capacity Tests

The assumptions of the SRC tests were validated in this data set for water, sucrose, and lactic acid solvents. Flour protein and Farinograph water absorption combined predict half of the variation in water SRC (Table 6). Sucrose SRC measures gliadin hydration and arabinoxylan absorption that contributes to the dough stiffening which elevates Alveograph P. For this set of varieties, flour protein was a more important predictor of sucrose SRC than Alveograph P, but both variables combined for a significant prediction of the solvent's effects. Lactic acid SRC is a measure of the hydration of glutenin macropolymers and gliadins. The other measures of gluten in this study are inter-related to the lactic acid SRC. Farinograph stability and Alveograph W combined to predict nearly half of the variation among the samples for lactic acid SRC.

Damaged starch was not correlated with sodium carbonate SRC. Sodium carbonate SRC was negatively correlated to flour yield ($p<0.01$). The test appears to be measuring milling behavior of the varieties. However, the degree to which starch in flour of soft wheat samples are damaged in the milling process does not appear to relate to the sodium carbonate SRC. This solvent is capturing some other aspect of the mill's effect on flour. This observation is consistent with previous studies of differences among soft wheat varieties.

Question 6. Does the solvent retention capacity test predict wire-cut cookie quality?

The solvent retention capacity tests were developed to predict the performance of flour in factory production of commercial soft wheat products such as cookies. The flour is suspended in an excess of the solvent, for example water or 50% sugar, to rapidly determine the optimum amount of water for a cracker or sugar syrup that will be needed to hydrate the flour in a bakery. The affinity of the flour for solvents within the dough will determine the behavior of the dough during machining of the product and baking. Do these tests predict the baking performance of the experimental models?

Discussion of SRC prediction of cookies.

The diameter or expansion of the wire-cut cookie is modeled by the Sucrose SRC and the overall water absorption as measured by the Water SRC. Sucrose SRC and Water SRC are the most consistent predictor of cookie quality characteristics, each appearing in three of the five cookie quality parameters measured in this study (Table 7). Flour protein was not an important predictor of cookie shape when SRC solvents are included in the model. Flour protein does appear to increase the hardness of a cookie and was retained as significant predictor of snapping force in combination with sucrose SRC to predict approximately a third of the variation in cookie texture. Based on the relative sizes of the R^2 value, the prediction of cookie quality with solvent retention capacity tests was better than the predictions derived from Alveograph or Farinograph parameters.

Table 10. Prediction models for solvent retention capacity tests using other quality measures based on the assumptions described above for the solvent retention capacity test.

Cookie characteristic	Prediction model	R^2
Water SRC	-0.732 – 0.711 Flour protein + 1.139 Farinograph absorption	0.53
Sodium carbonate SRC	Neither flour protein nor damaged starch were significant	
Sucrose SRC	67.87 + 1.55 Flour protein + 0.265 P	0.30
Lactic acid SRC	73.66 + 1.31 Stability + 0.223 W	0.45

Table 11. Prediction of cookie quality based on flour protein and solvent retention capacity measures.

Cookie characteristic	Prediction model	R^2
Diameter	23.4 – 0.0266 Sucrose[†]– 0.0968 Water	0.35
Height	5.60 + 0.0181 Lactic + 0.0916 Sodium carbonate + 0.140 Water	0.35
Shape factor	1.67 - 0.00129 Lactic -+ 0.0149 Water	0.34
Snapping force	243 + 54.0 Flour protein + 18.8 Sucrose	0.19
Force/Diameter	-13.9 + 3.52 Sucrose	0.23

[†]The solvent retention capacity tests are denoted only by their solvent, for example the sucrose SRC test is abbreviated only as 'Sucrose'.

Question 7. Does combining solvent retention capacity tests with alveograph or farinograph measures improve the prediction of wire-cut cookie quality?

Farinograph and Alveographs measure in very specific ways flour hydration effects and dough rheology. Solvent retention capacity tests measure a wider range of the flour hydration effects but provide only indirect information about dough rheology because a dough is never developed in the test. The tests often are considered to be correlated to each other as discussed above in the prediction models for the SRC tests (Question 5). Yet, they are measuring in flour in different ways and may provide complimentary information about the flour.

Discussion of combining different test for quality

Combining the Farinograph information with the solvent retention capacity data did not improve the models. The models were essentially the same as derived without the Farinograph data. Neither of the Farinograph measures appeared in the multiple regression models. Although, Farinograph absorption is an important predictor of cookie shape, the water SRC is a better predictor of the same thing and the Farinograph absorption adds no useful information to the prediction model after water SRC has been added to the system. The minor differences between these models and the models fit with SRC solvents alone were due to the slightly smaller data set used in this analysis because Farinograph data was available only for 112 samples and the SRC data discussed in Question 6 was available for a larger data set.

The Alveograph measures of P and L in combination with solvent retention capacity tests produce the best multiple regression prediction models for the quality of wire-cut cookies. Water SRC together with Alveograph P and L predict 44% of the variation in cookie diameter. The texture of the cookies as measured by snapping force was best predicted by flour protein, sucrose SRC and either Alveograph P or L, depending on whether the force was corrected or not for final diameter of the cookie.

In this set of samples, Alveograph parameters, flour protein concentration, and solvent retention capacity tests provide complementary information to the prediction of baked product quality.

Table 12. Prediction of cookie quality based on flour protein, solvent retention capacity and Farinograph measures in 112 samples of soft winter wheat

Cookie characteristic	Prediction model	R^2
Diameter	23.9– 0.0307 Sucrose[1]– 0.0984 Water	0.35
Height	7.79 + 0.042 Sucrose + 0.137 Sodium carbonate	0.36
Shape factor	1.74– 0.0365 Sucrose – 0.0124 Water	0.39
Snapping force	629 + 19.6 Sucrose	0.17
Force/Diameter	-3.55 + 3.38 Sucrose	0.26

[1] The solvent retention capacity tests are denoted only by their solvent, for example the sucrose SRC test is abbreviated as 'Sucrose'.

Falling Number Presentation

We have included a presentation given by Dr. Edward Souza and Mary Guttieri on the use and importance of the **Falling Number** technique for determination of preharvest sprouting in grain.

Details important for effective testing and interpretation of AACC Method 56-81B for determining starch degradation due to alpha amylase activity are highlighted in these slides.

The file name for the presentation that is attached is:

2009 Falling Number Presentation.pdf

Association Mapping Study

Introduction

Unlike bi-parental mapping, which utilizes two genotypes distinct in specific traits to map those same traits, association mapping (AM) takes advantage of diversity within a defined population to identify multiple associations between traits and genetic loci. The AM population in this study is comprised of 187 eastern U.S. cultivars, selected from the Soft Wheat Quality Laboratory database (Andrews and Souza 2008). Our goal is to identify robust, simple markers employable by breeders to facilitate breeding for improved wheat quality using marker assisted selection. We focused on loci identified as influencing milling quality in multiple, bi-parental mapping studies (Sneller, 2008) to probe the AM population with characterized, PCR-SSR genetic markers spanning wheat chromosome 2B. Evaluation of the markers with compiled physiological quality measurements in the population over two years and seven locations, identified associations of two independent markers (representing two qualitative trait loci) with distinct characteristics of milling quality; flour yield and softness equivalent. A stem rust resistance locus, *Sr36*, was also characterized for quality. We define publicly available cultivars from the population suitable for integrating into breeding programs and markers specific for improved quality, nutrition and disease resistance.

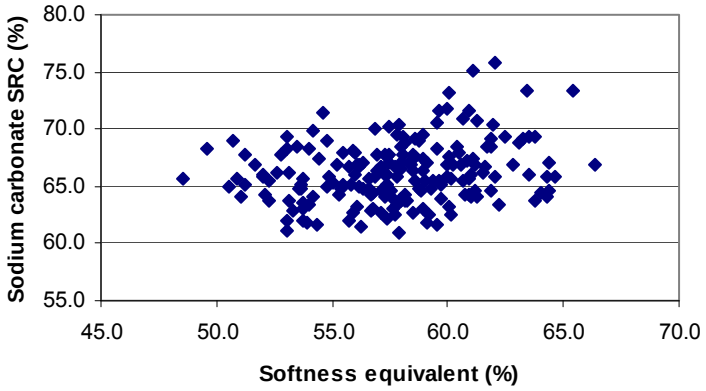
Results

The size and diversity of the AM set along with the reliability of the quality data used to evaluate the population provided a valuable resource to test the utility of flour measurements traditionally used at the Soft Wheat Quality Laboratory. Softness equivalent (SE) is routinely measured for flour samples. We evaluated the relationship among sucrose SRC, SE and cookie quality.

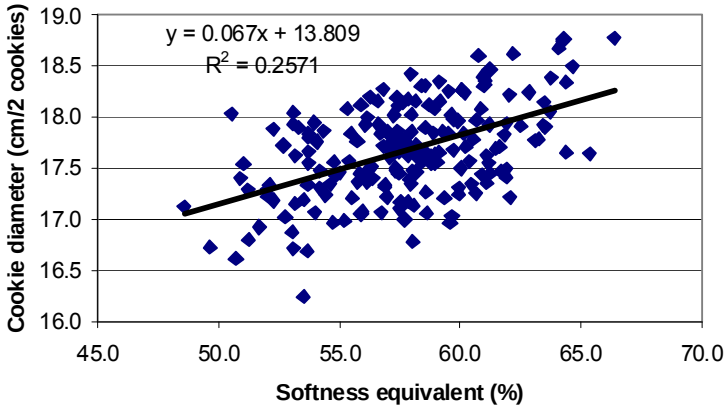
The best predictors of cookie quality (diameter) in this data set were sucrose SRC and (SE). The two factors were additive in their predictive power. For individual samples (187 genotypes x 4 environments) the model for the combined sucrose SRC and softness equivalent was Diameter=19.9 cm – 0.053 cm/% sucrose SRC + 0.047 cm/% SE (R^2=0.51%). The prediction model for these two factors of the average of genotypes (187 genotypes) was Diameter=19.4 cm – 0.059 cm/% sucrose SRC + 0.062 cm/% SE (R^2=0.66%). Sucrose SRC and softness equivalent (effectively a particle size after break rolls) can predict 50% of the variation in cookie size among all flour samples received at the lab for this study. The predictions improve by adding flour protein and other quality traits. However, the improvements are only incremental adding a few percentage points to the R^2 value.

Figure 1. Correlations between means for (a) sodium carbonate SRC vs. softness equivalent, (b) cookie diameter vs. softness equivalent, and (c) cookie diameter vs. sucrose SRC, over 7 environments using phenotypic data produced for the Soft Wheat Association Mapping Study.

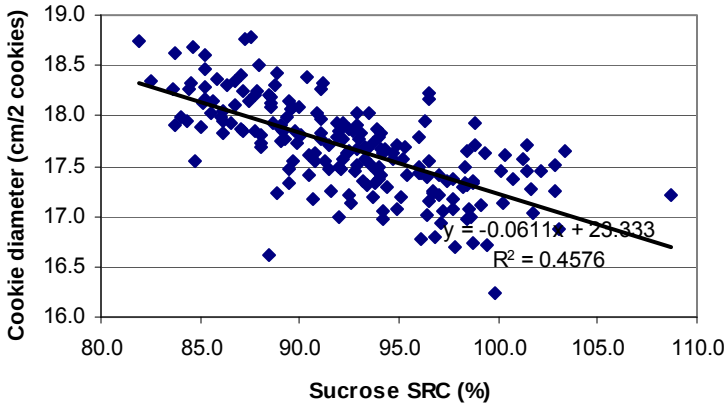
(a) Sodium carbonate SRC vs. softness equivalent.



(b) Cookie diameter vs. softness equivalent



(c) Cookie diameter vs. Sucrose SRC



Association Mapping Compiled Milling Results

The attached table lists individual least square means for the combined years and environments for test weight, flour protein, flour yield, softness equivalent, solvent retention capacities for water, sodium carbonate and lactic acid and cookie diameter for each of the cultivars.

Table 13. Association Mapping Population Soft Wheat Quality 2007-2008

Association Mapping Population analysis of variance of all quality measures for Quad Advanced milling, SRC, and sugar snap cookie quality of wheats grown in trials at Wooster, OH and Lafayette, IN in 2007 and 2008, Blacksburg, VA and Ithaca, NY in 2007

		MICRO	FLOUR	SOFT.	FLOUR	WATER	SODIUM	SUCROSE	UNADJ.		COOKIE	TOP
		T.W.	YIELD	EQUIV.	PROT.	SRC	CARB.	SRC	LACTIC		DIAM.	GR.
		LB/BU	%	%	%	%	SRC	%	ACID		CM.	SCORE
Source and Degrees of Freedom	Mean square terms									d.f. for cookie		
Environment	6	1920.0	193.88	9831.4	125.27	88.6	414.6	3675.1	29031.8	3	4.02	99.8
Cultivar	191	9.0	15.26	695.1	2.18	15.6	41.1	132.4	782.2	191	0.86	3.8
Environ x Cultivar	1129	1.0	0.91	37.6	0.26	2.2	5.6	18.8	89.9	559	0.12	1.19
Residual - Within year reps	60	0.1	0.23	5.3	0.14	0.5	1.0	4.7	25.5	32	0.10	0.74

Association Mapping Population analysis of variance continued.

Variance components for sources from Expected Mean Square terms

	Variance terms associated with sources of variations											
Environment		10.09	1.01	51.26	0.65	0.45	2.14	19.14	151.47		0.021	0.522
Cultivar		1.3	2.0	93.7	0.3	1.9	5.1	16.2	98.6		0.180	0.642
Environ x Cultivar		0.9	0.7	30.9	0.1	1.6	4.3	13.5	61.7		0.042	1.070
Residual - Within year reps		0.1	0.2	5.3	0.1	0.5	1.0	4.7	25.5		0.078	0.078

Percent of variance attributed to each source												
Environment		81	26	28	55	10	17	36	45		6	23
Cultivar		10	52	52	23	43	40	30	29		56	28
Environ x Cultivar		7	17	17	10	36	35	25	18		13	46
Residual - Within year reps		1	6	3	12	11	8	9	8		24	3

For the Association Mapping population all measured traits had significant cultivar effects. The greatest ratio of cultivar variance to cultivar and cultivar x environment variance (An approximate heritability) occurred for cookie diameter (81%), flour yield (72%) and softness equivalent (72%). In most studies, solvent retention capacity values would have greater heritability than cookie diameter. In this study, they were all significant at 50 to 60% of the variation but smaller than typically observed. This may be due to the unusual combination of older cultivars and newer cultivars.

See attached Excel file for means tables:
Association Mapping Population Soft Wheat Quality 2007-2008

Stem Rust Resistance

Resistance to stem rust Ug99 (race TTKS of *P. graminis*) is a priority for breeding wheat. The stem rust gene *Sr36 gene*, derived through crosses with *Triticum timopheevi*, was reportedly effective against Ug99 stem rust (Jin, et al, 2007)[1]. The gene was localized to chromosome 2B, and is identified by a codominant SSR marker, *wmc477* (Tsilo, Toi J et al. 2008)[2]. 192 cultivars of Eastern soft wheat from an association mapping population were screened for the presence of the *Sr36* stem rust resistance gene at the USDA/ARS Regional Small Grains Genotyping Lab. Forty cultivars were identified as positive for *Sr36* using the wmc477 marker. Furthermore, no associated detrimental affects on quality measurements were associated with these cultivars in studies at the Soft Wheat Quality Lab in Wooster. The *Sr36* containing cultivars are listed below.

Cultivars containing the *Sr36* gene for Stem Rust resistance

Abe	**Coker 9663**	**Jaypee**	**Pioneer 26R31**
Adder	**Coker 9766**	**Kenosha**	**Progold**
Adena	**Coker 9803**	**Madison**	**Scotty**
Arthur	**Coker 9835**	**Magnum**	**Severn**
Coker 47-27	**Compton**	**Massey**	**Sisson**
Coker 747	**Doublecrop**	**McNair 1003**	**Sullivan**
Coker 762	**FFR 555**	**McNair 1813**	**Tecumseh**
Coker 797	**Foster**	**Neuse NC**	**USG 3209**
Coker 833	**Freedom**	**Pioneer 2643**	**VA 96W-247**
Coker 916	**INW 0411**	**Pioneer 2684**	**Wheeler**

[1] Jin et al., 2007, Characterization of Seedling Infection Types and Adult Plant Infection Responses of Monogenic *Sr* Gene Lines to Race TTKS of Puccinia graminis f. sp. *Tritici*, Plant Disease, Vol 91, No. 9, 1096-1099.

[2] Tsilo, Toi J., et al, 2008, Diagnostic Microsatellit Markers for the Detection of Stem Rust Resistance Gene Sr36 in Diverse Genetic Backgrounds of Wheat, Crop Science, Vol 48, 253-261.

New Wheat Cultivars

Information on new releases is important to breeders in the wheat community. We include a compilation of new releases for the past two years, 2007 and 2008. Descriptions of new wheat cultivars are listed by contributing collaborator. The SWQL thanks each of the breeders, growers and researchers for his/her contributions providing cultivar descriptions for this report.

AgriPro COKER Syngenta Seeds, Inc., Barton Fogleman

W1062

W1062 is a soft white winter wheat marketed by Syngenta Seeds, Inc. for grain production. W1062 is a medium to medium-tall height wheat with medium to medium-full season heading. W1062 is moderately resistant to the powdery mildew races prevalent in Michigan in 2007 & 2008 and is moderately resistant to the leaf rust races prevalent in Michigan, NW Ohio, and W. Kentucky in 2007 & 2008. W1062 has shown better tolerance to in-head sprouting and better falling number data in weathered samples than most soft white winter wheats currently grown in Michigan. W1062 has shown very good milling flour yields and very good baking properties. It is best adapted for grain production in Michigan and NW Ohio.

W1377

W1377 is a soft red winter wheat bred by Syngenta Seeds, Inc. for grain and wheat straw production. W1377 has consistently produced very high test weight grain. It is a medium-tall height wheat with medium heading (about 2 days later than Branson). W1377 has shown very good resistance to stripe rust. It has shown moderate resistance to leaf rust in the Midwest and upper Midsouth. W1377 has shown susceptibility to powdery mildew in Michigan and the Northeast. It has demonstrated very good forage and straw production in the Kentucky trials. At maturity its straw has an attractive “snowy” bright color.

Beck's Superior Hybrids , Kris Johnson

BECK 113
BECK 113, released in Fall 2009, is a tremendous new double crop option for the southern part of Beck's marketing area. It heads very early and offers fast dry down for early harvest. It responds to higher seeding populations and offers tremendous standability for great double cropping.

BECK 122
BECK 122, released in Fall 2006, is an exciting yield leader at a medium-early maturity. This variety has had tremendous performance topping originator trials and Beck's strip trials and continuing its great performance in Beck's customer's fields. BECK 122 also earns excellent premiums in Kraft's Quality Premium Program. For excellent grain and straw yields, plant BECK 122.

BECK 137
BECK 137, released in Fall 2009, is an improved version of BECK 117. This variety has a similar genetic background and offers a more uniform look and is higher yielding. Place BECK 137 just like BECK 117 and enjoy similar characteristics such as high test weight and tremendous winter hardiness with additional yield.

BECK 164
BECK 164, released in Fall 2008, is a very high yielding stable performer that has excellent resistance to Head Scab and great Winter hardiness. BECK 164 dominated the Central and Northern portions of Beck's Marketing Area in 2007 and is an excellent all-around wheat variety.

Bio-Plant Research, Ltd, Camp Point, IL, Ken McKlintock

Excel 341
Excel 341 is a SRWW distributed by Bio-Plant Research, Ltd. of Camp Point, IL. The line was first released in 2007. It has very good winter hardiness and is moderately resistant to Leaf rust, Stripe rust, and Septoria Tritici. The line heads 2 days later than SR30-530J or Branson. This line is moderately susceptible to Powdery mildew.

Excel 286
Excel 286 is a SRWW distributed by Bio Plant Research, Ltd. of Camp Point, IL. The line was released in 2008. It is a medium tall wheat. The line is medium early in maturity and heading date is the same as SR30-530J and Branson. It has very good yield potential. This line has good resistance to Leaf rust, stripe rust and head scab, and moderate susceptible to Powdery mildew and Septoria Tritici.

Excel 314
Excel 314 is a SRWW and is schedule to be released in 2009 by Bio Plant Research, Ltd. of Camp Point, IL. It has good resistance to Leaf rust, stripe rust and Head scab and it is winter hardy. It is similar in maturity to SR30-530J and Branson. This line has moderate resistance to Powdery mildew, Septoria Tritici and head scab.

Excel 271
Excel 271 is a SRWW and is schedule to be released in 2009 by Bio Plant Research, Ltd. of Camp Point, IL. It is a large seeded line with its 1000-kernal weight in 2008, an excellent growing conditions year, measuring 42.3 grams and it has exceptional test weight. This line has good resistance to Leaf rust, Septoria Tritici, Stripe rust, Barley Yellow Dwarf Virus and Powdery Mildew. This line heads 2 days later than SR30-530J and Branson.

Excel 343
Excel 343 is a SRWW distributed by Bio Plant Research, Ltd. of Camp Point, IL. The line was first released in 2008. This line has good winter hardiness and is moderately resistant to Leaf rust, Powdery mildew and Septoria Tritici. It is moderately susceptible to Stripe rust. It heads 3 days later than SR30-530J and Branson.

Excel 302
Excel 302 is a SRWW distributed by Bio Plant Research, Ltd. of Camp Point, IL. The line was first released in 2008. It has very good resistance to Septoria Tritici, Leaf rust, and Powdery mildew. This line is 3 days later in maturity than SR30-530J and Branson.

Excel 328
Excel 328 is a SRWW and is schedule to be released in 2009 by Bio Plant Research, Ltd. of Camp Point, IL. It has very good resistance to BYDV and Powdery mildew. This line has moderate resistance to Septoria Tritici and Leaf rust. The line is moderately susceptible to Stripe rust. The line heads 4 days later than SR30-530J and Branson.

Excel 446
Excel 446 is a larger seed SRWW and is scheduled to be released in 2010 by Bio Plant Research, Ltd. of Camp Point, IL. This line does particularly well in Ohio and the eastern U.S. It has very good resistance to Powdery mildew, Septoria Tritici and BYDV. The line is moderately susceptible to Stripe rust. It is a later maturing wheat, heading 5 days later than SR30-530J and Branson.

Excel 336
Excel 336 is a larger seed SRWW and is scheduled to be released in 2010 by Bio Plant Research, Ltd. of Camp Point, IL. This line has good test weight and winter hardiness. It has moderate resistance to Powdery mildew, Septoria Tritici and Leaf rust. The line is moderately susceptible to Stripe rust. The line heads the same as SR30-530J and Branson.

Excel 410TW
Excel 410TW is a SRWW distributed by Bio-Plant Research, Ltd. of Camp Point, IL. The line was released in 2007. This line has good winter hardiness and straw characteristics, as well as a good level of resistance to Leaf rust, Stripe rust and Head scab. It is moderately resistant to Powdery mildew and Septoria Tritici. This line heads 2 days later than SR30-530J and Branson.

Breeder Foundation and Cornell University, Mark Sorrells – check this entry

Jensen
Proposed Name: **JENSEN** (NY88046-8138)
Name: Approval for "Jensen". To be confirmed at submission of PVP application.
Pedigree: Susquehanna/Harus
Grain Yield: Over 4 years, this line is similar in grain yield to Caledonia and Richland at 76 b/a. Test Weight: NY88046-8138 has excellent test weight and is averaging 57.4 lbs/bu over 4 years versus 55.7 lbs/bu for Caledonia and 56.3 for Richland.

Winter Hardiness: Winter survival is similar to current varieties. Lodging Resistance: Lodging resistance of NY88046-8138 appears to be comparable to Richland. Caledonia may be slightly more lodging resistant.

Disease Resistance: NY88046-8138 is more resistant than current soft white wheat varieties to Fusarium Head Blight (scab). It is rated as moderately resistant to Wheat Spindle Streak Mosaic Virus and susceptible to Wheat Soil Borne Mosaic Virus. The powdery mildew rating is better than all other current varieties except Richland. Seedling tests at Virginia Tech show that NY88046-8138 is resistant to a powdery mildew composite with virulence for resistance genes Pm1,2,3,3a,3c,3f,4a,4b,5,6,7. NY88046-8138 is moderately susceptible to leaf rust race TNRJ. Reaction to other diseases is unknown.

Quality Characteristics: From four different evaluations over three years, NY88046-8138 appears to have satisfactory milling and baking properties and is comparable to Caledonia and Richland. It is moderately resistant to preharvest sprouting with a sprouting score higher than Cayuga but much lower than all other current varieties.

Morphology: Plant height is 2-4 inches taller than Caledonia and nearly the same height as Richland. This line is awnless and has white chaff color. Heading date about 2 days later than Caledonia or Richland.

Status of Breeder Seed: Approximately 2 acres of Breeder seed were planted in the fall of 2005. This line is a public release with Breeder, Foundation, and Certified classes. PVP is pending and will be submitted in fall 2007.

University of Georgia, Jerry Johnson

AGS 2020 (GA 991336-6E9)

GA 991336-6E9 is a medium maturing soft red winter wheat with white chaffed and medium in height. It was derived from the cross GA92432 // AGS 2000 / PIO 26R61. It is similar to AGS 2000 in maturity. GA 991336-6E9 is widely adapted in the Deep South and mid-South area. GA 991336-6E9 is resistance to current biotypes of Hessian fly in Georgia and is resistant to races of leaf rust and stripe rust in the southeast U.S. It is also resistant to soil-borne mosaic virus and powdery mildew.

GA 991336-6E9 has good milling and baking quality which is similar to AGS 2000. GA 991336-6E9 is equal to AGS 2000 in flour yield (72.6% vs. 73.1%), lower in softness equivalent score (54.9% vs. 58.9%), higher in flour protein (9.6% vs. 8.9%), slightly lower in lactic acid retention (103% vs. 113%) and equal in sucrose retention capacity (95% vs. 94%).

GA 991209-6E33

GA 991209-6E33 is a medium maturing soft red winter wheat with white chaffed and medium in height. It was derived from the cross, GA 901146 / GA 9006 // AGS 2000. Its maturity is 2 days earlier than AGS 2000. GA 991209-6E33 has excellent resistant to current biotypes of Hessian fly in Georgia including biotype L and is resistant to races of leaf rust and stripe rust. It is also resistant to soil-borne mosaic virus and susceptible to powdery mildew. GA 991209-6E33 has good milling and baking quality which is similar to AGS 2000. GA 991209-6E33 in comparison to AGS 2000 is equal in flour yield (71.9% vs. 73.1%), slightly lower in softness equivalent score (56.8% vs. 58.9%), equal in flour protein (8.3% vs. 8.9%), slightly lower in lactic acid retention (102% vs. 113%) and equal in sucrose retention capacity (91% vs. 94%).

GA 991371-6E12
GA 991371-6E12 is a medium maturing soft red winter wheat with white chaffed, and medium in height. It was derived from the cross, GA 931521 / *2 AGS 2000. It is similar to AGS 2000 in maturity. GA 991371-6E12 is moderately resistant to current biotypes of Hessian fly in Georgia including biotype L and is resistant to races of leaf rust (Lr37) and stripe rust (Yr17). It is also resistant to soil-borne mosaic virus and susceptible to powdery mildew. GA 991371-6E12 has good milling and baking quality which is similar to AGS 2000. GA 991371-6E12 in comparison to AGS 2000 is equal in flour yield (71.9% vs. 73.1%), equal in softness equivalent score (57.5% vs. 59.7%), equal in flour protein (8.9% vs. 9.1%), equal in lactic acid retention (115 vs. 110%) and equal in sucrose retention capacity (93% vs. 98%).

JGL, Inc. Bryan Gerard, Wade Wiley

EXP JG8001
EXP JG8001 is a soft red wheat variety licensed by JGL, Inc. EXP JG8001 is a medium maturity, medium plant height variety with awned heads. Across multi locations over the last two years, EXP JG 8001 has yielded 102.4% and 103% of the check cultivar Pioneer 25R47. The commercial launch will be in the fall of 2010.

EXP JG8002
EXP JG8002 is a soft red wheat variety licensed by JGL, Inc. EXP JG8002 is a medium-late maturity, medium plant height variety with awned heads. Across multi locations over the last two years, EXP JG 8002 has yielded 110.5% and 102% of the check cultivar Pioneer 25R47. The commercial launch will be in the fall of 2010.

EXP JG8003
EXP JG8003 is a soft red wheat variety licensed by JGL, Inc. EXP JG8003 is a medium-late maturity, medium plant height variety with awned heads. Across multi locations in 2008, EXP JG 8003 has yielded 105.6% of the check cultivar Pioneer 25R47. The commercial launch will be in the fall of 2010.

EXP JG8004
EXP JG8004 is a soft red wheat variety licensed by JGL, Inc. EXP JG8004 is a medium maturity, medium plant height variety with awned heads. EXP JG8004 is highly resistance to fusarium head blight. The commercial launch will be in the fall of 2011.

EXP JG8005
EXP JG8005 is a soft red wheat variety licensed by JGL, Inc. EXP JG8005 is a medium maturity, medium plant height variety with awned heads. Across multi locations over the last two years, EXP JG 8005 has yielded 104.1% and 104.8% of the check cultivar Pioneer 25R47. From initial milling and baking quality data, EXP JG8005 is showing very favorable results. The commercial launch will be in the fall of 2010.

EXP JG8006
EXP JG8006 is a soft red wheat variety licensed by JGL, Inc. EXP JG8006 is a medium-late maturity, medium plant height variety with awned heads. EXP JG8006 is highly resistance to fusarium head blight. The commercial launch will be in the fall of 2011.

EXP JG8007
EXP JG8007 is a soft red wheat variety licensed by JGL, Inc. EXP JG8007 is a medium-late maturity, medium plant height variety with awned heads. From initial milling and baking quality data, EXP JG8007 is showing very favorable results. The commercial launch will be in the fall of 2011.

EXP JG8008
EXP JG8008 is a soft red wheat variety licensed by JGL, Inc. EXP JG8008 is a late maturity, medium plant height variety with awned heads. From initial milling and baking quality data, EXP JG8008 is showing very favorable results. The commercial launch will be in the fall of 2011.

EXP JG8009
EXP JG8009 is a soft red wheat variety licensed by JGL, Inc. EXP JG8009 is a medium maturity, medium plant height variety with smooth heads. EXP JG8010 is showing strong yields in the Upper Corn Belt, especially in Ohio and Michigan. The commercial launch will be in the fall of 2010.

EXP JG8010
EXP JG8010 is a soft red wheat variety licensed by JGL, Inc. EXP JG8010 is a medium-late maturity, medium plant height variety with awned heads. EXP JG8010 is showing strong yields in the Upper Corn Belt, especially in Indiana, Ohio, and Michigan. Initial milling and baking evaluations shows EXP JG8010 is very strong gluten line making it desirable for use in making crackers and other products requiring strong gluten strength. The commercial launch will be in the fall of 2010.

EXP JG8011

EXP JG8011 is a soft red wheat variety licensed by JGL, Inc. EXP JG8011 is a very early maturity, medium-short plant height variety with smooth heads. EXP JG8011 has excellent yield for its maturity. Based upon multi-year testing and parentage, EXP JG8011 should be broadly adaptable to the majority of the Soft Red Wheat growing regions. EXP JG8011 is shows very good resistance to stem rust, powdery mildew, septoria glume blotch, and septoria leaf blotch. A small introductory launch will be in the fall of 2009 with a larger commercial launch in the fall of 2010.

EXP JG8012

EXP JG8012 is a soft red wheat variety licensed by JGL, Inc. EXP JG8012 is a late maturity, medium-tall plant height variety with smooth heads. The commercial launch will be in the fall of 2012.

Michigan State University, Janet Lewis

Envoy

'Envoy', experimental name MSU Line E1009, is a soft white winter wheat developed at Michigan State University (MSU). Envoy was selected from breeding population 950542, which was created from a cross in 1995 with the parentage 'MSU Line DC076' / 'PIONEER 2552'. Envoy is a high yielding soft white winter wheat well adapted to Michigan and Ontario, Canada. In addition to having acceptable grain quality and good yield, Envoy has high test weight, reduced deoxynivalenol mycotoxin accumulation from Fusarium head blight (in comparison with many soft white winter wheats), and is short. Its primary weakness is susceptibility to barley yellow dwarf virus.

Coral

'Coral', experimental name MSU Line E2017, is a soft white winter wheat developed at Michigan State University (MSU. Coral was selected from breeding population 950302, which was created from a cross in 1995 with the parentage 'D3913'/'D0331'. In addition to being adapted to Michigan, having good yield and acceptable grain quality, Coral's strengths include improved resistance to Fusarium head blight (visual), reduced levels of the Fusarium head blight mycotoxin deoxynivalenol (DON) in comparison to many other high yielding white wheats grown in MI. Furthermore, Coral has good test weight, and lacks awns. Its primary weaknesses are susceptibility to powdery mildew and stripe rust.

Ambassador
'Ambassador', experimental name MSU Line E0028, is soft white winter wheat developed at Michigan State University (MSU). Ambassador was selected from breeding population 940310, which was created from a cross in 1994 with the parentage 'Pioneer Brand 2737W' / 'MSU Line D1148'. Ambassador is a very high yielding soft white winter wheat with high flour yield and better winter hardiness than 'Caledonia'. Ambassador is adapted to Michigan and Ontario. Its primary weaknesses include lower than average test weight and susceptibility to Fusarium head blight and associated deoxynivalenol accumulation.

Red Amber
'Red Amber' (known in this report as 'Amber'), experimental name MSU Line D8006R, is a soft red winter wheat developed at Michigan State University (MSU). Red Amber was selected from breeding population 910009, which was created from a cross in 1995 with the parentage 'Pioneer Brand 2555'/'Lowell'. Red Amber is a sister line to 'D8006'. Red Amber adapted to Michigan.

MSU D8006
MSU D8006 is a soft white winter wheat, is awned, and is white chaffed. MSU D8006 is moderately resistant to stripe rust and wheat spindle streak mosaic virus and has superior milling and baking properties. Allis milling data is available from 2006 and Miag milling data is included in the 2007 Quality Evaluation Council data attached to this report.

Crystal
(MSU Line E1027) is a soft white winter wheat, is awned, and is white chaffed. Crystal is similar to Caledonia in height, flowering dates, and lodging resistance. Crystal is moderately resistant to wheat spindle streak mosaic virus and powdery mildew. Miag milling data was included in the 2007 Quality Evaluation Council report.

Ohio Seed Improvement Association, John Armstrong

Delta King DK 9577
DK 9577 is a high yielding, medium early, widely adapted, soft red winter wheat. It is an awnless, medium stature variety that performs from Western Kentucky to Northern Louisiana. DK 9577 has solid resistance to leaf rust and powdery mildew, with moderate resistance to stripe rust and septoria leaf blotch. It has excellent standability and winter hardiness. It is a small seeded variety with excellent test weight and performs well on all soil types.

Delta King DK 9108
DK 9108 is a very early maturing, high yielding soft red winter wheat variety with excellent early growth and grazing potential. It is an awnless, larger seeded variety with medium test weight. DK 9108 has excellent resistance to stripe rust, leaf rust, septoria leaf blotch, and powdery mildew. It is medium tall variety with good standability. Grain yields are best in AR, MS, and LA.

Armor GOLD
Armor GOLD is a new awnleted, medium maturing soft red winter wheat variety available in the fall 2008. It is a medium stature variety with excellent standability, and winter hardiness. Armor GOLD has excellent yield potential across soil types, but really stands out on heavier, wetter soils. It has excellent resistance to stripe rust, leaf rust, septoria leaf blotch, and powdery mildew. It has medium seed size with excellent test weight.

Ohio State University, Clay Sneller

BROMFIELD
Bromfield was tested as OH02-12678. It was released as a public variety due to its adaptation to Ohio, excellent overall disease resistance, low deoxynivalenol (DON), and its superior test weight. Yield of Bromfield was 2.4 bu/a superior to Hopewell, and test weight 0.8 lb/bu greater than Hopewell in 15 trials. Averaged over 14 environments, Bromfield had lower DON than the resistant check, Truman. Bromfield has very good resistance to powdery mildew, Stagonospora leaf and glume blotches, and leaf rust. Bromfield has moderate gluten strength and acceptable milling quality.

MALABAR
Malabar was tested as formerly OH02-7217. It was released as a public variety due to its adaptation to Ohio, outstanding tolerance to Fusarium Head Blight, and excellent resistance to lodging. In 15 trials, Malabar out yielded Hopewell by 3.8 bu/a and had 0.5 lb/bu better test weight. Malabar had an FHB index less than Truman and DON index similar to Freedom. Malabar has moderate resistance to foliar diseases common in Ohio. Malabar has moderate gluten strength and acceptable milling quality.

OH02-13567
OH02-13567 was a non-exclusive release for branding due to its numerically superior yield and disease resistance relative to Hopewell, scab resistance and adequate quality. OH02-13567 yielded 1.5 bu/ac better than Hopewell and its test weight was 0.8 lbs/bu greater. OH02-13567 has moderate resistance to foliar diseases common in the Midwest. OH02-13567 has moderate gluten strength and adequate milling quality.

Pioneer-Hybrid, Bill Lasker

Pioneer 25R39

25R39 (formerly XW06M) is a soft red winter wheat that was developed by Pioneer Hi-Bred International, Inc., derived from a single cross of a Pioneer experimental variety and previously released Pioneer variety, using a modified pedigree selection breeding method. 25R39 is primarily intended for grain production and it has shown good adaptation to the soft winter wheat region based on tests conducted in Arkansas, Kentucky, Missouri, Illinois, Indiana, Ohio, Michigan, Maryland and Ontario, Canada.

25R39 is awnless and heads about 1 day later than 25R47 on average. It has shown very good winter hardiness and moderate resistance to straw lodging. It has demonstrated excellent resistance to leaf rust and stripe rust and moderate resistance to powdery mildew. It has also shown moderate resistance to the complex of fungal organisms that incite leaf blights. It also exhibits moderate resistance to wheat spindle streak and soil borne wheat mosaic viruses.

Purdue University, Herb Ohm

INW0731 (P99608C1-1-3-4)

Parentage:
Sunset/Pioneer2571/3/Clark//Roazon/Caldwell/4/VPM1/Moisson//Clark/3/Clark*2/Caldwell/9/Caldwell*2/PioneerS76/8/Beau*2/Potomac//Auburn/Caldwell*2/7/Benhur/Arthur/6/Laporte/Konx*2/5/Hart/Beau/4/Arthur/3/Monon//Funo/Knox/10/Freedom/Fundulea201R. After the last cross, plant selections were made in F2, F3 and F4, with the pedigree method of selection, and INW0731 is the progeny of a single F4 plant. Off-type plants in an initial F4:8 seed increase plot in 2005 were discarded.

INW0731 soft red winter wheat (*Triticum aestivum* L.) was developed cooperatively by the Purdue University Agriculture Research Programs and the USDA-ARS, and was released by Purdue University Agriculture Research Programs in 2007. INW0731 was released for its high yield, excellent soft wheat milling and baking qualities, moderate resistance to yellow dwarf, fusarium head blight, leaf rust, powdery mildew, stagonospora nodorum blotch, septoria leaf blotch, Soilborne mosaic virus, and Wheat spindle streak mosaic virus. INW0731 is susceptible to prevalent biotypes of Hessian fly, and prevalent races of stripe rust and stem rust in Indiana.

It is adapted to Indiana, especially southern Indiana and adjacent regions, and has survived winters and performed well in northern Indiana, but winters have been mild since 1996. In multilocation trials in Indiana, 2004 – 2007 (20 year-location tests) average grain yield (kg/ha, Lsd 0.05 = 497) of cultivars INW0731, Pioneer25R47, Roane, and Patterson were 6480, 6527, 5868 and 5539, respectively, and their test weights (kg m-3, Lsd 0.05 = 21.9) were 775, 736, 789 and 773, respectively. In the Uniform Eastern Soft Winter Wheat Regional Nursery in 2006, INW0731 averaged 5586 kg/ha at 29 location tests, and ranked 24th of 46 entries. INW0731 ranked higher, even 1st of 46 entries at drier locations. In multilocation trials in Indiana in 2007, a season with significant drought conditions and moderate yellow dwarf infection, INW0731 excelled for grain yield, ranking 1st of 90 entries.

INW0731 is moderately early, heading typically on day 134 julian, one day later than 'Patterson' at Lafayette, Indiana. Plant height of INW0731 is mid tall, typically 91 cm. The coleoptile of INW0731 is colorless and seedling anthocyanin is absent. Plant color is green at booting and anthers are yellow. The stem does not have anthocyanin. Stem internodes are hollow and hairs of the last internode are absent. Spikes are awnless, fusiform and lax, and are inclined at maturity. Glumes are glabrous, mid-long, mid-wide and white at maturity. Kernels are mid-long and elliptical, the brush is short and not collared, cheeks are rounded. The crease is mid-wide and mid-deep. Juvenile plant growth is semi-erect.

Rupp Seeds, John King

RS953

RS953, Rupp Seeds: Maturity – Medium-Early, Head Type – Awnless, Test Weight – Heavy, Height – Medium, Standability – Excellent, Disease Resistance – Head Scab (MR), Powdery Mildew (MR), Septoria (MR).

RS978

RS978, Rupp Seeds: Maturity – Early, Head Type – Awnless, Test Weight – Heavy, Height – Medium-Tall, Standability – Excellent, Disease Resistance – Head Scab (MS), Powdery Mildew (MR), Septoria (MR).

RS908

RS908, Rupp Seeds Maturity – Early, Head Type – Awnless, Test Weight – Heavy, Height – Medium, Standability – Excellent, Disease Resistance – Head Scab (MS), Powdery Mildew (MR), Septoria (R).

Sunbeam Extract Company, Howard Lafever

Sunburst

Sunburst is a soft red winter wheat (Triticum aestivum L.) developed by the Sunbeam Extract Company of Wooster, Ohio. Sunburst is widely adapted to the Eastern Corn Belt, more specifically to Ohio, Michigan, Pennsylvania and parts of Canada. Sunburst is intended for the general-purpose wheat market. Sunburst originated from the cross Taishang1/GR863//Cardinal, made in Wooster, Ohio in 1991, and was designated as SE91-1942-4. Sunburst has blue-green head color, an erect-twisted flag leaf, short height, excellent straw strength and is awnless. Green stage variants include: 0.05% yellow green tall, 0.05% yellow reen, 0.05% yellow green awned, 0.35% yellow green, 0.6% tall awned, 0.1% tall for a combined variant total of 0.6%.

Sunburst was selected due to its excellent winter hardiness, excellent test weight, high yield potential, good scab resistance and leaf stripe resistance. Ohio Foundation seed will maintain breeder seed. The Certified classes of seed will be Foundation, Registered and Certified. Application for PVPA Title V will be made and the Certification options will be selected.

Virginia Polytechnic Institute, Carl Griffey

Southern States Brand 5205

The soft red winter wheat cultivar Southern States Brand 5205 (SS‘5205’) was derived from the three-way cross Pioneer Brand ‘2684’/VA93-54-185//’Pocahontas’. Parentage of VA93-54-185 is ‘Wheeler’/3/’Massey’*3/’Balkan’//’Saluda’. SS‘5205’ is a broadly adapted, high yielding, short stature, mid-season soft red winter wheat cultivar that provides producers and end users in the Deep South, mid-South, mid-Atlantic, and southern Corn Belt regions of the U.S. with a cultivar having very good milling and baking qualities. In the southern SRW wheat region, SS ‘5205’ on average is 0 to 1 days earlier heading than ‘McCormick’ and 1 to 4 days later than ‘USG 3209’. Plant height of SS‘5205’ (30 inch) on average is 1 to 2 inches shorter than those of USG 3209 and McCormick and 5 to 6 inches shorter than SS ‘MPV57’. Straw strength (0-9 scale) of SS‘5205’ (1.4) in the eastern SRW on average is better than those of USG 3209 (2.1) and McCormick (2.4).

SS‘5205’ was evaluated at 17 locations in the 2006-07 USDA-ARS Uniform Southern Soft Red Winter Wheat Nursery, and ranked 6th among 39 entries for grain yield (66.8 Bu/ac). SS‘5205’ produced yields that were similar to or significantly higher than the test averages at all 17 locations. SS‘5205’ also was evaluated in this uniform nursery in 2005-06 over 26 locations, and ranked 13th among 45 entries for grain yield (79.8 Bu/ac). SS‘5205’ produced yields similar to or significantly higher than the test average at 24 of the 26 test sites. Average test weight of SS‘5205’ in both years (59.1 Lb/Bu) was similar to that of McCormick and higher than that of USG 3209 (58.1 Lb/Bu). On the basis of winter kill ratings (0 = no injury to 9 = complete kill) reported at 4 of the 19 locations in 2007 and at 3 of the 26 test sites in 2006, winter hardiness of SS‘5205’ (5.1 and 1.0, respectively) is similar to that of USG 3209 and Pioneer 26R61, but less than that of McCormick (2.7 and 0.7).

SS‘5205’ is resistant to leaf rust (Puccinia triticina) and stripe rust (Puccinia striiformis). SS‘5205’ has expressed moderate resistance to powdery mildew (Blumeria graminis), stem rust (Puccinia graminis), Barley Yellow Dwarf Virus, Wheat Spindle Streak Mosaic Virus, Soil Borne Mosaic Virus, Septoria tritici leaf blotch, and Stagonospora nodorum glume blotch. It has expressed a moderate level of resistance to fusarium head blight [Fusarium graminearum (Schwabe)] with disease index scores (0 – 100) ranging from 2.7 to 16 and DON toxin concentrations ranging from 0.3 to 1.3 ppm in Virginia Tech’s inoculated, mist-irrigated FHB nursery. SS’5205’ is moderately susceptible to black chaff (Xanthomonas campestris) and Hessian fly [Mayetiola destructor (Say)].
On the basis of eight independent milling and baking quality evaluations over five crop years (2003-2007), SS‘5205’ has consistently exhibited very good milling and pastry baking quality.

The very good to excellent milling quality of SS‘5205’ is attributed to its soft grain texture, low endosperm separation indices (9.1%), high break flour yields (32.6 – 36.6%), and high straight grade flour yields (77.2 – 78.9%) on an Allis mill. Flour protein concentration of SS‘5205’ (8.61%) is lower than that of McCormick (9.23%), yet on the basis of Lactic Acid Retention Capacity, gluten strength of SS‘5205’ (113.3%) is higher than that of McCormick (109.7%). Thus, flour from SS‘5205’ likely can be used in the production of crackers, requiring moderate to high gluten strength, as well as production of excellent pastry products such as cookies and cakes.

Shirley

The soft red winter wheat cultivar Shirley (VA03W-409) was derived from the three-way cross VA94-52-25 / 'Coker 9835'// VA96-54-234. The parentage of VA94-52-25 is CI 13836/9* 'Chancellor'//2* 'Tyler'/3/2* 'Massey'/4/'Hunter'/5/'Saluda'. The parental line VA96-54-234 is a sib of 'Sisson' and 'Choptank'. Shirley is a broadly adapted, high yielding, short stature, full season soft red winter wheat cultivar that provides producers and end users in the mid-South, mid-Atlantic, Corn Belt, and Northeastern regions of the U.S. with a cultivar that has very good milling and pastry baking qualities. Head emergence of Shirley in the eastern SRW wheat region on average is 0 to 3 days later heading than 'Roane'. Average plant height of Shirley (32 inches) is 3 inches shorter than SS 'MPV57' and 1 to 2 inches taller than 'Jamestown'. Straw strength (0 – 9 scale) of Shirley (1.5 – 2.0) in the eastern SRW region is better than that of Roane (3.2 – 4.1).

Shirley Y was evaluated at 22 locations in the 2006-07 USDA-ARS Uniform Eastern Soft Red Winter Wheat Nursery, and ranked 1st among 44 entries for grain yield (81.2 Bu/ac). Shirley ranked among the top ten entries at 17 of the 22 locations and produced yields that were similar to or significantly higher than the test averages at all 22 locations. Average test weight of Shirley (57.6 Lb/Bu) was similar to those of check cultivars Patton (57.7 Lb/Bu) and INW 0411 (57.3 Lb/Bu). Shirley also was evaluated in this uniform nursery in 2005-06 over 29 locations, and ranked 1st among 46 entries for grain yield (91.6 Bu/ac). Shirley ranked among the top 10 entries at 17 of the 29 locations and produced yields that were similar to or significantly higher than the test average at all replicated test sites. Average test weight of Shirley (56.8 Lb/Bu) was similar to that of check cultivar INW 0411 (56.6 Lb/Bu). On the basis of winter kill ratings (0 = no injury to 9 = complete kill) reported at 9 of the 22 locations in 2007, Shirley had an average score of 2.0 compared to 1.7 for Roane.

Shirley is resistant to leaf rust (Puccinia triticina), stem rust (Puccinia graminis), powdery mildew (Blumeria graminis), Barley Yellow Dwarf Virus, Wheat Spindle Streak Mosaic Virus, Septoria tritici leaf blotch, Stagonospora nodorum leaf and glume blotch. Shirley is moderately resistant to black chaff (Xanthomonas campestris). It has expressed a moderate level of resistance to fusarium head blight [Fusarium graminearum (Schwabe)] with disease index scores (0 – 100) ranging from 6.5 to 18 and DON toxin concentrations ranging from 0.2 to 3.1 ppm in Virginia Tech's inoculated, mist-irrigated FHB nursery. Shirley expresses resistance to Hessian fly [Mayetiola destructor (Say)] biotype C, but is susceptible to biotypes B, D, and L. Shirley is susceptible to stripe rust (Puccinia striiformis).

On the basis of four independent milling and baking quality evaluations over three crop years (2005-2007), Shirley has consistently exhibited very good milling and pastry baking quality. Shirley's very good milling quality is attributed to its soft grain texture, low endosperm separation indices (8.9%), high break flour yields (32.3 – 32.8%), and high straight grade flour yields (77.7 – 77.9%) on an Allis mill. Flour protein concentrations of SHIRLEY are lower than average ranging from 7.62% to 8.65%, and protein gluten strength is weak on the basis of low Lactic Acid Retention Capacity values ranging from 84.6% to 93.6%. The aforementioned quality attributes of SHIRLEY and the low Sucrose Retention Capacity (87.6% – 90.8%) of its flour contribute to its very good pastry baking quality as exemplified by high values for cookie spread diameter (17.15 – 18.65 cm). See tables VA1 and VA2 for summaries of quality data.

Renwood Brand 3434

The soft red winter wheat cultivar Renwood Brand 3434 (Renwood '3434') was derived from the three-way cross 'Roane'/'Coker 9835'//VA96W-270. Parentage of VA96W-270 is VA88-54-612 ('Massey'*2/'Balkan') /'FFR511W'. Renwood '3434' is a broadly adapted, high yielding, short stature, full-season soft red winter wheat cultivar that provides producers and end users in the mid-South, mid-Atlantic, Northeast, and Corn-Belt regions of the U.S. with a stiff-straw cultivar having good baking quality. Head emergence of Renwood '3434' (124 d, Julian) is 1 day later than 'McCormick' and 1 day earlier than Roane. Plant height of Renwood '3434' is very short (28 inches) and on average is 2 inches shorter than 'USG 3209' and 6 inches shorter than SS 'MPV57'. Straw strength (0 – 9) of Renwood '3434' is better than that of USG 3209 (1.7 vs. 2.5) in the southern region and that of Roane (1.9 vs. 4.1) in the eastern SRW winter wheat region.

Renwood '3434' was evaluated at 17 locations in the 2006-07 USDA-ARS Uniform Southern Soft Red Winter Wheat Nursery, and ranked 7th among 39 entries for grain yield (66.3 Bu/ac). Renwood '3434' produced yields that were similar to or significantly higher than the test averages at all 17 locations. Average test weight of Renwood '3434' (57.5 Lb/Bu) was most similar to that of USG 3209 (58.1 Lb/Bu). Renwood '3434' also was evaluated at 22 locations in the 2006-07 USDA-ARS Uniform Eastern Soft Red Winter Wheat Nursery, and ranked 20th among 44 entries for grain yield (72.1 Bu/ac). Renwood '3434' produced yields similar to or significantly higher than the test averages at 21 of the 22 test sites. Average test weight of Renwood '3434' (57.9 Lb/Bu) was similar to those of check cultivars Patton (57.7 Lb/Bu) and Foster (58.1 Lb/Bu). On the basis of winter kill ratings (0 = no injury to 9 = complete kill) reported at 4 of the 19 southern nursery locations and at 9 of the 22 eastern nursery test sites, winter hardiness of Renwood '3434' (2.8 and 2.1, respectively) is similar to that of McCormick (2.7) and slightly less than that of Roane (1.7).

Renwood '3434' is resistant to powdery mildew (Blumeria graminis). It is moderately resistant to leaf rust (Puccinia triticina), stem rust (Puccinia graminis), Barley Yellow Dwarf Virus, Soil Borne Mosaic Virus, Septoria tritici leaf blotch, and Stagonospora nodorum glume blotch. Renwood '3434' has expressed a moderate level of resistance to fusarium head blight [Fusarium graminearum (Schwabe)] with disease index scores (0 – 100) ranging from 2.1 to 21.5 and DON toxin concentrations ranging from 0 to 1.5 ppm in Virginia Tech's inoculated, mist-irrigated FHB nursery. Renwood '3434' is moderately susceptible to stripe rust (Puccinia striiformis) and black chaff (Xanthomonas campestris). It is susceptible to Hessian fly [Mayetiola destructor (Say)].

On the basis of five independent milling and baking quality evaluations over three crop years (2005-2007), Renwood '3434' has exhibited acceptable milling and good pastry baking qualities. While endosperm separation indices (10.5 to 10.9%) of Renwood '3434' tend to be high, it has soft grain texture (70.8% – 88.0%) and moderately high break flour yields (31.4% – 32.7%). Straight grade flour yields of Renwood '3434' from an Allis Chalmers Mill have been 75.7% to 76.2%. Flour protein concentration of Renwood '3434' is moderately low and has varied from 7.57% to 9.46%. Gluten strength of Renwood '3434' is moderately weak with Lactic Acid Retention Capacity values varying from 98.8% to 110.1%. The aforementioned quality attributes of Renwood '3434' and the low Sucrose Retention Capacity (85.8% – 88.5%) of its flour contribute to its good pastry baking quality as exemplified by relatively high values for cookie spread diameter (17.08 – 18.81 cm). See tables VA1 and VA2 for summaries of quality data.

Jamestown (VA02W-370)

The soft red winter wheat cultivar JAMESTOWN was derived from the cross 'Roane'/ Pioneer Brand '2691'. The cultivar was approved for release by the Virginia Agricultural Experiment Station in spring 2007, and certified seed will be available beginning in Fall 2009. JAMESTOWN is a distinctly early heading, high yielding, short stature, awned, soft red winter wheat cultivar. JAMESTOWN is widely adapted and provides producers in the mid-South, Deep South, and throughout the mid-Atlantic region with a distinctly early maturing, disease and pest resistant cultivar. JAMESTOWN is notable resistant to Hessian fly, leaf rust, stripe rust, powdery mildew, and fusarium head blight.

On the basis of milling and baking quality evaluations over four crop years (2003-2006), JAMESTOWN tends to have higher break flour yields (30.5% versus 28.3%) and slightly softer texture (higher softness equivalent score 57.4% versus 54.1%) than USG 3209. Straight grade flour yields of JAMESTOWN (71.7%) have been slightly higher than those of USG 3209 (71.1%).

On average JAMESTOWN has higher flour protein concentration (8.92% versus 8.66%) and gluten strength (lactic acid retention value of 113% versus 107%) than USG 3209 and, therefore, may be suitable for use in making crackers and other products requiring moderate gluten strength. Overall, JAMESTOWN has better baking quality than USG 3209 on the basis of lower values for sucrose retention capacity (93.8% versus 104%) and larger cookie diameters (17.0 cm versus 16.8 cm).

USG 3555 (VA02W-555)

USG 3555 is a high yielding, moderately-early heading, short stature, awnleted, soft red winter wheat. It was derived from the cross VA94-52-60/Pioneer Brand '2643'//'USG 3209'. It was released by the Virginia Agricultural Experiment Station in spring 2007, and certified seed will be available beginning in fall 2008. USG 3555 is widely adapted and has potential for production in the mid-South, Deep South, and throughout the mid-Atlantic region. USG 3555 notably possesses a high level of resistance to powdery mildew, stripe rust, and stem rust, but is susceptible to Hessian fly.

On the basis of milling and baking quality data for four crop years (2003-2006), USG 3555 tends to have higher break flour yields and slightly softer texture than USG 3209. Flour yields of USG 3555 have been similar to those of USG 3209. On average USG 3555 has higher grain protein concentration and stronger gluten strength than USG 3209. Overall, USG 3555 has better pastry baking quality on the basis of lower values for sucrose retention capacity and larger cookie diameters than USG 3209, and also has good cake baking qualities.

Table 14. Summary of advance milling and baking quality VA Tech

Summary of advance milling and baking quality means data of wheat cultivars evaluated in uniform soft red winter wheat nurseries in 2006 and 2007: SS'5205' (2006 and 2007 uniform southern nurseries), Renwood '3434' (2007 uniform southern and eastern nurseries), and 'Shirley' (2006 and 2007 uniform eastern nurseries)

	MILLING	BAKING	SOFT.	MICRO	FLOUR	FLOUR	LACTIC	SUCROSE	COOKIE	TOP
	QUALITY	QUALITY	EQUIV.	T.W.	YIELD	PROT.	ACID	SRC	DIAM.	GR.
VARIETY	**SCORE**	**SCORE**	**SCORE**	**LB/BU**	**%**	**%**	**SRC**	**%**	**CM.**	
Pion.26R61=STD	**69.3**	**52.2**	**64.6**	**62.5**	**69.4**	**9.35**	**108.6**	**93.1**	**17.32**	**3.3**
AGS 2000	80.9	66.5	76.3	62.0	71.7	8.72	106.9	92.2	17.75	4.0
McCormick	66.5	61.8	86.5	61.5	68.8	8.60	117.2	93.6	17.61	4.3
USG 3209	**67.1**	**46.3**	**65.1**	**61.4**	**68.9**	**8.53**	**110.6**	**101.9**	**17.14**	**3.3**
SS '5205'	**75.1**	**94.3**	**86.9**	**61.9**	**70.5**	**8.28**	**117.7**	**86.4**	**18.58**	**5.5**
Renwood '3434'	**67.5**	**79.7**	**77.2**	**62.0**	**69.0**	**8.42**	**107.5**	**86.9**	**18.49**	**5.7**
Patton=STD	**71.9**	**68.3**	**69.1**	**61.7**	**70.4**	**8.76**	**101.8**	**89.4**	**17.87**	**3.0**
Foster	87.4	87.8	75.3	61.8	73.5	8.18	106.6	88.2	18.46	5.5
Roane	62.7	48.3	72.0	64.0	68.6	8.22	114.2	96.4	17.27	2.0
INW0411	68.0	61.3	64.3	60.7	69.6	8.62	98.5	92.7	17.66	4.0
Shirley	**75.4**	**90.3**	**68.7**	**61.1**	**71.1**	**7.74**	**93.5**	**89.2**	**18.53**	**6.0**

Table 15. Summary of Allis milling and baking Quality VA Tech

Summary of Allis milling and baking quality means data of wheat cultivars SS'5205', 'Shirley', and Renwood '3434' evaluated in 2005 & 2006 Virginia State Wheat Tests

	MILLING	BAKING	TEST	BREAK	ST. GR.			FLOUR	FLOUR	LACTIC	COOKIE	
	QUALITY	QUALITY	WT.	FLOUR	FLOUR	E.S.I.	FRIAB.	PROT.	ASH	ACID	DIAM.	TOP
VARIETY	SCORE	SCORE	LB/BU	YIELD	YIELD	%	%	%	%	9% Prot.	CM.	GR.
Sisson	**65.8**	**53.5**	**64.1**	**29.7**	**76.9**	**10.1**	**28.7**	**8.53**	**0.39**	**90.6**	**17.04**	**2.5**
McCormick	**67.6**	**50.0**	**65.6**	**30.5**	**77.0**	**9.7**	**28.7**	**9.61**	**0.40**	**107.1**	**16.93**	**3**
Jamestown	**62.7**	**44.0**	**65.2**	**28.4**	**76.5**	**10.3**	**28.3**	**9.38**	**0.39**	**103.5**	**16.75**	**2**
USG 3555	**57.6**	**46.2**	**63.7**	**29.3**	**76.1**	**10.3**	**27.2**	**8.89**	**0.42**	**103.9**	**16.82**	**3.5**
USG 3209	**59.7**	**38.4**	**64.7**	**27.5**	**76.7**	**10.2**	**27.1**	**9.04**	**0.43**	**99.0**	**16.58**	**2**
SS '5205'	**75.1**	**68.2**	**65.0**	**32.6**	**77.5**	**9.0**	**29.9**	**8.61**	**0.37**	**109.2**	**17.48**	**5.5**
Renwood '3434'	**59.9**	**61.0**	**63.6**	**32.1**	**75.9**	**10.7**	**28.4**	**8.76**	**0.39**	**99.3**	**17.26**	**2.5**
Shirley	**75.0**	**69.2**	**62.7**	**32.6**	**77.8**	**8.9**	**29.4**	**8.55**	**0.41**	**85.3**	**17.51**	**5.0**

Materials and Methods

Quality Characteristics of Soft Wheat Cultivars with Allis Milling

Milling quality is a highly heritable genetic trait. Milling-quality score consists of straight-grade flour yield, endosperm separation index (ESI) and friability. Other milling quality parameters also can be utilized from the Allis-Chalmers milling data. Data represent millings from a modified Allis-Chalmers mill of “shrivel-free” grain from various locations and/or crop years (1975-2008). Every effort has been adopted to insure that milling-quality data are representative of the cultivar. However, there is a measure of uncertainty in data representing a cultivar singularly milled. Known standard cultivars that are contained within a set are milled and then compared to the previous milling information for those cultivars. The break-flour yield, test weight and 1000-kernal weight for an individual sample are not especially useful parameters, but comparing the break-flour yields, test weights and 1000-kernel weights of the various known standards can be utilized to establish confidence in verification of the named standards provided in a set

Grain Handling

Grain Production

Historic varieties dating to 1808 and likely earlier were acquired through the National Small Grains Collection (located in Aberdeen, Idaho, and formerly in Beltsville, Maryland). Those are grown with contemporary cultivars. Plant characteristics of the historic varieties and contemporary cultivars are compared with recorded plant descriptions; confirm the identity of the various varieties. Yearly, the SWQL grows 200 to 300 cultivars/varieties in forty-square-foot plots.

Grain Cleaning and Sizing

Prior to 1985, most of the shriveled grain was removed mechanically utilizing a modified Carter-Day dockage tester or an air-flow scourer. However, some shriveled grain could be present in the remaining sample. In 1985, the Carter-Day was further modified to remove shriveled kernels by air aspiration. The ability to remove shrunken grain was greatly enhanced, but the process was time consuming.

In 1989, a large air-aspirator was fabricated by the SWQL that reduced cleaning time significantly and removed shriveled kernels. In 2002, the SWQL began to re-evaluate cultivars that were tested prior to 1989 and update the milling information if needed. That effort was mostly completed in the summer of 2006.

Every cultivar designated for Allis milling is mechanically sized into three or four fractions on a SWQL-modified Carter-Day Dockage Tester and then aspirated. A maximum of 2500 grams can be aspirated at one time. Air flow is electronically adjustable and the lower density shriveled grain within each sized fraction is removed. Visual inspection through a lighted magnifier is used to ascertain that only sound grain remains. Once aspiration of the wheat has been completed, the cleaned sized fractions are blended. Test weight, 1000-kernel weight and moisture are determined prior to milling.

Weather and Environment

Weather damaged cultivars that produce diminished milling quality can be difficult to identify if known standards are not incorporated within the field trial. In the northern soft wheat region, wet weather at or near harvest time occurred most years from 1990 to 2000 and again in 2003. Some cultivars prominent during that decade produced milling quality data unreflective of their true genetic potential. After a specific cultivar is identified that produced “invalid” milling data, that milling information will be replaced with the updated analysis. A cultivars’ revised milling score could increase by as much as two standard deviations.

An “off color” flour can appear in wheats which are genetically “white” when there is an excessive quantity of wet weather at harvest time. A yellowish flour color sometimes occurs in cultivars that are normally white when the environment “produces” a coarser granulating flour than normal.

Wet weather at harvest time will lower test weights and grain density, and can greatly increase the softness of the kernel so that the flour produces larger cookie spread, although milling-yield potential is not affected. Throughput at the 1st-break rolls is diminished with weathered wheat. However, since the wheat is softer, break-flour yield increases and less middling stock is passed to the reduction rolls. That would result in reduced energy required to power the rolls with less wear on the roll surface. More throughput could possibly be realized with softer-weathered wheat versus coarser type wheat if a double 1st-break system were employed.

Excessively wet weather at harvest time can damage wheat for milling quality. Sprouted wheat (after aspiration) can possess higher test weights than unsprouted wheats. After aspiration to remove shriveled grain, a sprouted wheat may have a test weight in excess of 60# / bushel compared to weathered, unsprouted, non-shriveled wheat with 57# / bushel test weight. Alpha-amylase activity may be present despite a lack of visual evidence of sprouting.

Moderate infection from leaf diseases apparently does not affect milling properties once damaged (shriveled) kernels have been removed, however, baking quality of sugar snap cookies may be affected.

Milling Methods

ALLIS MILL

The Allis-Chalmers mill was acquired in 1909 by the Ohio Agricultural Experiment Station. Chester Evans, a practical miller, was put in charge of the milling operation and baking plant. Mr. Evans came to the station from Williams Brothers Milling, Kent, Ohio. Apparently the Allis-Chalmers mill was donated to the Soft Wheat Quality Laboratory around 1937. The mill was extensively modified during the early 1970's: self-aligning, double-row roller bearings, and extensions manufactured for the roll spacing control arms. A one-inch movement of the control arm around a twenty-four inch radius is equal to one thousandth of an inch (25 microns) change in roll separation. The standard deviation for flour yield of duplicate millings is 0.15%.

Kernel weight is determined on each cleaned sample and grain volume weight measured. Following grain measurements, samples are tempered to 15% moisture. Tempered grain is milled on the SWQL Allis-Chalmers flour mill using the AACC method 26-32 as modified by Yamazaki and Andrews (1982)[3]. The Allis-Chalmers mill is a long flow experimental milling system with adjustable roll gaps. Grain is initially milled with 6 break roll passes then reduced in 7 reduction roll passes to produce straight grade flour. The roll settings, sifting screen sizes, and mill flow were as diagramed in Yamazaki and Andrews (1982).

For each grain sample, straight grade flour yield and break flour yield are recorded.

Data Analysis and Interpretation of Allis Milling

Since milling quality is a highly heritable genetic trait, excluding weather damaged examples; a single sample likely will produce representative milling yield, ESI and friability. Also, lactic acid solvent retention capacity values within a milling system are highly heritable in all published genetic studies of wheat. However, test weight, kernel weight, break flour yield, cookie baking, flour protein and ash can be influenced significantly by environmental variations. Usually, mean data from three millings will yield quality assessments that are more representative of those traits that are less stable. The number of samples included in the computation of the average is specified for each cultivar. A cultivar that has been composited from several locations/crop years may produce quality data more nearly reflects its genetic nature. Cultivars listed in the tables that have a "c" beside the "number for the average" indicate that a composite sample has been milled to generate the quality data.

[3] Yamazaki, W.T. and L.C. Andrews. 1982. Experimental milling of soft wheat cultivars and breeding lines. Cereal Chem. 59:41-45.

MIAG MULTOMAT MILL

The Miag Multomat Mill is a pneumatic conveyance system consisting of eight pair of 254 mm diameter x 102 mm wide rolls, and ten sifting passages. Three pair are corrugated and employed as break rolls and five pair are smooth rolls utilized in the reduction process. Each sifting passage contains six separate sieves. The two top sieves for each of the break bolls are intended to be used as scalp screens for the bran. The third break sieving unit of the Soft Wheat Quality Laboratory (SWQL) Miag Multomat Mill was modified so that the top four sieves are employed to scalp bran. That modification increased the final bran sieving surface by 100% and essentially eliminated any loss of flour. Thus, the mill very closely approximates full scale commercial milling.

Experimental Milling Procedure: All SRW varieties are tempered to a 14.0% moisture level. Generally tempered wheat is held for at least 24 hours in order for the moisture to equilibrate throughout the grain. Wheat is introduced into the first break rolls at a rate of 54.4 Kg/hour (120 #/hour). Straight grade flour is a blend of ten flour streams, the three break flour streams and the five reduction streams, plus the grader flour from the break streams and the duster flour from the reduction streams. The straight grade flour mean volume diameter is about 50 microns with an ash content usually between 0.42% and 0.52%.

Flour generated by the (SWQL) Miag Multomat Mill very nearly represents that of commercially produced straight grade flour. Bran, head shorts, tail shorts and red dog are by-products which are not included with the flour. Flour yields vary between 70% and 78% which is variety dependent due to milling quality differences and/or grain condition. Sprouted and/or shriveled kernels negatively impact flour production. Recovery of all mill products is usually about 99%. Least significant differences for straight grade flour yield and break flour yield are 0.75% and 0.82%, respectively.

QUADRUMAT JUNIOR FLOUR MILL

Micro Milling Method

Based on average whole grain moisture determination of a subset of the group to be milled, samples are tempered to 15% moisture. Sample preparation for moisture determination uses the low speed Tag-Heppenstall corrugated rolls that have a roll speed differential of 1:1. Tempered grain samples are milled after 48 hours to allow for equal water distribution throughout the kernel.

Samples are milled in a control temperature and humidity room (19 – 21 C and RH 55% - 60%). Milling is conducted on a modified Quadrumat Junior flour mill. Prior to sample analysis, mill should be operating, warm, and equilibrated (36 C + /- 1.0) when mill has equilibrated. Standard sample size for micro milling is 80 g, although other samples sizes can be used. Tempered grain is milled and the product recovered for sifting on a Great Western Sifter Box. The sifter should have 40 mesh and a 94 mesh screen to separate mill product into bran (above 40), mids (between 40 and 94) and flour (through 94 screen and recovered in the flour pan on the bottom).

To calculate softness equivalent (a modified particle size index), the weights of the bran and mids are recorded. The mids are added back to the flour that passed through the 94 mesh screen to produce the final flour product for analysis.

Advanced Milling Method

Mids from micro milling method are further processed as reduction milling on a second Quadrumat Junior mill and sieved as for the micro milling method using an 84 mesh screen to produce baking quality flour. Standard sample size for advanced milling is 200 g, and grain samples are tempered individually to 15% moisture prior to milling. Milled flour is passed through an 84 mesh screen and combined with flour from the micro milling for baking.

Because samples are tempered individually to 15%, the formulas for advanced milling yield are calculated without the adjustment to15% moisture.

Milling Tests

Endosperm Separation Index (ESI) was calculated as described by Yamazaki and Andrews (1982). ESI is the estimated endosperm adhering to bran and bran pieces after the third through fifth break passes and first reduction pass, expressed as a percentage based on the weight of milled grain divided into the flour recovered in the break rolls after the second break stream and the reduction rolls after the first break. Lower ESI values indicate better bran separation from endosperm and better milling quality than higher ESI values.

The quantities of final bran plus four other bran-rich fractions obtained at an intermediate stage of milling are recorded and essentially represent all of the bran. The bran (14.5%) and the germ (2.5%) are subtracted to yield endosperm remaining attached to the bran. The lower that value is, the better the separation was between endosperm and bran. Thus, a lower ESI value indicates better wheat for milling since less energy is required to produce straight-grade flour.

Friability Gaines et al., 2000[4], estimated the ease with which mill stock is reduced to flour. Friability is calculated by dividing the weight of flour recovered during milling by the summed weight of mill stock passed through all roll stands, break and reduction, after the first break. The earlier in the break and reduction process that flour is recovered, the lower the weight of mill stock that passes to the later break and reduction rolls. Higher values of friability indicate better milling efficiency and reduced energy requirements to recover flour.

Friability is the tendency of the wheat endosperm conglomerates to reduce to flour as a result of corrugated and smooth roll action. The cumulative quantity of stock entering the rolls (usually 20 streams) and the percent of flour extracted from the stock relate to the total energy consumed by the milling process. A higher percentage of friability means that less energy is required per unit of flour extraction.

Friabilities above 30.5% are rare and only exceptionally good-milling wheats fall into this category. Those cultivars displaying friabilities below 27% usually reflect very poor reduction of middling stock on the smooth rolls.

Poor milling-quality cultivars produce middling stocks which do not release flour well after being crushed on the smooth rolls, resulting in higher quantities of carry-over to subsequent reduction rolls. Cultivars that have reduced milling properties due to “weathering” do not reduce well on the smooth rolls and the endosperm and bran do not separate well on the corrugated rolls.

Milling a cultivar with a friability of 25% compared to one of 30% would produce about a 15% increase in the amount of stock entering the corrugated and smooth rolls of the SWQL Allis-Chalmers mill. When milling 60,000 # (1000 bu) of wheat per hour, the quantity passing thru the SWQL mill (not including 1st break) would be 179,000 # of stock for the cultivar with lower friability compared to 156,000 # for the cultivar with higher friability. The cultivar with friability of 25% would also yield about 3.5% less flour.

Flour yield

Flour yield “as is” is calculated as the bran weight (over 40 weight) subtracted from the grain weight, divided by grain weight and times 100 to equal “as is” flour yield. Flour yield is calculated to a 15% grain moisture basis as follows: Flour moisture is regressed to predict the grain moisture of the wheat when it went into the Quad Mill using the formula Initial grain moisture=1.3429 x (flour moisture) – 4. The flour yields are corrected back to 15% grain moisture after estimating the initial grain moisture using the formula $\text{Flour Yield}_{(15\%)} = \text{Flour Yield}_{(\text{as is})} - 1.61\% \times (15\% - \text{Actual flour moisture})$.

[4] Gaines, C.S., P.L. Finney, and L.C. Andrews. 2000. Developing agreement between very short flow and longer flow test wheat mills. Cereal Sci. 77:187-192.

Softness Equivalent

Softness Equivalent (as is) is calculated from the fraction of mill product that is in the mids, with smaller amounts of mids correlating to smaller particle size, greater break flour yield, and greater softness equivalent. The mids weight (over 94) is subtracted from the unadjusted flour yield to calculate the quantity of fine flour that passed through the 94 mesh, which is divided by the unadjusted flour yield and multiplied by 100%. Softness Equivalent at 15% grain moisture is calculated using the estimated grain moisture prior to milling (see milling formulas). The softness equivalents are adjusted to 15% grain moisture with the formula $\text{Softness Equivalent}_{(15\%)} = \text{Softness Equivalent}_{(\text{as is})} - 1.08\% \times (15\% - \text{Actual flour moisture})$.

Flour yield adjustment[5] based on flour particle size 52% is subtracted from the actual softness equivalent. That difference is multiplied times 0.17% which is the change in flour yield per percentage point change in softness equivalent. Therefore, $\text{Adjusted Flour Yield} = \text{Flour Yield}_{(15\%)} + (\text{Softness Equivalent}_{(15\%)} - 52\%)$[6].

Mill Score: Mill score represents a standard adjustment based on flour yield by comparing the test cultivar to a check. The check cultivar produces a score that can be used as a handicap against its traditional expected yield, and the test cultivar mill score is adjusted to the same degree as the check. This method relates test cultivars providing a score that is independent of the environmental influences. The mill score standard deviation will be about 1.43 when evaluating cultivars and test lines that have been grown and harvested together.

Kernel and Whole Wheat Tests

Test Weight: (AACC Method 55-10) Weight per Winchester bushel of cleaned wheat subsequent to the removal of dockage using a Carter-Day dockage tester. Units are recorded as pounds/bushel (lb/bu) and kilograms/hectoliter (kg/hl).

1000 Kernel Weight: Units are recorded as grams/ 1000 kernels of cleaned wheat. There is little difference between 1000-kernel weight and milling quality when considering shriveled-free grain. However, small kernelled cultivars that have 1000-kernel weight below 30 grams likely will have reduced milling yield of about .75%.

Single Kernel Characterization System (SKCS): (AACC Method 55-31) SKCS distribution showing % soft (A), semi-soft (B), semi-hard (C), and hard (D); SKCS hardness index; SKCS moisture content; CKCS kernel size; and SKCS kernel weight; along with standard deviations.

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[5] On the small Quad Mill, coarser type soft wheats will appear to mill better than they should and conversely, softer type soft wheats will have suppressed “as is” flour yields.

[6] Micro milling adjustments were developed by Lonnie Andrews with Patrick Finney and Charles Gaines. Additional details are included in the Standard Operating Procedures for the Soft Wheat Quality Laboratory

Whole Wheat Moisture: (AACC Method 44-15A) Air-oven method.

Whole Wheat Crude Protein: Nitrogen combustion analysis using Elementar Nitrogen Analyzer. Units are recorded in % protein converted from nitrogen x 5.7 and expressed on 12% moisture basis.

Whole Wheat Falling Numbers: (AACC Method 56-81B) Units are expressed in seconds using the Perten Falling Numbers instrument.

Whole Wheat - Amylase Activity: (AACC Method 22-06) Units are expressed in alpha amylase activity as SKB units/gram (@ 25°C).

Flour Tests

Flour Moisture: (AACC Method 44-15A) Units are expressed as % of flour.

Flour Crude Protein: Protein determined by NIR using a Unity NIR instrument calibrated by nitrogen combustion analysis using Elementar Nitrogen Analyzer. Units are recorded in % protein converted from nitrogen x 5.7 and expressed on 14% moisture basis.

Flour protein differences among cultivars can be a reliable indicator of genetic variation provided the varieties are grown together, but can vary from year to year at any given location**.** Flour protein from a single, non-composite sample may not be representative. Based on the Soft Wheat Quality Laboratory grow-outs, protein can vary as much 1.5 % for a cultivar grown at various locations in the same ½ acre field.

Flour protein of 8% to 9% is representative for breeder's samples and SWQL grow-out cultivars. As flour protein increases, the expansive capability of the cookie during the baking process decreases. Flour protein is negatively correlated to cookie diameter ($r=-0.62$, $p<0.0001$) with the cookie shrinking 0.4 cm for every 1 percentage point increase in protein[7]. The effect of flour protein on cookie size is related in part to increased water absorption due to greater protein content, however the amount of cookie shrinkage is greater than that explained by increased water absorption alone.

[7] Correlations and prediction models cited in this section are based on 2289 samples milled at the Soft Wheat Quality Laboratory in 2007 an 2008 on the Quadrumat Advanced milling system.

Protein quality is an evaluation of "elasticity" or gluten strength and is not the same as protein quantity. A cultivar possessing a low quantity of protein could still exhibit strong gluten strength. Gluten strength is thought to be a desirable characteristic for cracker production. Gluten strength is measured using a mixograph and is graded on a scale of 1-8, with 1 as weakest and 8 as strongest gluten. Evaluation of gluten strength using the mixograph or farinograph is difficult for soft wheat flours that are 8.5% protein and lower. Since the representative protein range for breeders' samples is 8-9%, many of these flours are not adequately evaluated using the mixograph or farinograph methods. The Lactic Acid SRC, which does not require mixing action to assess gluten, tends to be a better measurement of protein quality when evaluating soft wheats. Lactic acid hydrates the native matrix of insoluble polymeric protein (IPP) present in the flour.

Flour Ash: (AACC Method 08-01) Basic method, expressed on 14% moisture basis.

Flour Falling Numbers: (AACC Method 56-81B) Units are expressed in seconds using the Perten Falling Numbers instrument. Numbers above 400 seconds reflect factors other than alpha amylase activity (such as particle size). The correlation between alpha amylase activity and falling number is best for samples with falling number values between 200 and 300 seconds. For cake flours and batters, 350 seconds is a common minimum value. For breakfast cereals or cookies and other high sugar products values of 250 seconds are more common cut-off values.

Flour Amylase activity: (AACC Method 22-06) Units are expressed in α-amylase activity as SKB units/gram (@ 25°C).

Solvent Retention Capacity Test (SRC): (Flour Lactic Acid, Sucrose, Water, and Sodium Carbonate Retention Capacities AACC Method 56-11)
Units are expressed as %.

Water SRC is a global measure of the water affinity of the macro-polymers (starch, arabinoxylans, gluten, and gliadins). It is often the best predictor of baked product performance. Water SRC is correlated to Farinograph water absorption but does not directly measure the absorption of the glutenin macropolymer hydration during mixing as does the Farinograph. Water SRC is negatively correlated to flour yield and softness equivalent among flour samples milled on the Quad advanced flour mill (r=-0.43 and r=-0.45, respectively). Lower water values are desired for cookies, cakes, and crackers with target values below 51% on small experimental mills and 54% on commercial or long-flow experimental mills.

Sucrose SRC is a measure of arabinoxylans (also known as pentosans) content, which can strongly affect water absorption in baked products. Water soluble arabinoxylans are thought to be the fraction that most greatly increases sucrose SRC. Sucrose SRC probably is the best predictor of cookie quality with sugar snap cookie diameters decreasing by 0.07 cm for each percentage point increase in sucrose SRC. The negative correlation between wire-cut cookie and sucrose SRC values is $r=-0.66$ ($p<0.0001$). Sucrose SRC typically increases in wheat samples with lower flour yield ($r=-0.31$) and lower softness equivalent ($r=-0.23$). The cross hydration of gliadins by sucrose also causes sucrose SRC values to be correlated to flour protein ($r=0.52$) and lactic acid SRC ($r=0.62$). Soft wheat flours for cookies typically have a target of 95% or less when used by the US baking industry for biscuits and crackers. Sucrose SRC values increase by 1% for every 5% increase in lactic acid SRC. The 95% target value can be exceeded in flour samples where a higher lactic acid SRC is required for product manufacture since the higher sucrose SRC is due to gluten hydration and not to swelling of the water soluble arabinoxylans.

Sodium carbonate SRC is a very alkaline solution that ionizes the ends of starch polymers increasing the water binding capacity of the molecule. Sodium carbonate SRC increases as starch damage due to milling increases. Sodium carbonate is an effective predictor of milling yield and is negatively correlated to flour yield on the Quad advanced milling system ($r=-0.48$, $p<0.0001$). It also is one of several predictors of cookie diameter ($r=-0.22$, $p<0.0001$). Normal values for good milling soft varieties are 68% or less.

Lactic acid SRC measures gluten strength. Typical values are below 85% for “weak” soft varieties and above 105% or 110% for “strong” gluten soft varieties. See the above discussion of protein quality in this section for additional details of the lactic acid SRC. Lactic acid SRC results correlate to the SDS-sedimentation test. The lactic acid SRC is also correlated to flour protein concentration, but the effect is dependent on genotypes and growing conditions. The SWQL typically reports a protein-corrected lactic acid SRC value to remove some of the inherent protein fluctuation not due to cultivar genetics. Lactic acid is corrected to 9% protein using the assumption of a 7% increase in lactic acid SRC for every 1% increase in flour protein. On average across 2007 and 2008, the change in lactic acid SRC value was closer to 2% for every 1% protein.

Flour Damaged Starch: Chopin SDMatic starch damage instrument using the supplied AACC calibration. Starch damage is a measure of the damage to the starch granule occurring during the milling process.

Experimental Baked Product Tests

Wire Cut Cookie: (AACC Method 10-53, Macro Method)
This method determines the texture (hardness) of the cookies. The use of high-fructose corn syrup and lower sucrose concentration allows for a texture more similar to standard commercial cookie formulations. Differences in hardness reflect differences in flour quality, with softer cookie texture produced with better soft wheat quality.

Baking Quality of Cookie Flour: (AACC method 10-52, Micro Method)
See new method presented in this document. Diameter and stack height of cookies baked according to this method are measured and used to evaluate flour baking quality. All data reported in this report were produced using the accepted method prior to December, 2008.

Cookie spread determined within a location is a reliable indicator of the source cultivar's genetic characteristics. However, cookie spread, unlike milling quality, is greatly influenced by environmental conditions. An absolute single value for cookie spread could be misleading. Within a location the single value is significantly important in comparison to known standards. The average cookie spread for three different examples of a cultivar is representative of that wheat.

Cultivars with larger cookie spreads tend to release moisture efficiently during the baking process due to lower water absorption while cultivars yielding smaller diameter cookies tend to be higher in water absorption and hold the moisture longer during baking.

The best single predictor of cookie diameter is sucrose SRC. The strong negative correlation of sucrose SRC to cookie diameter ($r=-0.66$, $p<0.0001$) has led to its adoption in lieu of baking cookies for most samples. The best prediction model for cookie diameter among grain samples milled on the Quadrumat advanced system uses a combination of sucrose SRC, softness equivalent, and flour protein ($R^2=0.61$). These three measures are combined into the baking quality score used in Quad Micro milling with the baking quality score favoring lower sucrose SRC and flour protein and greater softness equivalent values.

Cultivars that possess excellent milling properties nearly always produce large diameter cookie spreads. Poor milling cultivars nearly always produce smaller cookie spreads. Cultivars that are very soft in granulation usually produce good cookie spreads.

Milling Formulas Used for SWQL Reports

Micro Milling

Grain Moisture Estimate
Grain moisture=1.3429 x (flour moisture) – 4

Estimated Flour Yield Corrected to 15% Moisture
Flour Yield$_{(15\%)}$= Flour Yield$_{(as\ is)}$-1.61% x (15% - Actual flour moisture)

Softness Equivalent (SE)
SE$_{(as\ is)}$=((GW-Bran)-Mids)/(GW-Bran)
Where:
SE = Softness Equivalent
GW = Weight of grain milled
Bran = Weight of milled product that remains above a 40 mesh screen
Mids = Weight of mill product through a 40 mesh and remaining above a 94 mesh screen.

Softness Equivalent at 15% grain moisture (SE$_{15\%}$)
SE$_{(15\%)}$= SE$_{(as\ is)}$-1.08% x (15% - Actual flour moisture)

Flour yield adjustment[8]
Adjusted Flour Yield= Flour Yield$_{(15\%)}$ + 0.17 x (Softness Equivalent$_{(15\%)}$ - 52%)

Milling Quality Score (MQS)
MQS=MF + (5.0144 x Adjusted Flour Yield) -292.6425
Where:
MF = Allis Milling Score - (5.0144 x SAFY) -292.6425
Allis Milling Score = Mill score from Allis database for the quality standard designated for the group.
SAFY = Adjusted Flour Yield for the quality standard designated for the trial as measured in the trial being evaluated.

[8] On the small Quad Mill, coarser type soft wheat samples will appear to mill better than they should and conversely, softer type soft wheat samples will have suppressed “as is” flour yields. When compared to soft wheat samples with lower softness equivalents, wheat samples with higher softness equivalents typically require greater break roll milling to completely separate endosperm from bran. Micro milling adjustments were developed by Lonnie Andrews with Patrick Finney and Charles Gaines. Additional details are included in the Standard Operating Procedures for the Soft Wheat Quality Laboratory.

Baking Quality Score (BQS)
BQS=BF+ (33.3333*CS)-526.667
Where:
BF = Allis Baking Score – SCS
CS = Cookie Score = (-0.145 x Flour Protein) + (-0.07 x Sucrose SRC) + (0.049 x SE) + 21.9
SCS = Standard Cookie Score – cookie score for the quality standard designated for the trial as measured in the trial being evaluated.
Allis Baking Score = Allis baking score for the quality standard as determined in the Allis Milling Database.

Advanced Flour Milling
All formulas for Advanced milling are the same as Micro milling with the exception of Baking Quality Score.

Baking Quality Score (BQS)
BQS = (33.33333 x Cookie Diameter)-526.667+BF
Where:
BF = Baking Factor = Allis Bake Score - (33.33333 x SCD)-526.667
Allis Baking Score = Allis baking score for the quality standard as determined in the Allis Milling Database.
SCD = Standard Cookie Diameter – cookie diameter for the quality standard designated for the trial as measured in the trial being evaluated.

Allis-Chalmers Flour Milling

Recovery Weight
Recovery Wt. = Bran Wt. + Red Dog Wt. + Shorts Wt. + Straight Grade Wt.

Flour Yield
Flour yield = Straight Grade Wt. / Recovery Wt.

Endosperm Separation Index (ESI)
ESI= [(Bran Wt. + Red Dog Wt. + Shorts Wt.) /Recovery Wt]-17. [9]

Friability
Friability = (Summed weight of material milled by 2nd to 6th Break and 1st to 7th Reduction)/Weight of straight grade flour
Tom says (Straight Grade Weight)/Summed weight of material milled by 2nd to 6th Break and 1st to 7th Reduction)

Allis Softness Equivalent (Allis SE)
Allis SE = Break Flour % + 21%

[9] In practice the recovery weight is estimated at 98% of milled weight

Allis Milling Score

Allis milling score = 33.3 – [80 - Allis straight grade flour yield) x 3.7]
+ 33.6 + [(6 - ESI) x 2.8]
+ 33 - [32-Friability) x 3.3]

Allis Baking Score

Allis Baking Score = (33.33333 x Cookie Diameter)-526.667

Genotyping

Commonly used PCR markers for testing Wheat Quality Soft Wheat Quality Laboratory
The markers listed below and other published assays for wheat evaluation can be referenced at the Wheat Cap website under the "MAS protocols" section. http://maswheat.ucdavis.edu/index.htm
SSR markers were accessed from the GrainGenes website: http://wheat.pw.usda.gov/GG2/index.shtml

Primers	*Sequence*	*Product*	*RXN*
	High Molecular Weight Glutenins		
GluA1	*Zang&Gale Euphytica 134:51-60, 2003*		
AxFwd	ATGACTAAGCGGTTGGTTCTT	1,200	58°C
Ax2* (reverse)	ACCTTGCTCCCCTTGTCTTT		
Ax1 (reverse)	ACCTTGCTCCCCTTGTCCTG		
GluD1	*Guttieri,M., 2008, unpublished, Wan, et al. TAG 2005 111:1183-1190*		Touch
DxL_151 (forward)	AGGATTACGCCGATTACGTG		Down*
Dx2R (reverse)	AGTATGAAACCTGCTGCGGAG	664	2+12
Dx5R (reverse)	AGTATGAAACCTGCTGCGGAC		5+10
GluB1	*Z.A. Lei et al. J Cereal Sci 43:94-101 (2006)*		
Glu1By8_F5	TTAGCGCTAAGTGCCGTCT	527	64°C
Glu1B_R5	TTGTCCTATTTGCTGCCCTT		
Glu1By9_F1	TTCTCTGCATCAGTCAGGA	662 / 707	59°C
Glu1B_R3	AGAGAAGCTGTGTAATGCC		
Glu1By9_F7	TACCCAGCTTCTCAGCAG	0/2/3	59°C
Glu1B_R6	TTGTCCCGACTGTTGTGG	bands	
Glu1By9_F2	GCAGTACCCAGCTTCTCAA	0/2/3	62°C
Glu1B_R2	CCTTGTCTTGTTTGTTGCC	bands	
Bx7 over-expression	*Guttieri, 2008, PAG poster*		
Bx7oe_L1	GCGCGCTCAACTCTTCTAGT	404 / 447	64°C
Bx7oe_R1	CCTCCATAGACGACGCACTT		

Primers	*Sequence*	*Product*	*RXN*
	Low Molecular Weight Glutenins		
	Zhang et al, Theor Appl Genet (2004) 108:1409–1419		
GluA3F1	GTACGCTTTTGTAGCTTGTGC	1,414	59°C
GluA3R1	TCCATCGACTAAACAACGGAGA		
GluA3F1	As above	1,346	59°C
GluA3R2	GATGCCAACGCCTAATGGCACAC		
GluA3F1	As above	596	59°C
GluA3aR	TGGTGGTTGTTGTTGTTGCTACA		
GluA3bF	CACAATTTTCACAGCAACAGCAG	823	59°C
GluA3bR	GGCACATTGACACTACACATTG		
GluA3bF	As above	196	59°C
GluA3cR	TTGGTGGCTGTTGTGAAGACGA		
GluA3dF	ACCAGTTATTCATCCATCTGCTC	488	59°C
GluA3dR	GTGGTTTCGTACAACGGCTCG		
GluA3eF	CAATGAAAACCTTCCTCGTCTG	1,151	59°C
GluA3R2	As above		
GluA3F1	As above	1,101	59°C
GluA3fR	GTTGCTGCTACAACTGCTGTA		
GluA3gF	CAGCAGCCACCACATTCGCAA	861	59°C
GluA3R2	As above		
Gliadins	*Zhang Theor Appl Genet 107:130-138*		
GligDF1	AAGCGATTGCCAAGTGATGCG	264	56°C
GligDR1	GTTTGCAACACCAATGACGTA		
GligDF1	AAGCGATTGCCAAGTGATGCG	270	56°C
GligDR2	GCAAGAGTTTGCAACAGCG		
Rye translocation	*deFroidmont, Journal of Cereal Science 27 (1998) 229–232*		Touch
O11B3	GTTGCTGCTGAGGTTGGTTC		Down*
O11B5	GGTACCAACAACAACAACCC	412	
SECA2	GTTTGCTGGGGAATTATTTG		
SECA3	TCCTCATCTTTGTCCTCGCC	632	

Primers	*Sequence*	*Product*	*RXN*
1B/1R & 1A/1R	*Saal and Wricke, 1999. Genome 42:964-972*		
SCM9_L_M13	CACGACGTTGTAAAACGACTGACAACCCCCTTTCCCTCGT	227/243	Tailed
SCM9_R	TCATCGACGCTAAGGAGGACCC		Reaction*
Waxy - GBSS	*Nakamura et al, Genome 45: 1150–1156 (2002)*		
AFC	TCGTGTTCGTCGGCGCCGAGATGG	425, 455, 497	65°C
AR2	CCGCGCTTGTAGCAGTGGAAGTACC		
BDFL	CTGGCCTGCTACCTCAAGAGCAACT	370, 389,	65°C
BRD	CTGACGTCCATGCCGTTGACGA	410,408	
BDFL	CTGGCCTGCTACCTCAAGAGCAACT	1,731, 2,307	65°C
DRSL	CTGTTTCACCATGATCGCTCCCCTT		
Tailed	Better to use M13-tailed AFC and BRD, analyze via capillary electrophoresis		
AFC_M13	**CACGACGTTGTAAAACGAC**TCGTGTTCGTCGGCGCCGAGATGG		
BDFL_M13	**CACGACGTTGTAAAACGAC**CTGGCCTGCTACCTCAAGAGCAACT		
Pre-harvest sprout	*Yang, Y., et al, TAG (2007) 115:971-980*		
Vp1BF	TGCTCCTTTCCCAATTGG	652	61°C
Vp1BR	ACCCTCCTGCAGCTCATTG	569, 845	Tolerant
Milling QTL	*Souza, PAG 2009*		
	Softness Equivalent/Break Flour Yield		reaction*
barc10L_M13TAIL	**CACGACGTTGTAAAACGAC**GCGTGCCACTGTAACCTTTAGAAGA		73°C
barc10R	GCGAGTTGGAATTATTTGAATTAAACAAG	300/303	60°C
	Straight Grade Flour Yield		
barc98L_M13TAIL	CACGACGTTGTAAAACGACCCGTCCTATTCGCAAACCAGATT		
barc98R	GCGGATATGTTCTCTAACTCAAGCAATG	171/174	60°C

*PCR reaction conditions vary by laboratory and equipment. The SWQL is happy to share its PCR conditions upon request.

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Large Allis Milling Data Tables

Quality Characterization of Wheat Cultivars

Alphabetically Sorted Excel File of Wheat Cultivar Data, Grouped by Market Class. The attached file is:

2008 Allis Summary Table.XLS

Table 16. Genotypic correlation coefficients (*r*) among traits in Allis database.

	Flour Yield	ESI	Friability	Flour Ash	Break Flour	Cookie Diameter	Flour Protein	Lactic Acid SRC†
Normalized Test Wt.	0.111 ***	-0.075 *	NS	NS	-0.489 ***	-0.297 ***	0.161 ***	0.182 ***
Flour Yield	--	-0.911 ***††	0.755 ***	NS	-0.113 ***	0.227 ***	NS	-0.171 ***
ESI		--	-0.813 ***	0.158 ***	NS	-0.298 ***	0.187 ***	0.117 *
Friability			--	-0.204 ***	0.140 ***	0.406 ***	-0.292 ***	NS
Flour Ash				--	NS	NS	0.193 ***	-0.177 ***
Break Flour					--	0.544 ***	-0.449 ***	NS
Cookie Diameter						--	-0.394 ***	-0.208 ***
Flour Protein							--	-0.140 **

†lactic acid SRC adjusted to 9% protein basis
†† NS, Non-significant, *, **, *** significant at $p < 0.05, 0.01, 0.001$

Table 17. Recent cultivars (since 1995) with high break flour yield† on the Allis Chalmers mill.

Absolut	Coker 9184	Magers	Stine 484
AG 2020	Croplan 594W	Monarch	Stine 488
AGI 202	Cyrus	OH 515	Stine 501
AGI 538	Daisy	Pioneer 25R47	T 71
Anthony	Ernie	Pioneer 25R57	TS 3060
Arise X17	FS 530	Quantum 708	TS 6020
Armor 4045	G3566	Raven	TS 8040
Bascom	Garfield	Reo	T 71
Beck 102	Genesis 9511	RS 901	TS 3060
Beck 103	Genesis 9821	RS 917	TS 6020
Beck 107	Genesis 9939	Raven	TS 8040
Beck 110	GL 9400	Reo	USG 3592
Beretta	GR 962	RS 901	Voris 8044
Big Red	GR 983	RS 917	W 120
Bowerman	Hoffman 14	RS 987	W 150
Branson	Hopewell	RW 1487	W 9420
Brazen	HS 222R	RW 1488	W 9501
Cedar	INW 0102	RW 1505	W 9710
Citron	INW 0123	RW 1517	W 9830
Clemens	INW 0303	SC 1330	W 9850
Clemson 201	Jacob	SC 1343	Warwick
CM 529	Julie IV	Schultz 130	Willcross 795
CM 539	Kilen	Shiloh	Wilson
CM 569	L 409	SR 211	Wisdom
CM 577	LG 1388	SR 216	Wonder
Coker 9025	LG 1433	Steyer 1809	X4-261

†Top 25% of cultivars for break flour yield (>34.4%).

Table 18. Recent SRW cultivars with high friability[(k)†] upon Allis Chalmers milling.

527 W	Excel 400	Neuse	Succession
556 W	FFR 566W	OH 515	Sunsation
Absolut	Foster	OH 708	Terral LA 422
AGI 525	FS 332	Pat	TS 4020
AGI 535	FS 527	Pioneer 2552	TS 8040
AGS 2000	FS 530	Pioneer 25R23	USG 3650
AR 910	FS 539	Pioneer 25R47	Venture
Arise W33	FS 569	Pioneer 25R49	W 111
Arise X17	Genesis 9511	Pioneer 25R54	W 115
Armor 3035	Genesis 9959	Pioneer 26R46	W 121
Armor 4045	Goldberg	Pocahontas	W 9140
Bascom	GR 983	Raven	W 9830
Beck 107	H 101	Roazon	W 9850
Beck 108	Hoffman 37	RS 909	W 9940
Besecker	Honey	RS 931	Wisdom
Clemens	INW 0315	RW 1480	Wonder
CO 9184	Jaypee	RW 1498	Wonderly
Coffman	Julie IV	RW 151	X4-261
Coker 9152	Kilen	SG 1555	
Cooper	Kristy	SG 1560	
Cropland 514	L 15	SR 215	
Daisy	LG 1433	SR 218	
Dyna Gro 246	Magers	SS 520	
Dyna Gro 419	Merrell	SS 8404	
Dyna Gro 422	Mitchell	Steyer 1809	
Elkhart	MO 011126	Stine 482	
Emmit	Monarch	Stine 501	
Excel 300	MPG 7921	Stine 902	

† Friability > 29.5%; top 25% of newer cultivars.

Table 19. Recent SRW cultivars with low friability(I)† upon Allis Chalmers milling.

AG 2012	Dyna Gro 411	Patriot 210	Stine 455
AG 2020	Ernie	Pioneer 2568	Stine 479
AGI 201	Falcon	Pioneer 25R18	Stine 484
AGI 204	FFR 36803	Pioneer 25R35	Strike 205
Anthony	FFR 558	Pioneer 25R37	Stuckey
Beck 103	FS 309	Quantum 706	SW 403
Beck 110	FS 329	Quantum 708	SW 873
Beck 117	G2500	Quantum 7203	Truman
Benjamin	Gator	Rachel	TS 3060
Benton	Genesis 9953	Reino	TS 4040
Beretta	Gregory	Roane	USG 3209
Big Red	Harold	Rowland	USG 3408
Bounty	Hoffman 14	RS 901	USG 3555
Bradley	Hoffman 57	RS 917	Vigoro 9222
Brave	INW 0123	RS 947	Vigoro 9510
Brazen	INW 0301	RS 949	Vigoro 9512
Cedar	INW 0412	RS 987	Voris 8044
Chesapeake	INW 9531	RW 1487	W 130
Choptank	INW 9824	Santee	W 150
Clemson 201	Kaskaskia	SC 1325	W 9710
CM 577	Lisbo	SG 1530	W 9910
CO 9553	MacMillian	Shiloh	Warwick
Coker 9553	Natchez	SR 211	Webster
Coker 9663	Navigator	SR 219	Wiley
Cumberland	Panola		
Cyrus			
Dawson			
Declaration			

† Friability < 27.9%; lowest 25% of newer cultivars.

Table 20. Recent SRW cultivars with low lactic acid SRC† (from the Allis Chalmers milling database).

AGI 201	Douglas	Patton	SR 216
AGI 525	Dyna Gro 411	Pioneer 25R18	SR 218
AGI 535	Dyna Gro 419	Pioneer 25R23	Steyer 1809
AR 910	Emmit	Pioneer 25R35	Stine 480
Armor 4045	Excel 200	Pioneer 25R57	Stine 901
Autumn	Excel 300	Pioneer 26R58	Sunsation
Bascom	FFR 558	Pryer	Terral LA 422
Beck 102	FS 200	Rosco	USG 3342
Beck 110	Goldberg	RS 909	Vigoro 9212
Benton	GR 9956	RS 931	W 101
Bernard	H 101	RW 1480	W 115
Bowerman	Honey	RW 1488	W 9920
Bravo	INW 0304	RW 1498	W 9940
Brazen	INW 0315	Sabbe	W 9950
Choptank	INW 0316	SC 1330	Weaver
Citron	INW 9824	SC 1343	Willcross 738
Coffman	Jentes	Schultz 130	Willcross 795
Coker 9375	Mitchell		Wonderly
Coker 9436	MPV 57		
Cooper			

† Protein-adjusted lactic acid SRC < 86.4%; lowest 25% of newer cultivars.

Table 21. Recent SRW cultivars with high lactic acid SRC[†](from the Allis Chalmers milling database).

AG 2012	FFR 36803	Pioneer 25R63	TS 4040
AGI 301	FS 539	Pioneer 2643	USG 3555
AGI 521	Gator	Pioneer 26R15	USG 3592
AGS 2060	Gibson	Pioneer 26R24	USG 3706
Arise W34	Gregory	Pioneer 26R46	Venture
Beretta	Hartman	PS 1359	Vigoro 9222
Besecker	HS 243R	Rachel	Vigoro 9412
Bouillon	HTW 215	Raven #2	Vigoro 9510
Campbell 9455	INW 0101	Renwood 3260	W 111
CO 9184	INW 0102	Renwood 3706	W 126
CO 9312	INW 0412	Savage	W 132
CO 9553	INW 9853	SC 1352	Warrior
Coker 9184	Jacob	SG 1530	Warwick
Coker 9295	Jamestown	SR 219	Wiley
Coker 9553	Julie IV	SS 520	Wilson
Coker 9704	Kaskaskia	SS 8302	Wisdom
Crawford	Magnolia	SS 8308	
Cropland 514	MO 011126	Stine 455	
Dominion	Navigator	Stine 902	
Dyna Gro 403	Pioneer 25R26	SW 873	
Elkhart	Pioneer 25R44	Tribute	
Featherstone 176	Pioneer 25R54		
Feck			

[†] Protein-adjusted lactic acid SRC > 102.3%; top 25% of newer cultivars.

Regional Summaries Provided to the Wheat Industry

Quality Characteristics of Regional Nursery Entries

Each year, wheat breeders submit elite breeding materials to cooperative yield trials known as Regional Nurseries, which are grown by other programs throughout the target production region. Grain samples from some of these nurseries are evaluated each year by the SWQL, and this information is provided to breeders in the Regional Nursery Reports as well as being posted on the SWQL website.

Narratives describing recent quality evaluations are provided below and summary tables for are attached with this document as indicated.

Regional Performance Nurseries

2008 Uniform Southern Nursery – Samples provided by Steve Harrison (Attached Excel File 2008A07 Uniform Southern Nursery.xls)

A total of 42 samples were grown at collection of interior locations; the normal division of coastal locations was not included. The standard data is compared to the "historical average" for the cultivar, and quality scores for all entries are adjusted to this average. The samples in this nursery were compared to entry AGS 2000. Of the 830 cultivars in the SWQL database of Allis-milled cultivars, AGS 2000 ranks 25th for Milling Score based on data from 5 millings.

In this trial AGS 2000's quality was within the expectations of the cultivar based on comparison to Advanced quality evaluations since 2006. Pioneer 26R61, Coker 9553, and USG 3555 all have been evaluated before but have a smaller set of observations than AGS 2000 and therefore we have not presented comparisons to the means in the historical dataset. Generally the cultivars are consistent with their previous performance. Comparisons to previous cookie bakes are not presented due to changes in evaluations noted below. Very limited weathering and Fusarium affected kernels were present in the sample. No obvious pre-harvest sprouting was observed in the set.

Evaluation of Breeding Lines

In long-flow milling evaluations for the US Wheat Associates Overseas Varietal Analysis, Coker 9553 has had acceptable milling but has been at the lower end of acceptability for milling quality. In this trial it had a flour yield of 68.3%. Any line with significantly lower flour yield is likely to be unacceptable for milling quality if released as a cultivar. These lines include VA05W-250, MD01W233-06-16, M04-4715, and W98008P1. In this set, lines had a wide range of softness equivalent and selection for the trait would result in improved quality wheat. Only two breeding lines, P04287A1-10 and G41732, appeared not to fit the normal range for soft wheats and likely are unacceptable for break flour yield. Based on milling yield and softness equivalent (greater values preferred) and sucrose SRC (lower values preferred), the best quality wheat lines in this trial were LA01140D-70, GA991209-6E33, GA991371-6E13, and GA991227-6A33. They represent improvements to the average quality of soft wheats produced in the eastern US and may have value as crossing parents or cultivars if their agronomic and disease resistance characteristics are desirable.

None of the check cultivars are generally considered strong gluten cultivars. In this data set some of the samples appeared weathered and some did not. Lactic acid, a measure of gluten strength, is normally elevated with weathering and can give a false reading on the genetic potential of gluten strength. In a set where differential weathering has occurred, lactic acid scores should be evaluated and compared against other information about the cultivar before basing selection decisions on the lactic acid values. In this set the breeding lines with good milling quality (70% or greater) the strongest gluten lines were: NC04-15533, NC04-20814, AR96077-7-2, M04*5109, D04-5012, and G61505. These lines have good softness equivalents and should have acceptable quality for most products. However, they may have additional value for cracker production.

2008A14 Uniform Eastern Winter Wheat Performance Nursery, Composite of Three Locations, Jose Costa coordinator for quality samples. (Attached Excel file 2008A14 Uniform Eastern Nursery.xls)

A total of 45 samples were provided by Jose Costa as a composite of two locations. Samples from Wooster OH were composited with the samples shipped to provide the final composite for milling for each of the genotypes. The standard data is compared to the "historical average" for the cultivar, and quality scores for all entries are adjusted to this average. The samples in this nursery were compared to entry Roane. Of the 831 cultivars in the SWQL database of Allis-milled cultivars, Roane ranks 208th for Milling Score based on data from 18 millings. In comparing all the checks, test weights were lower than average for all three checks and softness equivalents greater than normal for two of the three. The composited samples had some weathering and sprouting that likely contributed to the reduction in test weight of samples and the increase in softness equivalent. The inspection of the grain condition identified 0% to over 10% tombstoned kernels in the samples. Aspiration likely minimized the impact of the disease on end-use quality.

Evaluation of Cultivars and Breeding Lines

Milling yield and softness equivalent are the most heritable traits evaluated by the Soft Wheat Quality Laboratory. Based on comparisons to the historical advanced milling sets, the ranking for the checks for milling quality is: INW0411 is similar to Branson, and Roane is poorer. The measured milling quality for the checks in this trial matched the historical rankings. Based on this any line significantly lower than Branson (<67.8% Flour yield), will have lower than normal flour yield and may have poor milling quality. Similarly, softness equivalent is measure of break flour yield on commercial mills and is negatively correlated to the particle size of flour. Small particle size is a desirable characteristic in soft wheat, particularly for cakes. Three lines had very low softness equivalent and would likely be poor for cakes: P04287A1-16, IL02-18228, and G41730.

The six breeding lines in the nursery had a good combination of flour yield (>70.0%), softness equivalent (>58.3%, the nursery ave.), sucrose SRC (<98.8, the nursery ave.), and cookie diameter (>18.4, the nursery average). The lines were VA03W-412, IL00-8530, MD99W483-06-9, VA05W-414, 21525c1*, and M04-4566. They would be expected to perform better than average in a wide range of cookie and cake formulations. A number of the lines were strong gluten types with lactic acid SRC values above 120%. These lines may have application in cracker products and other soft wheat foods that require leavening. Among the lines with strong gluten, the best quality lines for gluten and milling characteristics were IL00-8530, MO040152, M04-4802, and M04*5109. The lines highlighted good quality experimentals would like serve as sources of improved milling and baking quality in subsequent crossing programs for improved cultivars.

2008A06 Gulf Atlantic Wheat Nursery (GAWN) Samples Provided by Jerry Johnson:
(Attached Excel file 2008A06 Gulf Atlantic Wheat Nursery.xls)

A total of 17 samples were grown at Wooster OH. The standard data is compared to the "historical average" for the cultivar, and quality scores for all entries are adjusted to this average. The samples in this nursery were compared to entry Hopewell. Of the 767 cultivars in the SWQL database of Allis-milled cultivars, AGS 2000 ranks 25th for Milling Score based on data from 5 millings. USG 3209 was also compared to its performance in the Advanced Database. Some weathering was observed in the set, but no sprouting was recorded. The test weight of the check cultivars was approximately a 1.5 lbs less than average. While not unusual it suggests that some loss of test weight likely occurred during the weathering process.

Flour yields for both checks are less than 2 standard deviations from the mean but they are lower than normal. Rankings for the checks for all quality scores except softness equivalent are similar to database averages. AGS 2000 and USG 3209 both have had similar softness equivalents in database evaluations. However, in this set AGS 2000 has a significantly greater softness equivalent value than USG 3209. This suggests that relative values for most of the quality evaluations can be used to rank cultivars correctly. Selection of genotypes based on the measured performance for quality should result in an expected response to selection. Generally, the most reproducible trait for selection is adjusted flour yield followed by softness equivalent and the SRC valuates. Environmental factors may be causing the softness equivalent scores to have great spread in values than is normally observed.

Evaluation of Breeding Lines Any of the breeding lines with less flour yield than USG 3209 (<68%) likely are genetically conditioned for low flour yield. Similarly, lines with very low softness equivalent (<50%) likely will not produce flour that is consistent with normal soft wheat targets. In this trial the effect of the low softness equivalent is obvious in the very small cookie diameters of lines with softness equivalents of less than 52%. Genotypes that are poor for all three measures, milling yield, softness equivalent, and cookie diameter, likely are unacceptable for most soft wheat uses.

Based on observations for these three traits plus sucrose SRC, the best quality soft wheat lines in this set are: FL01005-K5, SCW990022A1, GA011636-2, VA06W-256, LA01140D-163 and LA01113D-44. The strongest gluten quality lines in the nursery are NC05-24757, VA05W-139, VA06W-194, AR99136-13-2, and FL01108C-K2. These lines have good softness equivalents and should have acceptable quality for most products. However, they may have additional value for cracker production. All of the strong gluten lines in this set are below optimum for milling yield.

2008A10 Mason-Dixon Regional Nursery, Samples Provided by David Van Sanford
(Attached Excel file 2008A10 Mason-Dixon Nursery.xls)

A total of 60 samples were grown at Lexington Kentucky. The standard data is compared to the "historical average" for the cultivar, and quality scores for all entries are adjusted to this average. The samples in this nursery were compared to entry Pioneer 25R47. Of the 767 cultivars in the SWQL database of Allis-milled cultivars, Pioneer 25R47 ranks 149th for Milling Score based on data from 4 millings.

Branson and Tribute also were compared to their performance in the Advanced Database. Some weathering was observed in the set, but no sprouting was recorded. On the whole the set was in good condition and the checks aligned well with the historical values. The softness equivalents of Pioneer 25R47 and Branson were greater than normal, while Tribute was normal for softness equivalent. Similarly, Pioneer 25R47 and Branson had lower than normal flour protein concentration, while Tribute was normal for flour protein concentration. The ranking of the cultivars was correct for softness equivalent and flour protein for the three checks. Generally, the most reproducible trait for selection is flour yield followed by softness equivalent and the SRC valuates. Environmental factors may be causing the softness equivalent scores to have great spread in values than is normally observed.

Evaluation of Breeding Lines Tribute had a milling yield of 68.4%. Any wheat lines that were significantly poorer than Tribute for milling yield (<67.6%) are likely to be unacceptable for milling yield in commerce. Softness equivalent is normally a reliable indicator of quality. In this set lines had a wide range of softness equivalent and selection for the trait would result in improved quality wheat. Only two breeding lines, the sibs MD00-W16-07-2 and MD00-W16-07-3, appeared not to fit the normal range for soft wheats and likely are hard genotypes. Based on milling yield and softness equivalent (greater values preferred) and sucrose SRC (lower values preferred), the best quality wheat lines in this trial were KY97C-0519-04-05, MD00W389-07-2, MD98W63-07-1, MD98W63-07-2, VA03W-509, and VA06W-256. They represent improvements to the average quality of soft wheats produced in the eastern US and may have value as crossing parents or cultivars if their agronomic and disease resistance characteristics are desirable.

Pioneer 25R15 and Tribute are generally considered strong gluten cultivars. In this data set some of the samples appeared weathered and some did not. Lactic acid, a measure of gluten strength, is normally elevated with weathering and can give a false reading on the genetic potential of gluten strength. In a set where differential weathering has occurred, lactic acid scores should be evaluated and compared against other information about the cultivar before basing selection decisions on the lactic acid values. In this set the breeding lines with acceptable milling quality that also had gluten strength greater than Tribute and similar to Pioneer 25R15 were KY97C-0540-01-03, KY98C-1446-02-1, MD00W389-07-2, MD99W13-07-1, and VA06W-423. These lines have good softness equivalents and should have acceptable quality for most products. However, they may have additional value for cracker production.

Regional Fusarium Head Blight Nurseries

2008 M06 Northern Uniform Winter Wheat Scab Nursery, samples provided by Herb Ohm
(Attached Excel file 2008M06 Northern Uniform Winter Wheat Scab Nursery.xls)

A total of 60 samples were grown by Purdue University in Indiana for this regional cooperative nursery sponsored by the US Wheat and Barley Scab Initiative. Funding for the evaluation was provided by the USWBSI. The standard data is compared to the "historical average" for the cultivar, and quality scores for all entries are adjusted to this average. The samples in this nursery were compared to entry Truman. Of the 767 cultivars in the SWQL database of Allis-milled cultivars, Truman ranks 552nd for Milling Score based on data from 2 millings. In general, the three checks were within two standard deviations of the mean of their database average. The exception is the test weight of Truman is significantly less than the database average. Most of the samples were weathered (exposed to moisture after harvest). They did not appear to be sprouted, however the flour yield was less than average with significantly greater sucrose SRC value for Truman a slight elevation in Freedom. As a result, the results of this trial are likely to be internally consistent for milling characteristics. However, the ranking for sucrose SRC may have some cross-over GxE effects that may limit a breeder's ability to select heavily using that measure in this test. As a set, the nursery average for flour yield and flour quality was similar to Truman with better baking scores than Truman, due primarily to the elevated sucrose SRC of Truman.

Evaluation of Breeding Lines Milling yield is the most heritable of the traits that we evaluate. In this set lines with milling yield marked with a Q or a '*' are poor for milling quality; that is, their flour yield is likely significantly less than Truman, which is near the lower range of the targeted milling yield. The line KY97C-0321-05-2 is unusual in having a 40% flour extraction. We will remill the sample and see if it is what it seems to be. Lines with softness equivalent values below 50% are generally considered to be poor for a wide range of soft wheat products. They tend to be particularly poor for cakes.

Within this nursery the lines with the best combination of milling yield, softness equivalence, and sucrose SRC are: MSU LINE E5011, MO 050921. NYCALRESEL-L, NYW103-1-9100, SE93-1094-8, OH03-235-2 and Malabar (OH02-7217). The lines with very high softness equivalent (56% and greater) and low sucrose SRC (less than 90%) likely are well suited to cake applications. The lines SE89-1873-2, OH03-235-2, M04-4802, and KY00C-2059-16 had generally good milling and flour quality with greater than normal gluten strength as measured by lactic acid SRC. These lines may have some specialty applications for products such as crackers.

Coupling the Fusarium head blight resistance information to the quality data will give an index for selecting crossing parents. Among the lines with lower FHB index than Freedom, the following lines had the best milling and flour quality: IL04-10118, IL04-10721, IL04-10741, KY00C-2143-08, M03-3616-B11, MO 050921, and Malabar (OH02-7217). The milling and flour quality selection was based on adjusted flour yield, softness equivalent, and sucrose SRC.

2008M08 Southern Uniform Fusarium Head Blight Nursery, samples provided by Ben Edge, Clemson University
(Attached Excel file 2008M08 Southern Uniform Fusarium Head Blight Nursery.xls)

A total of 52 samples were grown by Clemson University in South Carolina for this regional cooperative nursery sponsored by the US Wheat and Barley Scab Initiative (USWBSI) and the North American Millers Association. Funding for the evaluation was provided by the USWBSI. The Fusarium head blight data included on the score sheet was provided by Paul Murphy based on the average of information provided by cooperators for the nursery. The standard quality data was compared to the "historical average" for the cultivar, and quality scores for all entries are adjusted to this average. The samples in this nursery were compared to entry Ernie. Of the 831 cultivars in the SWQL database of Allis-milled cultivars, Ernie ranks 722nd for Milling Score based on data from 8 millings. The samples had limited weathering of grain, no observed pre-harvest sprouting, and very limited kernels affected by Fusarium. In general, the two checks were within two standard deviations of the mean of their database average. The exception is the baking scores based on the sucrose SRC values. Ernie's sucrose SRC value was significantly greater than normal compared with the Advanced Milling database. However, its Baking Quality Score was similar to Allis Database. In this nursery, a cross-over between the checks occurred for expected performance for both Lactic acid and Sucrose SRC. The milling and softness equivalent ratings should be used as the primary selection criteria for evaluating the quality of a cultivar. The solvent retention capacity levels of cultivars in this trial may not be characteristics of the cultivar's performance in other environments and should be used as a secondary selection trait only.

Milling yield is the most heritable of the traits that we evaluate. Ernie is generally considered poor for flour extraction. New cultivars with Fusarium resistance should have improved flour yield relative to Ernie. Lines with flour yield of 68% are likely to be cultivars with poor flour extraction. Lines with softness equivalent values below 50% are generally considered to be poor for a wide range of soft wheat products. They tend to be particularly poor for cakes. In this set the North Carolina samples with softness equivalents below 40% are likely true hard wheats.

Within this nursery the lines with the best combination of milling yield, softness equivalence, and sucrose SRC are: AR 97002-10-2, ARGE97-1047-2, D04*5546, GA031454-DH7, M03-3616B, M04*5109. The lines with very high softness equivalent (56% and greater) and low sucrose SRC (less than 90%) likely are well suited to cake applications. M04*5109 had good milling and flour quality with greater than normal gluten strength as measured by lactic acid SRC. This line may have some specialty applications for products such as crackers.

Coupling the Fusarium head blight index and severity information (Averaged across all locations) to the quality data will give an index for selecting crossing parents. Among the lines with FHB index and severity similar to Ernie, the following lines had the best milling and flour quality: AR 97002-2-1, LA01162D-131-8-B, NC05-21090, and M03-3616B. The milling and flour quality selection was based on adjusted flour yield and softness equivalent.

State Performance Nurseries

2007A16 Soft Wheat Quality Laboratory Wheat Quality Plots, USDA-ARS Wooster Ohio
(Attached Excel file 2007A16 SWQL Wheat Quality Plots.xls)

The Soft Wheat Quality Laboratory collects samples of new and old cultivars for evaluation at Wooster to provide baselines for comparison to nurseries provided by other researchers. Samples are harvested at 20% moisture, prior to rain events and then dried to 10% to 14% moisture for storage and cleaning. Samples this year had light amounts of *Fusarium* in the grain and no obvious signs of weathering or preharvest sprouting. In many years these samples are used for Allis Milling evaluation. Due to retirements and delay in rehiring, no Allis milling was conducted on this set. However, all four SRC solvents were evaluated to provide full flour evaluation. This nursery, the Association Mapping nursery, and the other state nurseries described below will be used for a new database to provide the industry with a more rapid profile of cultivars currently in the marketplace.

2008A01 Ohio Wheat Yield Performance Nursery Wooster OH, Samples provided by Rich Minyo, Ohio State Univ.
(Attached Excel file 2008A01 Ohio Wheat Yield Performance Nursery.xls)

Samples from the extension nursery produced by Ohio State University were submitted to the SWQL. The standard check cultivars Hopewell, Pioneer 25R47, and Tribute all had below average milling yield and above average softness equivalent. This is consistent with some weathering occurring in the trial. In comparing all the checks, test weights were lower than average for all three checks and softness equivalents greater than normal for two of the three. The composited samples had some weathering and sprouting that likely contributed to the reduction in test weight of samples and the increase in softness equivalent. The inspection of the grain condition identified 0% to over 10% tombstoned kernels in the samples. Aspiration likely minimized the impact of the disease on end-use quality.

We have combined the 2008 evaluations at Wooster with the 2007 Wooster nursery data to create two year averages for the nursery. Grain yield performance data from the field trials were also included in the spreadsheet for comparison of lines.

2008A16 Illinois Variety Trial, University of Illinois, Urbana and Brownstown Locations.
Cooperator: Emerson Nafziger and Darin Joos. Samples facilitated by Fred Kolb
(Attached Excel file 2008A16 UI Wheat Variety Trial – Urbana and Brownstown.xls)

A total of 64 samples were grown at Urbana IL and 60 at Brownstown IL. Only 41 of the cultivars were in common between the two locations. The standard data is compared to the "historical average" for the cultivar, and quality scores for all entries are adjusted to this average. The samples in this nursery were compared to entry Patterson. Of the 831 cultivars in the SWQL database of Allis-milled cultivars, Patterson ranks 208th for Milling Score based on data from 18 millings.

Other check cultivars that were summarized included Pioneer 25R47 and Truman. The comparison of those cultivars to the Advance Database is given on the worksheets title Historical for each location. In comparing all the checks, test weights for both of these locations were lower than average and softness equivalents greater than normal. Both locations had some weathering and sprouting that likely contributed to the reduction in test weight of samples and the increase in softness equivalent. The inspection of the grain condition identified 0% to over 10% tombstoned kernels in the samples. Aspiration likely minimized the impact of the disease on end-use quality. However, Fusarium affected kernels still likely contributed to a reduction in the milling quality scores and test weight, particularly at Brownstown, which appeared to have a greater incidence of Fusarium affected kernels than did Urbana.

Additional information about these extension trials is posted at: http://vt.cropsci.uiuc.edu/wheat.html. Grain yield from this web-site has been included on the score sheets.

Evaluation of Cultivars and Breeding Lines Evaluation of means across locations can provide a more reliable estimate of the genetic potential of a cultivar's milling and baking quality. In this trial, the following comments are based on the two location averages for the 41 cultivar planted in two locations. Based on other evaluations, Patterson and Pioneer 25R47 are considered to be excellent milling wheat cultivars and Truman below average but still acceptable. In this trial the average flour yield for the three cultivars were: Patterson – 71.6%, Pioneer 25R47 – 72.0%, and Truman – 68.4%. None of the cultivars were significantly poorer than Truman for flour yield. Any of cultivars with greater than 72% flour extraction are likely to have excellent flour yield when milled commercially. Softness equivalent is our best predictor of break flour yield. Larger values for break flour yield or softness equivalent are often indicators of cultivars that produce good cake flour. Pioneer 25R47 has an excellent softness equivalent and break flour yield. Lines that have softness equivalents within 4 % points of Pioneer 25R47's value (64.7%), also likely are very soft milling wheats with excellent break flour yields.

For this trial, we used all four of the SRC solvents. Selecting cultivars with low sodium carbonate SRC and sucrose SRC will identify lines that have good flour quality for most soft wheat quality products. Using these two traits in combination with the milling data, the best quality soft wheats in this trial for cookies or cakes are: EXCEL 209, Vigoro 9723, MWS 135, Lewis 830, FS 628, Pioneer 25R47, and Cooper. Cultivars that are used for cracker manufacture often require greater than average gluten strength as measured by lactic acid SRC. Cultivars with strong gluten, as measured by lactic acid that also had generally acceptable quality for other traits were: BECK 122, FS 628, IL00-8530, Lewis 830, MWS 135, Vigoro 9712, and Vigoro 9723. FS 628, Lewis 830, MWS 135, and Vigoro 9723 appeared in both of these lists. They may have adaptation to a broad range of soft wheat products. Given that cultivars appear under different brands several of these cultivars may be synonymous. Still, it appears you have a number of good quality cultivars for recommendation to growers, to millers, and for use in your future crossing programs.

2008A19 Michigan State University State Variety Trial, Cooperator: Lee Siler and Janet Lewis
(Attached Excel file 2008A19 MSU Wheat Variety Trial.xls)

The attached file has a summary of two year performance for Michigan in 2007 and 2008.

The bulk of the narrative pertains to the 2008 evaluation. A total of 123 samples were grown in Michigan as part of the statewide variety evaluation. The standard data is compared to the "historical average" for the cultivar, Hopewell, and quality scores for all entries are adjusted to this average. Of the 831 cultivars in the SWQL database of Allis-milled cultivars, Patterson ranks 710th for Milling Score based on data from 14 millings. Other check cultivars that were summarized included Branson and Roane. The comparison of those cultivars to the Advance Database is given on the worksheets title Historical for each location. The check cultivars in this trial appear to have lower flour yield and harder grain (lower softness equivalent) than normal although the milling yield is the only trait consistently out of tolerances for the cultivars. The relative ranking of the three cultivars for quality performance is correct for the milling traits; that is, Branson is the best milling wheat of the three checks, followed by Hopewell, then Roane. The selection of lines based on their milling performance is warranted based on the correct ranking of the checks. Selection for lines with greater flour yield in this trial will likely result in identification of cultivars with greater flour yield. The relative ranking of the cultivars for sucrose SRC does not follow the historical averages as closely as the milling data. The sucrose SRC for Branson is significantly greater than would be expected for the milling yield and softness equivalent scores of this cultivar. Selection using solvent retention capacity within this set is warranted, however it is expected to have a lower heritability than we normally report for the trait. Most heritability estimates for sucrose SRC or the other SRC variables typically are in the 75% to 95% range. In this trial, several cultivars were replicated so we can derive an error term based on the internal plot-to-plot variation of the trial. The ANOVA and means of replicated checks are presented on the worksheet titled 'Replicate Averages'. The sucrose SRC LSD (95%) is 5.7 g/100g, so lines that are different by more than that value truly are different for the pentosan concentration in the flour.

Evaluation of Cultivars and Breeding Lines Flour yield is the most heritable trait that we evaluate at the laboratory. Roane, with a milling yield of 68.5% in this trial, is generally considered to be a poor milling wheat. Lines that are performing poorer than Roane will likely have poor milling performance if released as commercial cultivars. Among the breeding lines in this category are the following MSU lines: E7023, E7024, E7035R, E7046R, E6001R, E6002, and E6055. The second trait that we recommend for use in selection is softness equivalent. This is an important predictor of break flour yield and for performance in cakes. Tribute typically is considered to be poor for softness equivalent. In this trial Tribute had a softness equivalent of 49.9%. Lines with softness equivalent values less than Tribute will likely have poor flour quality for the milling and baking industry if released as a commercial cultivar. Among the breeding lines in the trials the following MSU lines have questionable softness equivalent (poorer than Tribute): E5024, E6023, E7002, E7024, E7056R, E6002, E6003, and E6055.

Selecting sequentially for the following traits, greater flour yield, greater softness equivalent, reduced sucrose SRC, reduced water SRC, and larger cookie diameter identifies the following MSU breeding lines as having superior milling and baking quality: E2017, E3024, and E6045. They are similar to Ambassador, D8006, and Pioneer 25R47 for milling and baking quality. These are lines that have value as breeding parents and would improve the overall milling and baking quality of the soft wheat germplasm pool if they are superior for agronomic and disease resistance traits.

2007 Virginia State Wheat Test, samples provided by Carl Griffey, Virginia Tech.
(Attached Excel file 2007A24 Virginia Wheat Variety Trial.xls)

A total of 56 entries were analyzed from the State Wheat Test. These entries formed a single nursery and were all evaluated together. Entry #721422, MCCORMICK, was used as the standard for this group. Of the 830 cultivars in the SWQL database of Allis-milled cultivars, MCCORMICK ranks 375th for Milling Score based on data from 8 millings. The grain condition was judged prior to analysis and nearly all entries displayed evidence of FHB, however, amounts were generally low. Sprouting was generally not observed in the nursery. Very few entries showed signs of weathering. The samples were aspirated prior to milling and in most cases all shriveled grain was removed. Test weights tended to be somewhat higher than anticipated as many of the checks exceeded their historic test weights on the order of 1-to-2 lb/bu.

With regard to milling data, the checks produced typical flour yields as nearly all were within 1% of their respective historic values. S.E. values tended to indicate that the checks were a little softer than normal as many produced S.E. values that were 3-to-5% above their database values. With the exception of PION 26R24 and SS 520 which had typical cookie diameters, the remaining checks produced cookies that were often in excess of 0.7 cm larger than their historic values. As a result, 41.1 points were subtracted from each Baking Quality Score.

Evaluation of Cultivars and Breeding Lines We have used your State Trial as one of the first group for inclusion in a new database for making cultivar quality recommendations. We are using the advanced mill with a four solvent SRC evaluation and cookie bake. We will use this to complement our Allis Database. The Allis Database will still remain our internal Gold Standard for milling quality. The Four Solvent Database will include a broader range of genotypes from more states, replication of observations, and a more intense evaluation of flour. We have started this project because our repeated evaluation is that R2 values for milling yield between the Quad Advanced and Allis Mill were in the high 90's. Similarly, the prediction of Allis break flour yield by Quad Advanced flour yield had R2 values in the 90's. With the Quad Advanced system we can mill many more samples and have a faster turn around of cultivar evaluation. This seemed like a good year, with Lonnie Andrew's retirement, to begin something new. The other trial that will be included in this data set is the Association Mapping study. I will discuss the use and interpretation of the new database in greater depth at the research review.

Within this dataset lines that had flour yield 1% point or greater below USG 3209 likely are significantly poorer for flour yield. These include: NC00-15332(R) VA05W-668, VA05W-250, and VA04W-571. Using the sodium carbonate and sucrose SRC evaluation, the breeding lines with the poorest flour quality were: VA05W-125 and VA05W-258.

Based sodium carbonate and sucrose SRC evaluation, the lines with the best flour quality for soft wheat use were: SS5205, VA05W-436, and VA05W-414. Based on lactic acid SRC values, the lines with the strongest gluten were VA05W-436, VA04W-90, and SS 5205. However these lines were significantly weaker gluten than PIONEER 26R15 and RENWOOD 3260. Therefore these three experimental lines likely are not strong enough for use in a specialty milling program targeted at flour quality. However, these are relatively good quality and would be worth additional evaluation on their own merit.

2008 Quality Evaluation Council

Milling and Baking Evaluations

Milling and Baking Test Results for Ten Eastern Soft Winter Wheats Harvested in 2007

The Quality Evaluation Committee of the Soft Wheat Council
Edward Souza, Meera Kweon, and Scott Beil, USDA Soft Wheat Quality Laboratory

Objectives of Miag Milling New Soft Wheat Cultivars:

- Encourage wide participation by all members of the soft wheat industry.
- Determine, through technical consulting expertise, the parameters which adequately describe the performance characteristics which members seek in new variety.
- Promote the enhancement of soft wheat quality in new variety.
- Emphasize the importance of communication across all sectors and to provide resources for education on the continuous improvement of soft wheat quality.
- Encourage the organizations vital to soft wheat quality enhancement to continue to make positive contributions through research and communications.
- Offer advice and support for the U.S.D.A. - A.R.S. Soft Wheat Quality Laboratory in Wooster, Ohio

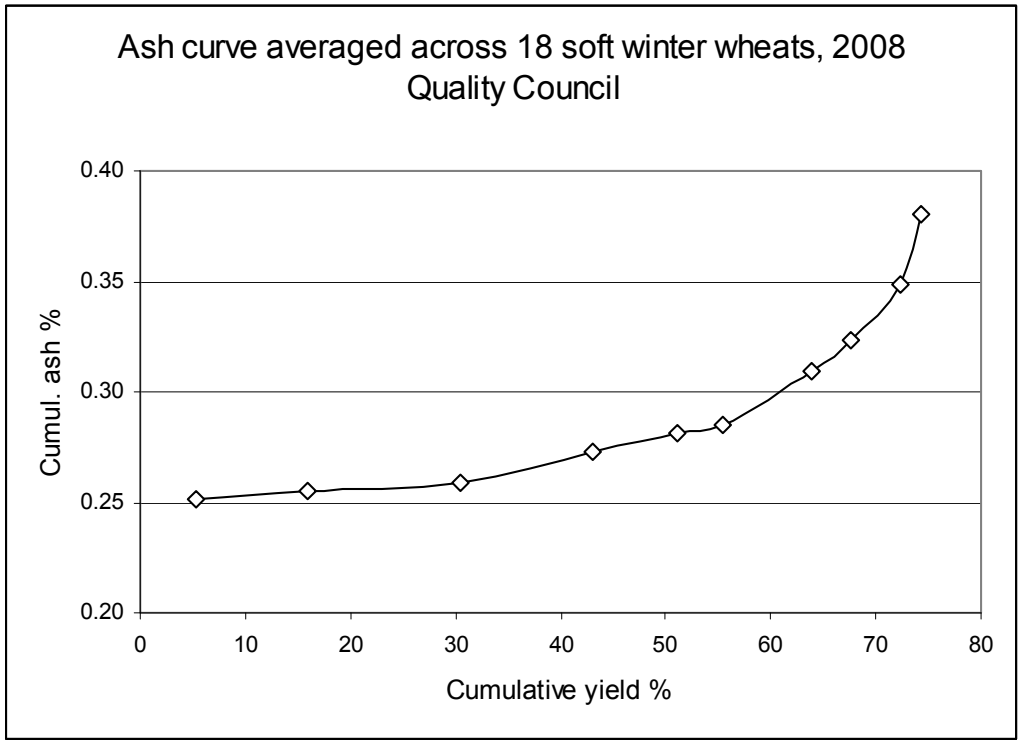
Milling Analysis and Ash Curves

Miag Multomat Mill

Milling was as described in the materials and methods section of this document.

Flour was collected from each of the 10 flour streams used to compose straight grade flour fractions. Flour ash on the fractions was determined using the basic method (AACC Method 08-01), expressed on 14% moisture basis. Then starting with the lowest ash flour streams, the percent flour recovery was estimated by arithmetically calculating the average ash and total flour recovery predicted by sequentially adding flour streams by order of their flour ash (lowest to highest). Those values are graphically represented in Figure 1.

Figure 1. Milling ash curves for eighteen soft winter wheat varieties, Wheat Quality Council samples for 2008. Cumulative flour streams in figures are arranged from the lowest ash stream to the highest ash stream. Tables are arranged with the lowest ash content stream to the highest ash content stream. Mill stream abbreviations are: 2RED – 2nd reduction, 1RED – 1st reduction, DUST – duster, 2BR – 2nd break, 1BR – 1st break, GRA – grader, 3RED – 3rd reduction, 3BR – 3rd break, 4RED – 4th reduction, 5th reduction, 5RED – 5th reduction, RD – Red Dog flour, HS – Head shorts, TS – Tail shorts, and Bran - Bran.



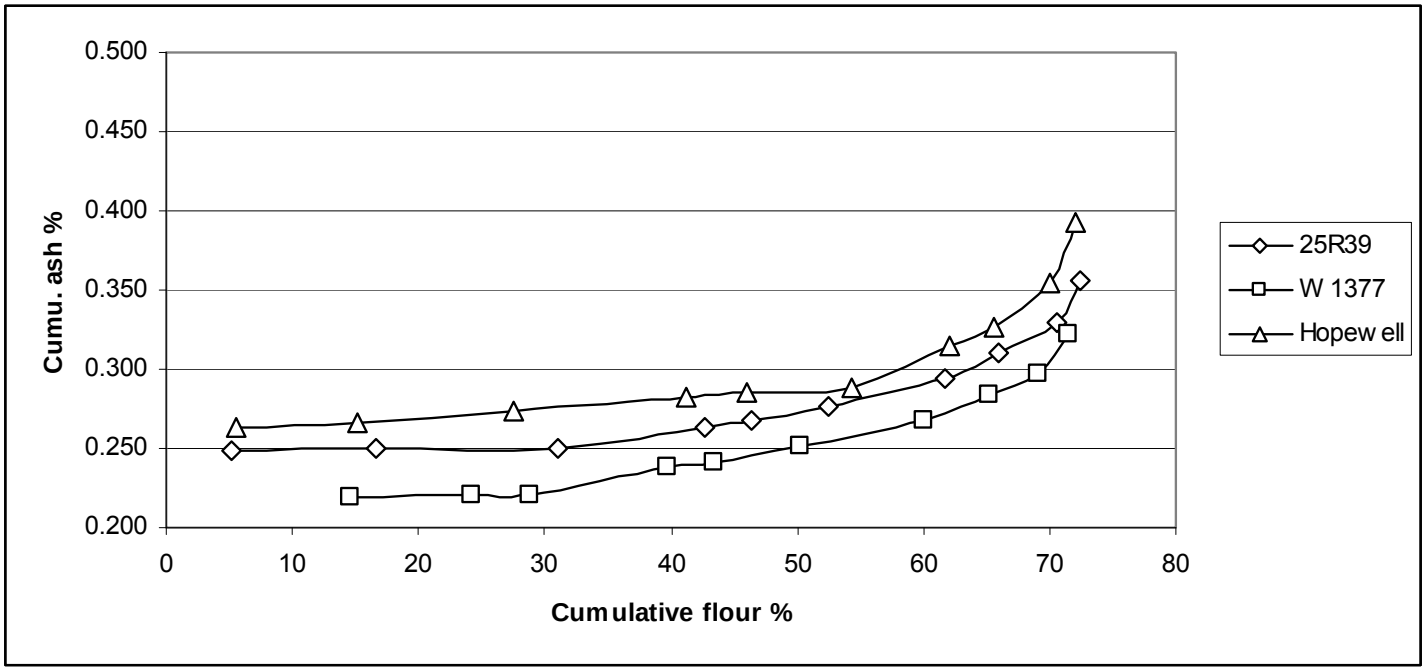
Ash and flour recovery from Miag Mill stream factions, averaged across 18 cultivars, Wheat Quality Evaluation Council samples, 2008

Mill stream	Ash %	Flour recovered %
Dust	0.251	5.4
1st Red	0.255	15.9
2nd Red	0.259	30.6
2nd Br	0.273	43.1
1st Br	0.281	51.0
Gra	0.285	55.4
3rd Red	0.310	63.9
3rd Br	0.323	67.6
4th Red	0.348	72.3
5th Red	0.380	74.3
RD	0.430	75.7
TS	0.448	76.2
HS	0.837	85.3
Bran	1.498	100.0

Ash curve for Pioneer 25R39		
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.249	5.2
1st Red	0.249	16.5
2nd Red	0.250	31.0
2nd Br	0.263	42.6
Gra	0.267	46.4
1st Br	0.276	52.5
3rd Red	0.294	61.7
3rd Br	0.310	65.9
4th Red	0.330	70.6
5th Red	0.356	72.5
RD	0.405	73.8
TS	0.423	74.2
HS	0.833	83.5
Bran	1.548	100.0

Ash curve for W 1377		
Mill stream	Cumulative ash %	Cumulative flour %
2nd Red	0.220	14.6
1st Red	0.220	24.1
Dust	0.220	28.7
2nd Br	0.238	39.7
Gra	0.242	43.4
1st Br	0.251	50.3
3rd Red	0.267	60.0
4th Red	0.285	65.2
3rd Br	0.297	69.0
5th Red	0.322	71.6
RD	0.375	73.2
TS	0.397	73.8
HS	0.827	84.4
Bran	1.433	100.0

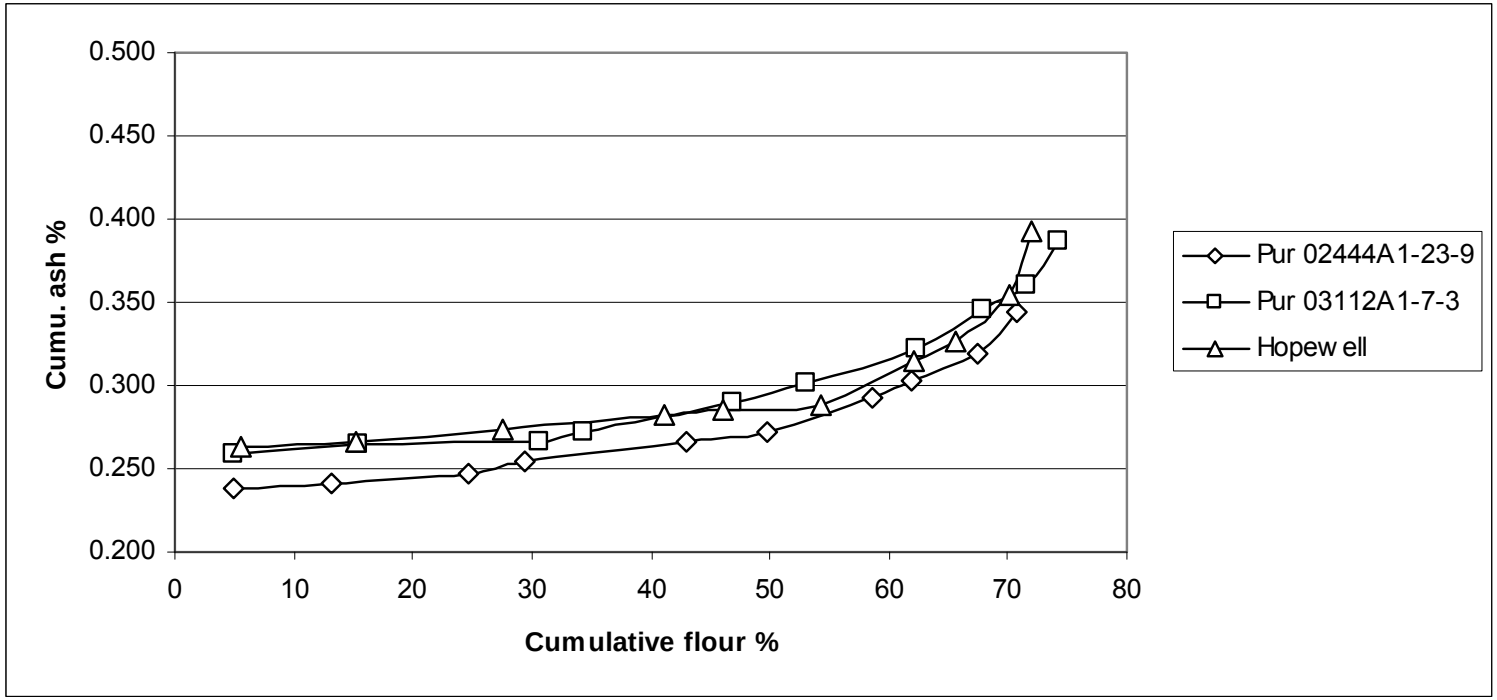
Ash curve for Hopewell		
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.264	5.6
1st Red	0.266	15.2
2nd Red	0.273	27.5
2nd Br	0.282	41.2
Gra	0.285	46.0
1st Br	0.289	54.3
3rd Red	0.315	62.1
3rd Br	0.327	65.6
4th Red	0.355	70.0
5th Red	0.393	72.0
RD	0.438	73.4
TS	0.455	73.8
HS	0.828	82.5
Bran	1.573	100.0



Ash curve for Pur 02444A1-23-9		
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.238	5.0
1st Red	0.241	13.1
2nd Red	0.248	24.6
Gra	0.254	29.5
2nd Br	0.266	42.9
1st Br	0.273	49.8
3rd Red	0.293	58.5
3rd Br	0.304	61.8
4th Red	0.320	67.5
5th Red	0.345	70.8
RD	0.400	73.3
TS	0.416	73.8
HS	0.814	83.6
Bran	1.538	100.0

Ash curve for Pur 03112A1-7-3		
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.259	5.0
1st Red	0.264	15.5
2nd Red	0.266	30.6
Gra	0.272	34.4
2nd Br	0.290	47.0
1st Br	0.301	53.0
3rd Red	0.323	62.3
4th Red	0.346	67.8
3rd Br	0.360	71.5
5th Red	0.386	74.2
RD	0.449	76.1
TS	0.471	76.6
HS	0.874	85.5
Bran	1.562	100.0

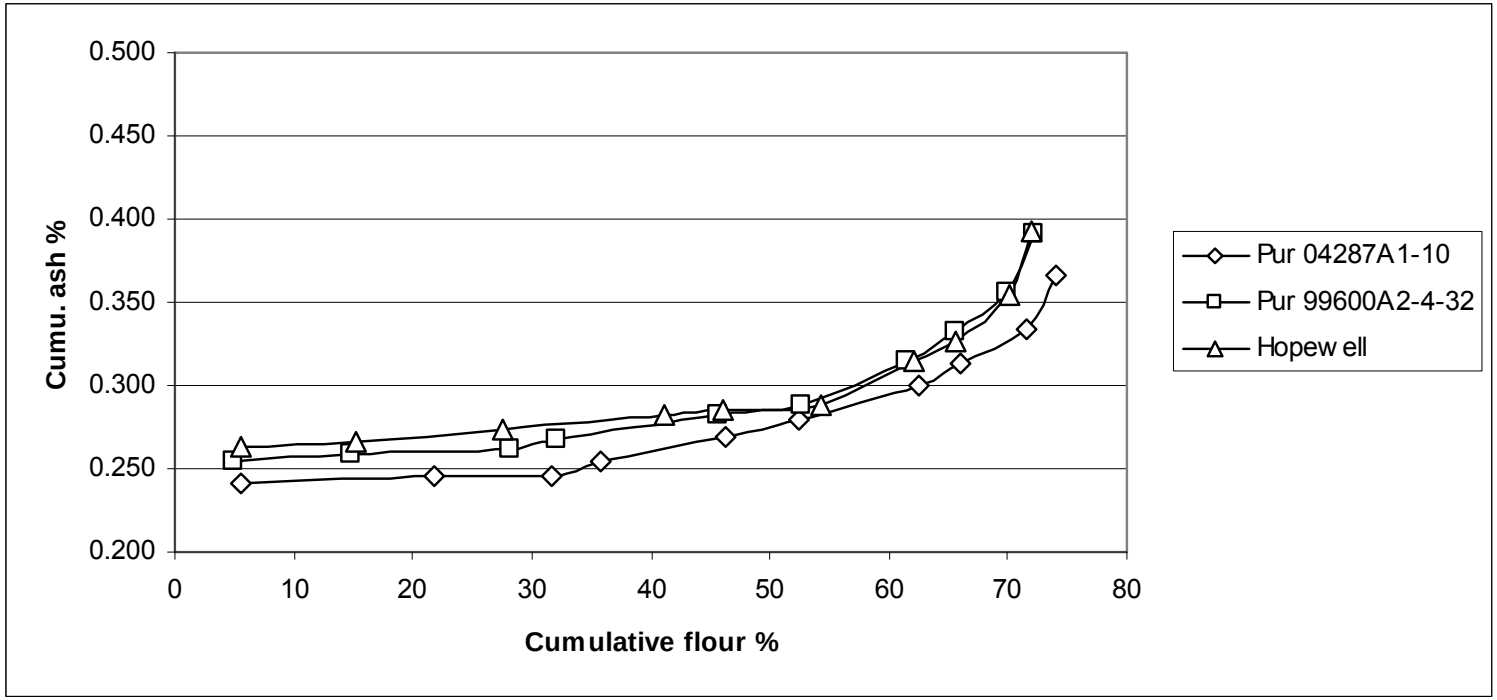
Ash curve for Hopewell		
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.264	5.6
1st Red	0.266	15.2
2nd Red	0.273	27.5
2nd Br	0.282	41.2
Gra	0.285	46.0
1st Br	0.289	54.3
3rd Red	0.315	62.1
3rd Br	0.327	65.6
4th Red	0.355	70.0
5th Red	0.393	72.0
RD	0.438	73.4
TS	0.455	73.8
HS	0.828	82.5
Bran	1.573	100.0



Ash curve for Pur 04287A1-10		
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.241	5.5
2nd Red	0.245	21.8
1st Red	0.246	31.7
Gra	0.254	35.7
2nd Br	0.269	46.3
1st Br	0.279	52.5
3rd Red	0.300	62.5
3rd Br	0.314	66.0
4th Red	0.334	71.5
5th Red	0.366	74.1
RD	0.419	75.6
TS	0.440	76.1
HS	0.825	85.4
Bran	1.466	100.0

Ash curve for Pur 99600A2-4-32		
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.255	4.9
1st Red	0.258	14.8
2nd Red	0.261	28.1
Gra	0.267	32.1
2nd Br	0.282	45.7
1st Br	0.288	52.7
3rd Red	0.315	61.5
3rd Br	0.333	65.5
4th Red	0.356	70.0
5th Red	0.391	72.2
RD	0.444	73.6
TS	0.468	74.1
Bran	1.239	91.0
HS	1.629	100.0

Ash curve for Hopewell		
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.264	5.6
1st Red	0.266	15.2
2nd Red	0.273	27.5
2nd Br	0.282	41.2
Gra	0.285	46.0
1st Br	0.289	54.3
3rd Red	0.315	62.1
3rd Br	0.327	65.6
4th Red	0.355	70.0
5th Red	0.393	72.0
RD	0.438	73.4
TS	0.455	73.8
HS	0.828	82.5
Bran	1.573	100.0



Ash curve for SS5205 (VA01W-205)

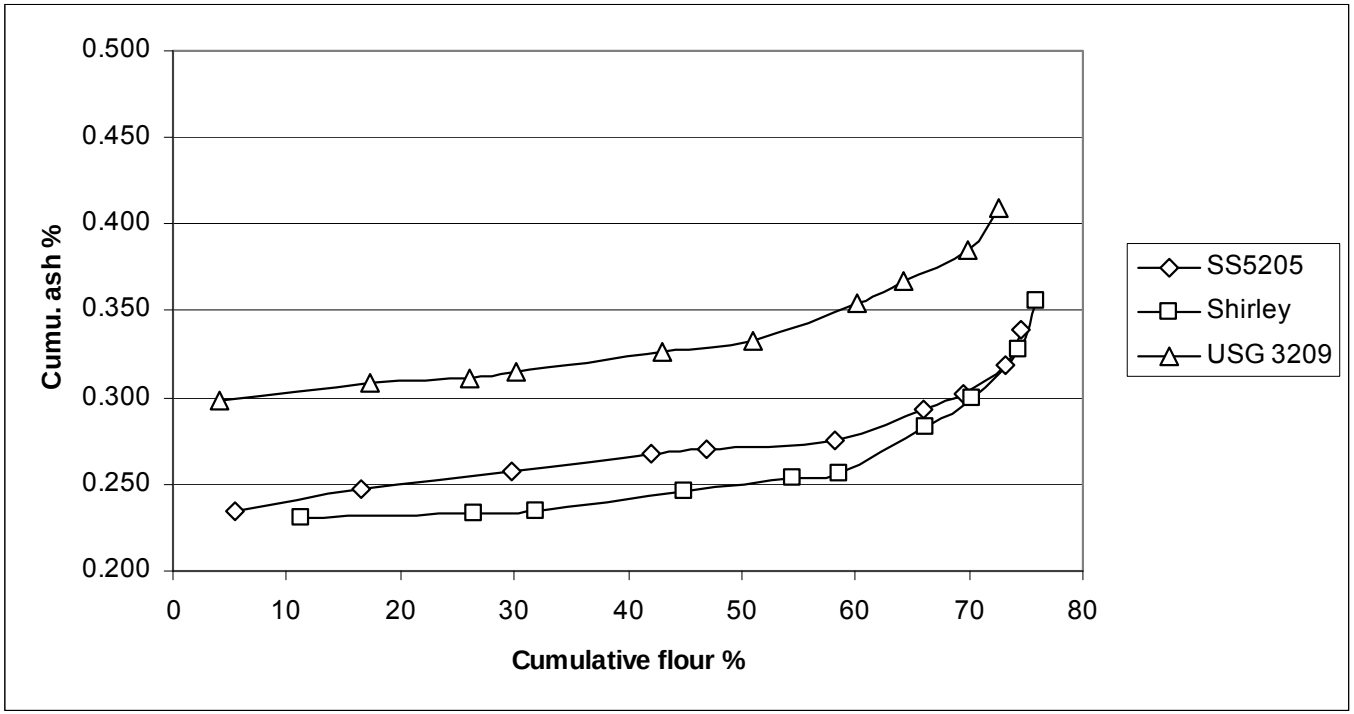
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.234	5.5
1st Red	0.247	16.5
2nd Red	0.258	29.8
2nd Br	0.267	42.1
Gra	0.270	47.0
1st Br	0.275	58.2
3rd Red	0.294	65.9
3rd Br	0.303	69.4
4th Red	0.319	73.1
5th		

Ash curve for Shirley (VA03W-409)

Mill stream	Cumulative ash %	Cumulative flour %
1st Red	0.231	11.3
2nd Red	0.233	26.4
Dust	0.234	32.0
2nd Br	0.247	44.9
1st Br	0.253	54.4
Gra	0.256	58.6
3rd Red	0.283	66.2
3rd Br	0.300	70.2
4th Red	0.327	74.3
5th Red	0.356	75.9
RD	0.404	77.4
TS	0.440	78.4
HS	0.832	88.2
Bran	1.330	100.0

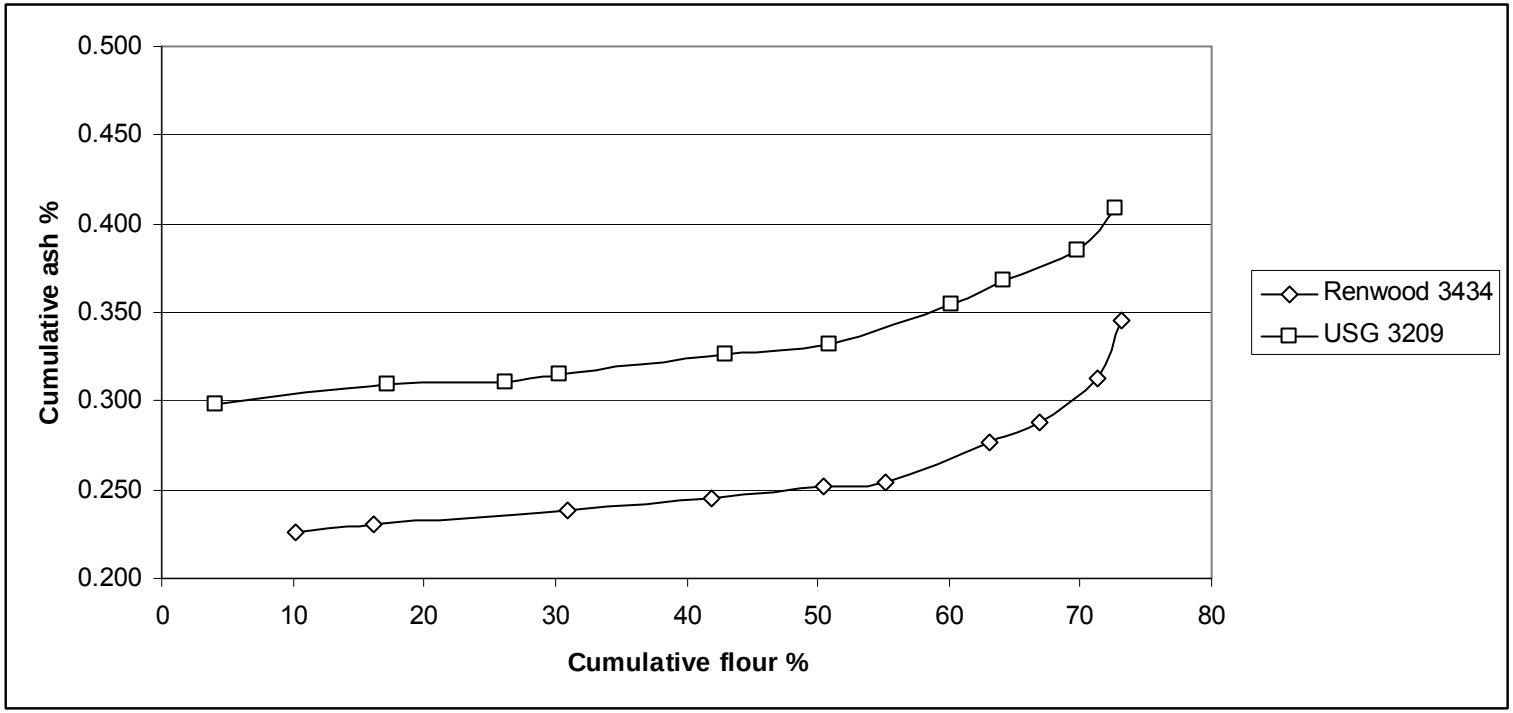
Ash curve for USG 3209

Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.298	4.1
2nd Red	0.309	17.3
1st Red	0.311	26.1
Gra	0.315	30.3
2nd Br	0.327	43.0
1st Br	0.332	51.0
3rd Red	0.355	60.2
3rd Br	0.368	64.2
4th Red	0.385	69.8
5th Red	0.409	72.7
RD	0.477	75.0
TS	0.503	75.6
HS	0.899	86.6
Bran	1.391	100.0



Ash curve Renwood 3434 (VA03W-434		
Mill stream	Cumulative ash %	Cumulative flour %
1st Red	0.226	10.2
Dust	0.231	16.2
2nd Red	0.238	31.0
2nd Br	0.245	41.9
1st Br	0.251	50.5
Gra	0.254	55.1
3rd Red	0.277	63.1
3rd Br	0.288	66.8
4th Red	0.313	71.4
5th Red	0.345	73.1
RD	0.386	74.3
TS	0.402	74.7
HS	0.756	83.3
Bran	1.484	100.0

Ash curve for USG 3209		
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.298	4.1
2nd Red	0.309	17.3
1st Red	0.311	26.1
Gra	0.315	30.3
2nd Br	0.327	43.0
1st Br	0.332	51.0
3rd Red	0.355	60.2
3rd Br	0.368	64.2
4th Red	0.385	69.8
5th Red	0.409	72.7
RD	0.477	75.0
TS	0.503	75.6
HS	0.899	86.6
Bran	1.391	100.0



Ash curve for Envoy (E1009)

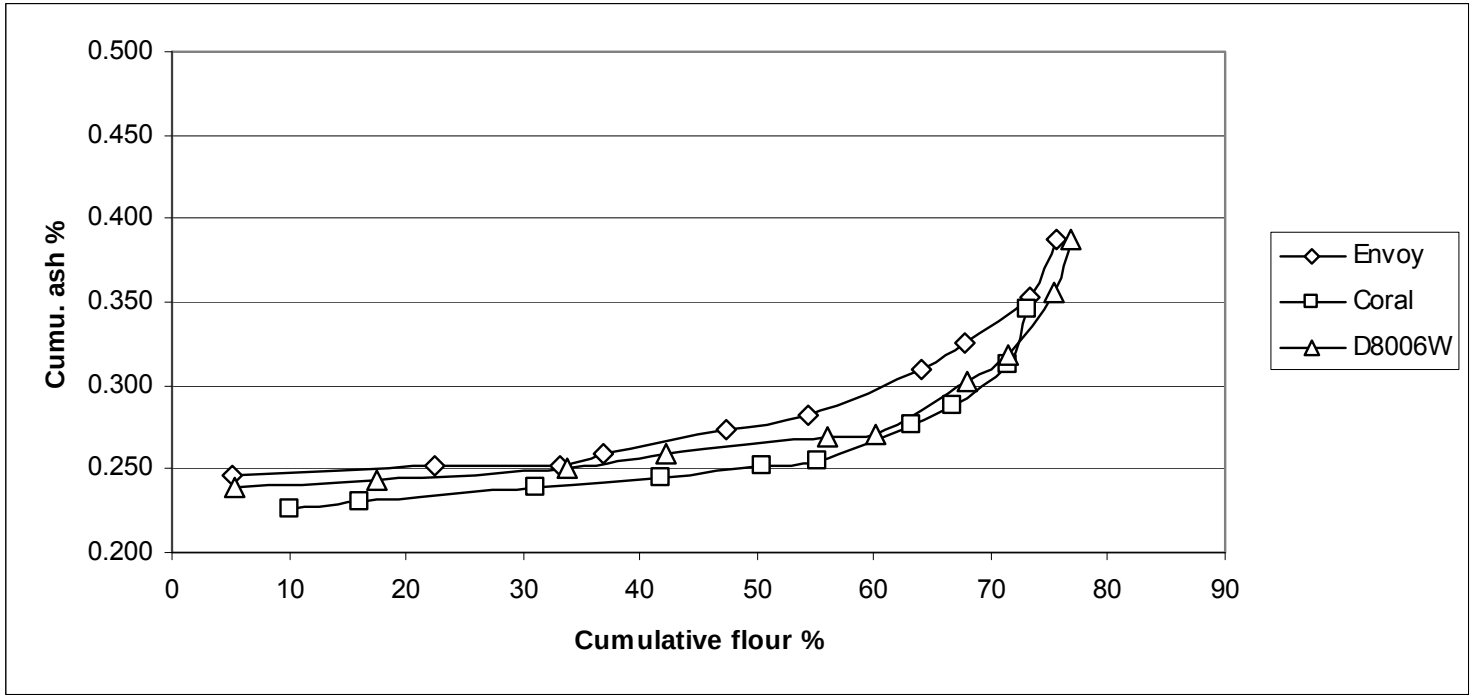
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.246	5.1
2nd Red	0.252	22.4
1st Red	0.252	33.2
Gra	0.259	36.9
2nd Br	0.273	47.4
1st Br	0.282	54.3
3rd Red	0.309	64.1
3rd Br	0.325	67.7
4th Red	0.353	73.4
5th Red	0.388	75.5
RD	0.433	76.9
TS	0.449	77.3
HS	0.812	86.0
Bran	1.474	100.0

Ash curve for Coral (E2017)

Mill stream	Cumulative ash %	Cumulative flour %
1st Red	0.226	10.2
Dust	0.231	16.2
2nd Red	0.238	31.0
2nd Br	0.245	41.9
1st Br	0.251	50.5
Gra	0.254	55.1
3rd Red	0.277	63.1
3rd Br	0.288	66.8
4th Red	0.313	71.4
5th Red	0.345	73.1
RD	0.386	74.3
TS	0.402	74.7
HS	0.756	83.3
Bran	1.484	100.0

Ash curve for D8006W

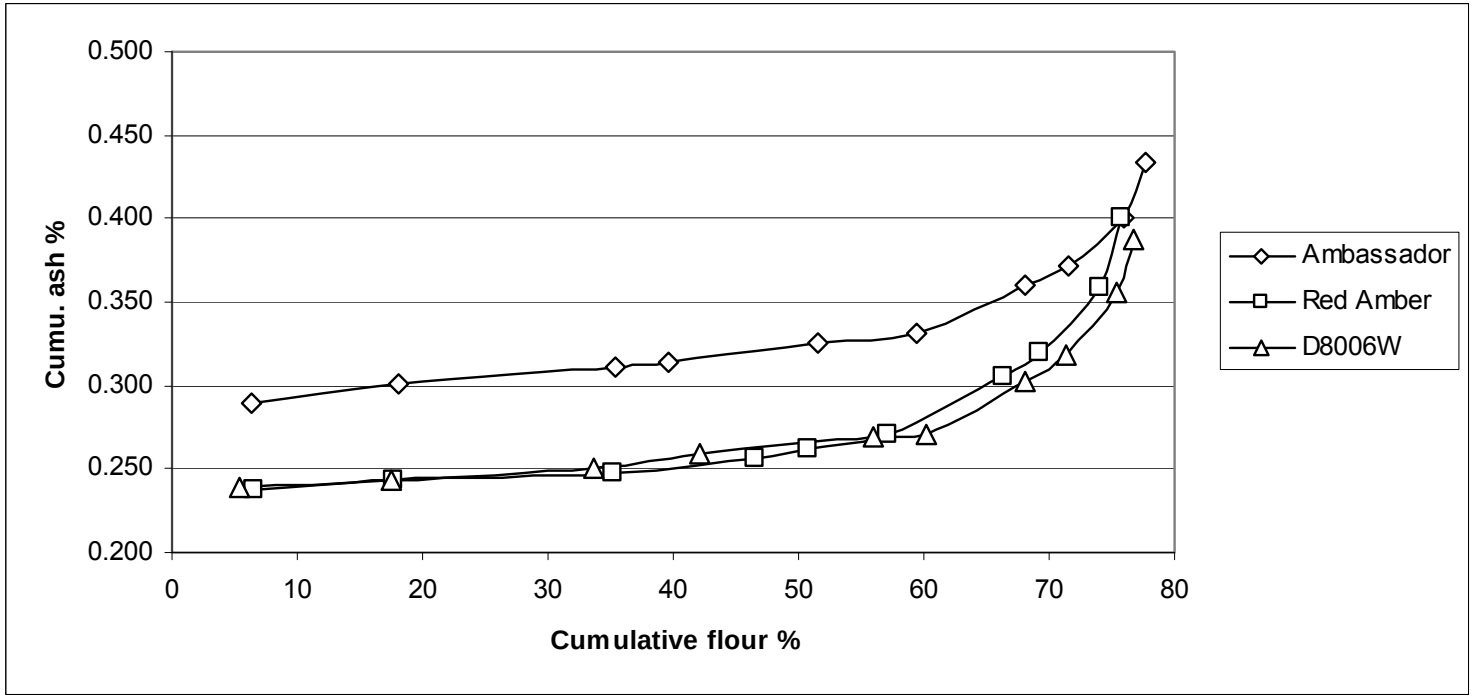
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.239	5.3
1st Red	0.243	17.6
2nd Red	0.250	33.7
1st Br	0.259	42.1
2nd Br	0.269	56.0
Gra	0.271	60.2
3rd Red	0.303	68.0
3rd Br	0.319	71.4
4th Red	0.356	75.4
5th Red	0.388	76.7
RD	0.433	77.7
TS	0.452	78.1
HS	0.848	86.6
Bran	1.556	100.0



Ash curve for Ambassador (E0028)		
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.289	6.4
1st Red	0.301	18.1
2nd Red	0.310	35.3
Gra	0.314	39.7
2nd Br	0.326	51.6
1st Br	0.331	59.4
3rd Red	0.360	68.1
3rd Br	0.372	71.5
4th Red	0.401	75.9
5th Red	0.434	77.6
RD	0.477	79.0
TS	0.493	79.4
HS	0.801	87.8
Bran	1.354	100.0

Ash curve for Red Amber (D8006R)		
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.237	6.6
1st Red	0.243	17.7
2nd Red	0.248	35.2
2nd Br	0.256	46.6
Gra	0.262	50.8
1st Br	0.271	57.2
3rd Red	0.305	66.3
3rd Br	0.320	69.2
4th Red	0.359	74.0
5th Red	0.400	75.7
RD	0.447	76.9
TS	0.468	77.4
HS	0.892	86.7
Bran	1.529	100.0

Ash curve for D8006W		
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.239	5.3
1st Red	0.243	17.6
2nd Red	0.250	33.7
1st Br	0.259	42.1
2nd Br	0.269	56.0
Gra	0.271	60.2
3rd Red	0.303	68.0
3rd Br	0.319	71.4
4th Red	0.356	75.4
5th Red	0.388	76.7
RD	0.433	77.7
TS	0.452	78.1
HS	0.848	86.6
Bran	1.556	100.0



Ash curve for MO 011126		
Mill stream	Cumulative ash %	Cumulative flour %
1st Red	0.255	10.8
Dust	0.256	16.8
2nd Red	0.260	28.8
Gra	0.263	34.3
2nd Br	0.268	49.2
1st Br	0.272	61.5
3rd Red	0.287	68.3
3rd Br	0.295	71.2
4th Red	0.312	74.6
5th Red	0.334	75.9
RD	0.362	76.9
TS	0.372	77.2
HS	0.660	83.8
Bran	1.535	100.0

Ash curve for Bess		
Mill stream	Cumulative ash %	Cumulative flour %
Dust	0.263	4.7
1st Red	0.273	15.8
2nd Red	0.283	29.5
2nd Br	0.293	45.4
1st Br	0.301	52.6
3rd Br	0.326	56.9
3rd Red	0.367	65.2
Gra	0.389	69.3
4th Red	0.421	73.2
5th Red	0.452	74.9
RD	0.506	76.3
TS	0.522	76.6
HS	0.990	86.8
Bran	1.642	100.0

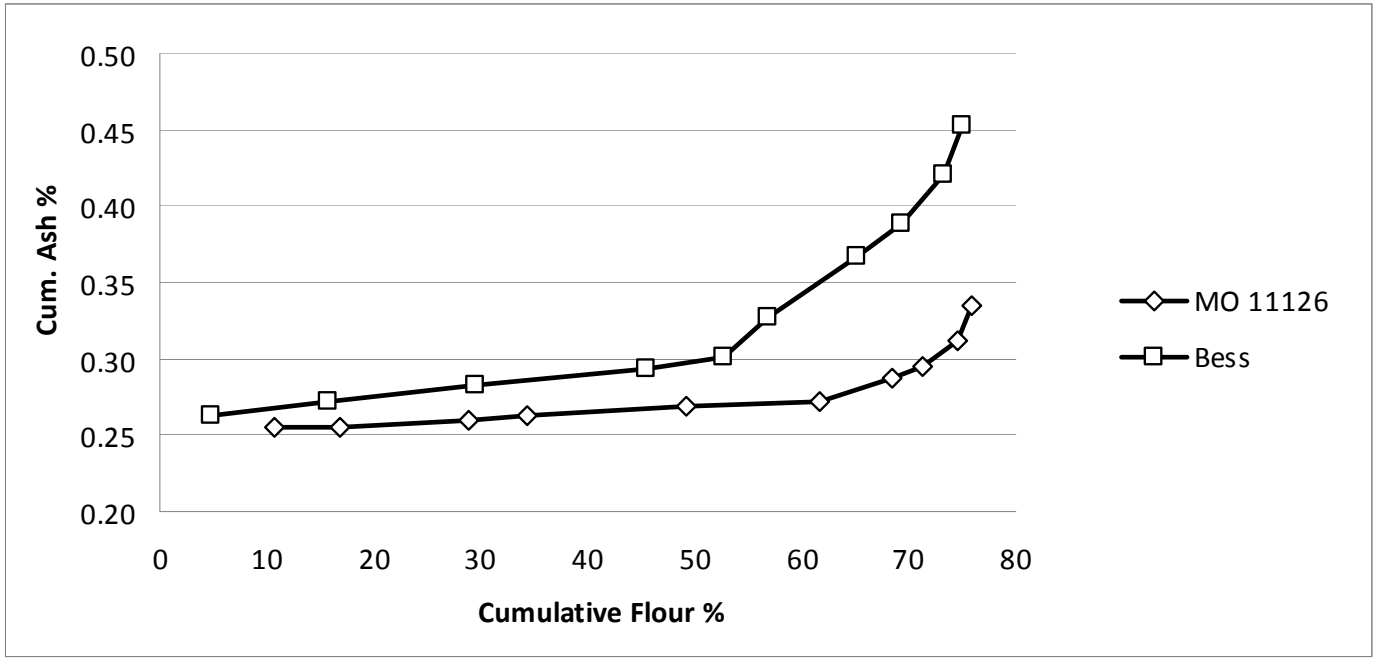


Table 22. USDA-ARS Soft Wheat Quality Laboratory grain evaluation of 18 soft winter wheat cultivars for 2008 Wheat Quality Council.

			SKCS Analysis						Miag milling	
	Variety	Grain test wt lb/bu	Grain hardness score	Grain wt. mg	Grain moist. %	Grain dia. mm	Falling no. sec	Alpha-amylase abs.	Straight grade %	Break flour %
Set 1	Pioneer 25R39 (XW 06M)	62.6	49.8	33.5	8.1	2.36	389	0.072	72.5	25.6
	PUR 02444 A1-23-9	59.0	29.7	32.5	8.5	2.35	382	0.073	70.7	28.4
	PUR 03112A1-7-3	59.5	48.0	27.1	8.9	2.31	390	0.104	74.2	26.2
	PUR 04287A1-10	61.7	45.1	31.6	8.5	2.59	366	0.122	74.1	24.3
	PUR 99600A2-4-32	60.6	41.7	28.8	8.5	2.27	414	0.069	72.2	28.6
	W 1377	64.9	41.7	33.9	8.6	2.44	385	0.108	71.5	25.5
	Hopewell (Check)	59.4	17.7	31.3	10.0	2.26	362	0.118	72.0	30.3
Set 2	USG 3209 (Check)	62.1	24.6	40.1	13.2	2.66	442	0.097	72.7	28.9
	SS 5205 (VA01W-205)	61.8	3.5	37.0	12.3	2.47	439	0.072	74.6	32.0
	Shirley (VA03W-409)	60.2	8.7	39.1	13.2	2.49	448	0.074	75.9	30.6
	Renwood 3434 (VA03W-434)	59.4	23.8	27.7	12.7	2.21	417	0.086	73.1	27.8
Set 3	Envoy (E1009)	62.5	21.5	43.1	12.2	3.05	388	0.089	75.5	24.8
	Coral (E2017)	62.9	16.2	42.1	13.7	2.59	354	0.110	77.1	30.0
	Ambassador (E0028)	62.9	16.1	41.3	13.5	2.60	378	0.074	77.4	27.5
	Red Amber (D8006R)	64.1	20.3	44.5	12.1	2.70	430	0.077	75.5	24.8
	D8006 W (Check)	64.5	19.9	40.5	12.4	2.65	371	0.104	76.1	29.7
Set 4	MO 11126	60.0	-5.5	39.6	12.5	2.58	421	0.046	75.9	35.6
	BESS (Check)	63.5	30.3	27.8	13.0	1.96	421	0.076	74.7	31.4

Table 23. USDA-ARS Soft Wheat Quality Laboratory flour evaluation of 18 soft winter wheat cultivars for 2008 Wheat Quality Council.

					Rapid Visco-analysis profile							
Variety	Flour protein %	Flour pH	Damage starch %	Flour moist. %	Peak cP	Trough cP	Break-down cP	Final cP	Set-back cP	Peak time min	Pasting temp. C	Peak/ Final ratio
Pioneer 25R39	9.06	6.10	4.34	13.45	3217	1644	1573	3107	1463	5.87	66.15	1.04
PUR 02444 A1-23-9	9.47	6.28	2.74	13.60	3579	1829	1751	3296	1467	5.93	68.23	1.09
PUR 03112A1-7-3	10.25	6.13	2.74	13.48	3470	1810	1660	3295	1485	6.03	75.80	1.05
PUR 04287A1-10	9.82	6.15	3.46	13.42	2566	1277	1289	2582	1305	5.77	66.60	0.99
PUR 99600A2-4-32	9.34	5.99	3.40	13.78	3633	1921	1712	3486	1566	6.00	75.40	1.04
W 1377	9.20	6.24	4.27	13.78	2971	1535	1437	3019	1484	5.83	82.78	0.98
Hopewell (Check)	7.80	6.07	1.87	13.47	3149	1629	1520	3288	1659	5.73	67.78	0.96
USG 3209 (Check)	7.11	6.56	4.72	13.51	3405	2208	1197	4191	1983	5.93	74.20	0.81
SS 5205	7.51	6.39	2.31	13.54	3504	2211	1294	4183	1972	5.93	82.35	0.84
Shirley	8.40	6.41	3.76	13.74	2953	2093	860	4055	1962	5.93	83.90	0.73
Renwood 3434	9.04	6.27	3.27	13.58	2749	1706	1043	3439	1733	5.73	83.55	0.80
Envoy	8.70	6.26	3.08	13.09	3203	1822	1381	3412	1590	5.93	82.30	0.94
Coral	8.21	6.33	2.42	13.42	2245	1169	1076	2483	1314	5.67	83.48	0.90
Ambassador	8.02	6.31	3.47	13.53	3086	1809	1277	3490	1681	5.80	74.30	0.88
Red Amber	7.66	6.55	2.80	13.31	3252	1718	1534	3168	1450	6.00	84.68	1.03
D8006 W (Check)	7.54	6.36	3.42	13.14	3472	1795	1677	3386	1591	5.90	74.18	1.03
MO 11126	8.67	6.16	0.79	13.15	3819	2300	1520	3894	1594	6.10	83.05	0.98
Bess (Check)	9.19	6.38	1.28	12.87	3831	2096	1735	3572	1476	6.07	68.48	1.07

Table 24. USDA-ARS Soft Wheat Quality Laboratory solvent retention capacity and wire-cut cookie of 18 soft winter wheat cultivars for 2008 Wheat Quality Council.

	Solvent Retention Capacity					Wire-cut cookie				
Variety	Water %	Sodium carbon. %	Sucrose %	Lactic acid %	Effective-ness ratio	Diameter cm	Stack height cm	Punch force g	Punch distance mm	Area g/sec
Pioneer XW 06M	57.4	76.4	94.9	95.7	0.56	14.55	2.41	1177	1.65	6028
PUR 02444 A1-23-9	55.2	77.8	102.3	105.0	0.58	15.85	2.09	1054	3.53	4351
PUR 03112A1-7-3	53.2	72.4	89.2	78.0	0.48	15.54	2.20	1020	2.68	4290
PUR 04287A1-10	53.6	72.3	92.4	92.3	0.56	14.45	2.44	1099	3.12	5684
PUR 99600A2-4-32	56.5	78.2	101.3	100.9	0.56	15.39	2.17	1107	2.08	4157
W 1377	56.9	76.6	95.4	108.1	0.63	15.05	2.27	1057	2.08	4721
Hopewell (Check)	52.8	76.3	90.6	102.7	0.62	15.89	2.12	1038	2.28	4053
USG 3209 (Check)	59.0	80.0	101.5	84.5	0.47	15.10	2.32	1067	2.69	5338
VA01W-205	51.9	67.4	86.5	100.7	0.65	16.09	2.07	1014	3.63	3708
VA03W-409	56.3	75.3	92.5	74.5	0.44	15.15	2.37	1147	2.93	5495
VA03W-434	53.5	70.6	92.0	96.8	0.60	15.07	2.26	1180	3.70	5793
Envoy	55.8	71.8	91.3	106.0	0.65	15.15	2.23	990	1.72	4217
Coral	51.5	71.2	83.9	93.1	0.60	15.86	2.06	947	2.77	3680
Ambassador	51.9	71.2	81.4	81.2	0.53	16.23	1.99	933	2.61	3481
Red Amber	51.3	70.1	82.5	93.5	0.61	15.76	2.10	1009	2.56	3652
D8006 W (Check)	54.7	74.5	83.3	86.7	0.55	15.81	2.01	981	2.17	3564
MO 11126	50.3	66.8	85.6	104.5	0.69	16.61	1.87	989	2.33	3257
Bess (Check)	53.5	73.8	87.0	80.1	0.50	15.87	2.03	1162	3.23	4267

GENOTYPING FOR QUALITY TRAITS BY THE SOFT WHEAT QUALITY LABORATORY

OCTOBER, 2008. BY ANNE STURBAUM, USDA-ARS WOOSTER

Amplification for high molecular weight glutenins at the GluA1 locus, using the *Ax1* or *Ax2** primer pair (3), identified the *Ax2** genotype in Pioneer 25R39, Pur 02444A1-23-9 and Pur 99600A2-4-32. All other varieties had the *Ax1* genotype. There were no nulls among these samples.

PCR product patterns specific to the GluB1 locus indicated the By8 allele only for Bess and the By9 allele for USG3209, D8006W, Pioneer 25R39, Pur-03112A1-7-3, Pur04287A1-10, Pur99600A2-4-32, VA01W-205 and VA03W-409, and Coral (E2017). The remaining lines, Pur-02444A1-23-9, W 1377, Hopewell, VA03W-434, Envoy (E1009), Abassador (E0028), Amber (D8006R) and D8006W (CK) produced patterns characteristic for one of the By8*, By15 or By18 genotypes. Primers specific to the Bx7 over-expressing allele amplified the appropriate product, with a 45 bp insertion, for D8006(W), Pur 02444A1-23-9, Pur04287A1-10, Ambassador (E0028), Amber (D8006R) and MO11126. Amplification for Pur04287A1-10 yielded both the over-expressing and the wild-type allele implicating some mixed seed for this line (2).

Amplification with primers specific for GluD1, *Dx5* (3), generated a product with DNA from Pur04287A1-10, Amber (D8006R), D8006(W) and USG 3209, corresponding to the "5+10" genotype. Both the Dx5 and Dx2 products amplified in DNA from Pur03112A1-7-3, identifying mixed seed or the presence of heterozygotes in this line.

Primer combinations to identify low molecular weight glutenins at the GluA3 locus identified Pur04287A1-10, W 1377 and USG3209 with the *Glu-A3g* allele, Pur02444A1-23-9 and Pur03112A1-7-3 with the *Glu-A3d* allele, VA03W-434 and VA01W-205 with the *Glu-A3b* allele and Bess with the *Glu-A3f* allele. All others produced amplification patterns implicating the *Glu-A3c* allele (7).

Gliadin allele-specific primers identified only Pur03112A1-7-3 with the *GliD1.2* allele. All other varieties had the *GliD1.1* allele (6).

The Rye 1B/1R translocation was identified in varieties Pur03112A1-7-3, Pur 04287A1-10, VA03W-409, VA03W-434 and USG3209, as they produced an amplification product with primers specific for rye ω-secalin. Although the 1BS LMW Glu (indicative of the presence of the short arm of the 1B chromosome) amplified as well in Pur03112A1-7-3, Pur 04287A1-10 and VA03W-434, the 1B translocation was confirmed for these varieties using an alternate primer set (Scm9) that differentiates the 1B and 1A translocations (1,8).

All genotypes in this set produced the anticipated banding patterns for normal amylose genotypes (non-waxy) at both the A and B GBSS loci (4).

Alleles of the *Vp1B* gene (Viviparous-1), as assayed using Vp1B3 primers, are associated with tolerance to preharvest sprouting (9). Pioneer25R39, Envoy (E1009), Amber (D8006R) and D8006(W) produced a product indicating tolerance to PHS, USG3209 amplified both a tolerant and susceptible type. All other varieties amplified the larger product, indicating probable susceptibility to PHS at this locus. The effect of this locus is likely less than the effect of red seed coat color. None of the cultivars were found to have the most resistant allele that has been identified in some Chinese wheat cultivars.

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Table 25. Quality Genotypes of 18 soft winter wheat cultivars for 2008 Wheat Quality Council.

Cultivar	*Bx7Oe*[5]	*GluA1*[3]	*GluB1*[2]	*GluD1*[3]	*LMW gltns*[7]	*Gliadins*[6]	*Vp1*[9]	*RyeTL*[8]	*Waxy*[4]
Ambassador (E0028)	*OE*	*Ax1*	*By8**	*Dx2*	*GluA3c*	*GliD1*	*Susceptible*	*0*	*WT*
Red Amber (D8006R)	*OE*	*Ax1*	*By8**	*Dx5*	*GluA3c*	*GliD1*	*Tolerant*	*0*	*WT*
Bess	*WT*	*Ax1*	*By8*	*Dx2*	*GluA3f*	*GliD1*	*Susceptible*	*0*	*WT*
Coral (E2017)	*WT*	*Ax1*	*By9*	*Dx2*	*GluA3c*	*GliD1*	*Susceptible*	*0*	*WT*
D8006W (CK)	*OE*	*Ax1*	*By8**	*Dx5*	*GluA3c*	*GliD1*	*Tolerant*	*0*	*WT*
Envoy (E1009)	*WT*	*Ax1*	*NON By8 or By 9*	*Dx2*	*GluA3c*	*GliD1*	*Tolerant*	*0*	*WT*
Hopewell(CK)	*WT*	*Ax1*	*NON By8 or By 9*	*Dx2*	*GluA3c*	*GliD1*	*Susceptible*	*0*	*WT*
MO 11126	*OE*	*Ax1*	*By8**	*Dx2*	*GluA3c*	*GliD1*	*Susceptible*	*0*	*WT*
Pioneer 25R39	*WT*	*Ax2**	*By9*	*Dx2*	*GluA3c*	*GliD1*	*Tolerant*	*0*	*WT*
Pur 02444A1-23-9	*OE*	*Ax2**	*By8**	*Dx2*	*GluA3d*	*GliD1*	*Susceptible*	*0*	*WT*
Pur 04287A1-10	*OE/WT*	*Ax1*	*mixed: By8*/By9*	*Dx5*	*GluA3g*	*GliD1*	*Susceptible*	*1B/1R*	*WT*
Pur 99600A2-4-32	*WT*	*Ax2**	*By9*	*Dx2*	*GluA3c*	*GliD1*	*Susceptible*	*0*	*WT*
Pur03112A1-7-3	*WT*	*Ax1*	*By9*	*Dx2/Dx5*	*GluA3d*	*GliD2*	*Susceptible*	*1B/1R*	*WT*
USG 3209(CK)	*WT*	*Ax1*	*By9*	*Dx5*	*GluA3g*	*GliD1*	*Tol/Sus*	*1B/1R*	*WT*
VA01W-205	*WT*	*Ax1*	*By9*	*Dx2*	*GluA3b*	*GliD1*	*Susceptible*	*0*	*WT*
VA03W-409	*WT*	*Ax1*	*By9*	*Dx2*	*GluA3c*	*GliD1*	*Susceptible*	*1B/1R*	*WT*
VA03W-434	*WT*	*Ax1*	*Non By8 or By 9*	*Dx2*	*GluA3b*	*GliD1*	*Susceptible*	*1B/1R*	*WT*
W 1377	*WT*	*Ax1*	*Non By8 or By 9*	*Dx2*	*GluA3g*	*GliD1*	*Susceptible*	*0*	*WT*

Overseas Varietal Analysis
2007 Crop Soft Red Winter Wheat

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ACKNOWLEDGEMENTS

On behalf of U.S. Wheat Associates, Arkansas Wheat Promotion Board, Maryland Grain Producers Utilization Board, Virginia Small Grains Board, and the USDA-ARS Soft Wheat Quality Laboratory (SWQL)**,** we wish to extend our appreciation to the overseas cooperators for providing an unbiased evaluation of the quality of U.S. Soft Red Winter wheat varieties. Countries involved in the Overseas Varietal Analysis (OVA) program were China, Columbia, Indonesia, Malaysia, Peru, Philippines, Thailand, and United Arab Emirates**.**

The author wishes to thank the staff of the USDA ARS Soft Wheat Quality Laboratory at Wooster, Ohio, for providing quality data. The author also wishes to thank the members of the Arkansas Wheat Promotion Board**,** the Maryland Grain Producers Utilization Board and the Virginia Small Grain Board for supporting this important evaluation.

Project Purpose
The objective of this Overseas Varietal Analysis Program is to evaluate the quality of soft red wheat varieties in cooperation with international millers and bakers. The specific purpose of the cooperative study is to enhance the milling and end-processing quality of SR wheat to better meet the needs of international customers.

Project Approach
Ten soft red winter wheat samples were provided to overseas collaborators: USG 3665, USG3550 and Armor 260Z from Arkansas; Coker 9553, Magnolia and NC Neuse from North Carolina; McCormick and Tribute from Virginia; Pioneer 25R47 from Indiana and Hopewell from Ohio. The varieties were selected because they were 1) true to characteristics of the soft red wheat class and 2) they were either grown over wide geographic areas or were increasing in production area. All varieties were provided from seed fields and graded U.S. number 2 or above.

The Soft Wheat Quality Laboratory provided milling, baking and Alveograph information to cooperators with the flour samples. The methods used for milling and flour evaluation by the Soft Wheat Quality Laboratory were as described in the materials and methods section of this report

USDA-ARS Soft Wheat Quality Laboratory Evaluation

Milling Characteristics (Figure 1)
Flour samples were milled on the SWQL Miag Multomat flour mill. Descriptions of methods are given in the appendix to the report. Ash curves were used to measure the milling characteristics of the varieties in a long-flow mill (Figure 1a-k).

Flour ash is the mineral concentration of the mill-stream. The center of a kernel is typically low in mineral content compared with the aleurone and bran layers, which have high concentrations of minerals. The mill stream analysis depicts the increase in flour ash as a function of flour recovery.

Cumulative ash curves for wheat varieties should have flat lines initially with all the first streams of flour having very similar, low ash levels. The varieties in this set that best fit the idealized milling curve were NC Neuse, Magnolia, McCormick, and Pioneer 25R47.

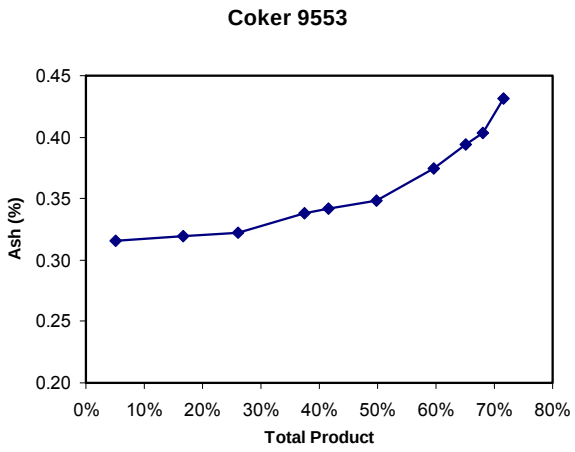
Grain Characteristics (Table 1)
The varieties were within the normal range of soft wheat protein samples. Coker 9553, USG 3350, Armor 260Z, and Hopewell had grain protein levels greater than 10%. Tribute and Pioneer 25R47 had grain protein less than 9%. The 2007 crop year was relatively high for grain protein in many regions. The samples of this study reflect that trend. All samples had grain hardness values less than 50 and falling number levels consistent with sound unsprouted grain.

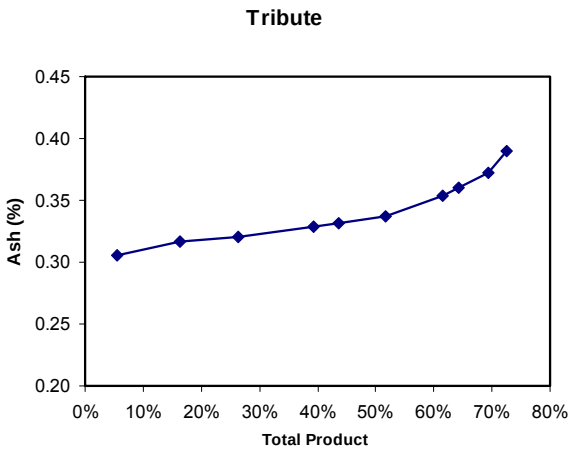
Milling, Proximate, and Alveograph Flour Analysis (Table 2)
The samples with the best straight grade flour extraction were Armor 260Z and NC Neuse, both with 75% or greater flour extraction. Break flour yield is an important indicator of grain softness, with the greatest break flour levels in USG 3665, McCormick and Pioneer 25R47. The Coker 9553 and Tribute samples were low for both break flour and straight grade flour yield. Flour ash was not correlated to flour yields in this study. In the Alveograph analyses, NC Neuse and Pioneer 25R47 had low P values (<30 mm) and very low W values (<80 mm). Tribute and Magnolia had strong Alveographs with P values of approximately 50 mm and W values in excess 150 mm. Alveogram images are included in the Appendix to this report. Similarly, mixograph analysis of samples were completed and the mixograms are provided in the Appendix to this report.

Solvent Retention Capacity Tests and Bake Evaluations (Table 3)
The NC Neuse sample had a 49% water absorption, nearly 3 percentage points less than the next lowest sample USG 3350. The highest water absorption samples in this set were Coker 9553 and Armor 260Z. However all of these flour samples are low water absorption by international standards and are consistent with the soft wheat characteristics. Similarly, significant variation is present in this set for sodium carbonate and sucrose SRC values, yet all are within the expected range for soft wheat varieties. The lactic acid SRC values that measure gluten strength were greatest in Tribute and Magnolia. These two wheats also had the largest Alveograph W values, indicating consistent strength across gluten measures. Among soft wheat samples, pentosans often have a greater contribution than gluten to the total amount of work required for the Alveograph. In this dataset sucrose SRC, a measure pentosan content, was significantly correlated to Alveograph W. This was largely due to the increase in initial resistance of the dough as indicated by the correlation of sucrose SRC to Alveograph P value ($r=0.7$, $p<0.05$). In contrast lactic acid SRC was correlated to Alveograph W at a much lower level ($r=0.5$, $p<0.10$).

For the wire-cut cookie test, the traditional preference is for larger diameters, smaller stack heights, and small forces required for snapping. By these standards, the Pioneer 25R47, USG 3665, and NC Neuse samples had the best cookie performance with the largest diameters. The stack height and snapping force for these samples also were the lowest of the set, which is consistent with all three measures being correlated and strongly interrelated.

Rapid Visco-Analysis (Table 4)
All samples were consistent with the flour coming from sound grain with minimal alpha-amylase activity as the initial peaks were similar and large for all samples. The ratio of the initial peak flour viscosity to the final peak flour viscosity is diagnostic for wheat varieties that have reduced amylose concentrations (partial-waxy). The initial peak viscosity is elevated and the final viscosity is reduced to give a ratio greater than 1 (often 1.2 or greater). All of the varieties in this set had ratios of peak to final flour viscosity that were consistent with the lines having normal amylopectin:amylose ratios (Wild type, non-partial waxy wheat).





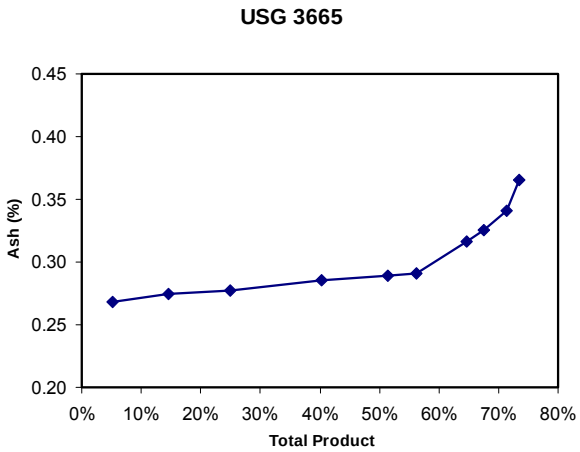


Figure 1a. Coker 9553

Mill stream	Estimated cumulative ash %	Cumulative flour %
2RED	0.316	5.16
1RED	0.320	16.63
DUST	0.322	26.04
2BR	0.338	37.43
1BR	0.342	41.50
GRA	0.348	49.80
3RED	0.375	59.69
3BR	0.394	65.03
4RED	0.403	67.99
5RED	0.431	71.55

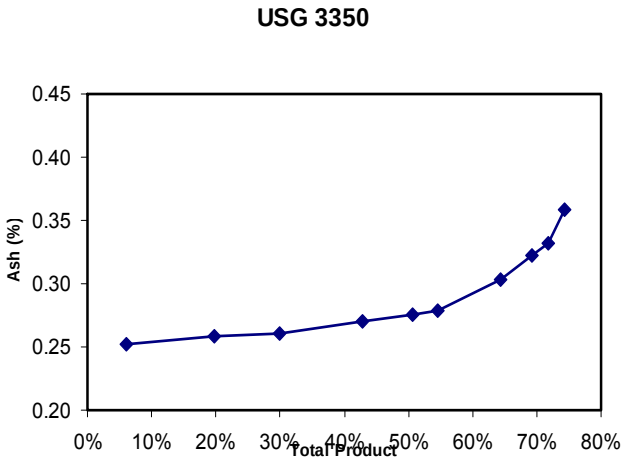
Figure 1b. Tribute

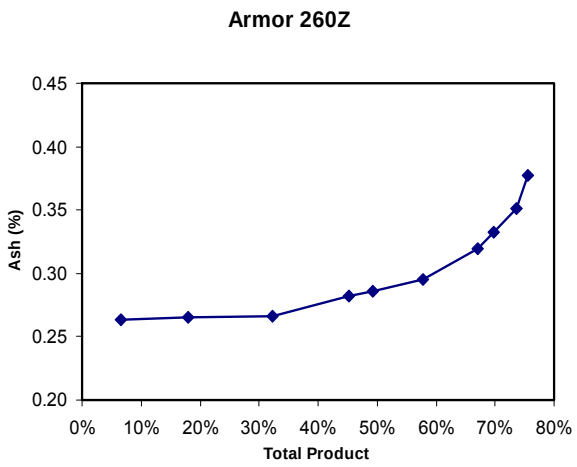
Mill stream	Estimated cumulative ash %	Cumulative flour %
2RED	0.305	5.47
1RED	0.317	16.33
DUST	0.320	26.39
2BR	0.329	39.39
1BR	0.331	43.63
GRA	0.337	51.69
3RED	0.353	61.45
3BR	0.361	64.25
4RED	0.373	69.35
5RED	0.390	72.57

Figure 1c. USG 3665

Mill stream	Estimated cumulative ash %	Cumulative flour %
2RED	0.268	5.20
1RED	0.274	14.55
DUST	0.277	24.87
2BR	0.285	40.38
1BR	0.289	51.48
GRA	0.291	56.16
3RED	0.316	64.61
3BR	0.325	67.51
4RED	0.341	71.35
5RED	0.365	73.42

Figure 1. Milling ash curves for ten soft red winter wheat varieties, US Wheat Associates, 2007 Overseas Varietal Analysis. Cumulative flour streams in figures are arranged from the lowest ash stream to the highest ash stream. Tables are arranged with the same stream order for each sample beginning with the lowest ash content to the highest ash stream when averaged across all ten flour samples. Mill stream abbreviations are: 2RED – 2nd reduction, 1RED – 1st reduction, DUST – duster, 2BR – 2nd break, 1BR – 1st break, GRA – grader, 3RED – 3rd reduction, 3BR – 3rd break, 4RED – 4th reduction, 5th reduction, 5RED – 5th reduction.





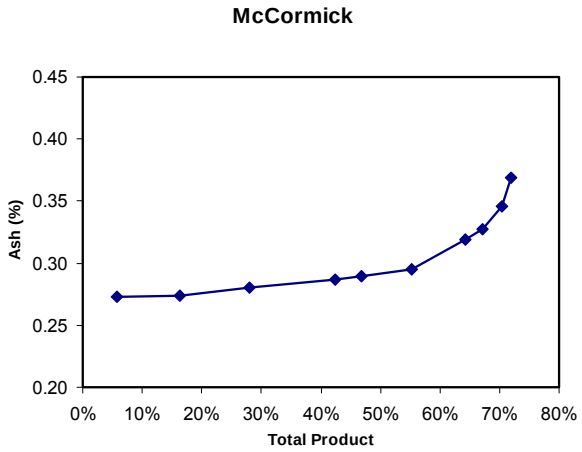


Figure 1d. USG 3350

Mill stream	Estimated cumulative ash %	Cumulative flour %
2RED	0.252	6.08
1RED	0.258	19.68
DUST	0.260	29.83
2BR	0.271	42.93
1BR	0.276	50.57
GRA	0.278	54.54
3RED	0.303	64.44
3BR	0.322	69.19
4RED	0.332	71.86
5RED	0.359	74.42

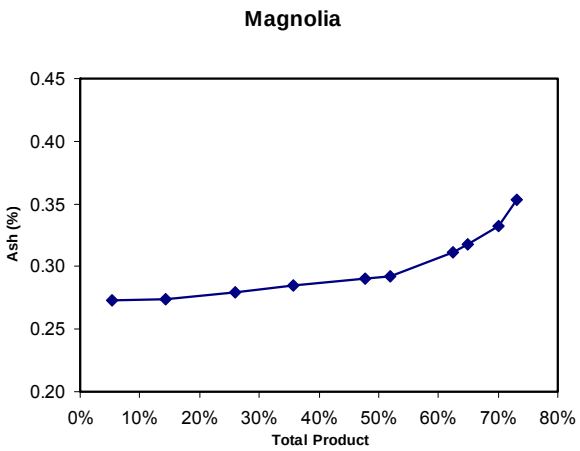
Figure 1e. Armor 260Z

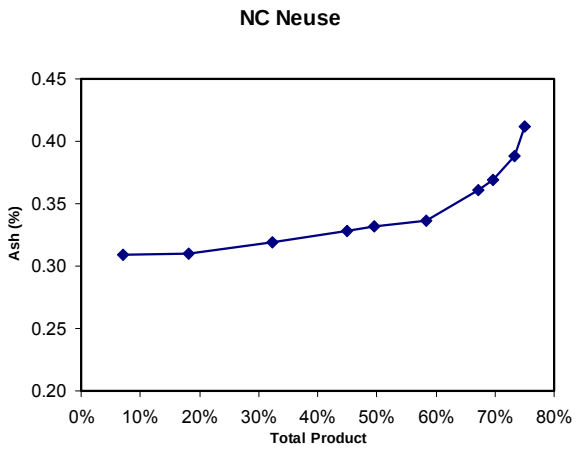
Mill stream	Estimated cumulative ash %	Cumulative flour %
2RED	0.264	6.53
1RED	0.265	17.96
DUST	0.266	32.27
2BR	0.282	45.17
1BR	0.286	49.31
GRA	0.295	57.79
3RED	0.319	67.1
3BR	0.332	69.68
4RED	0.351	73.63
5RED	0.378	75.58

Figure 1f. McCormick

Mill stream	Estimated cumulative ash %	Cumulative flour %
2RED	0.273	5.83
1RED	0.274	16.37
DUST	0.280	28.06
2BR	0.287	42.42
1BR	0.290	46.90
GRA	0.295	55.24
3RED	0.319	64.28
3BR	0.328	67.19
4RED	0.346	70.40
5RED	0.368	71.92

Figure 1 (Continued).. Milling ash curves for ten soft red winter wheat varieties, US Wheat Associates, 2007 Overseas Varietal Analysis.





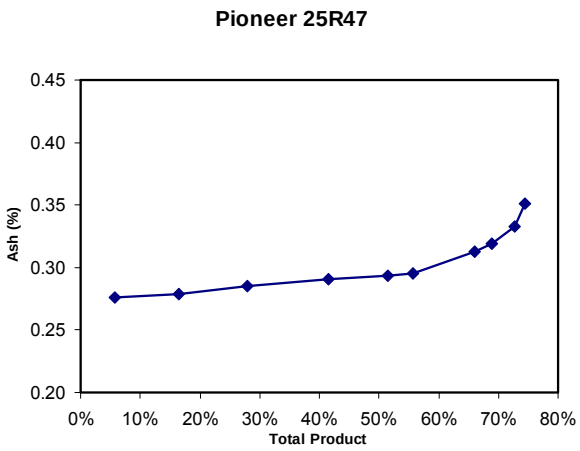


Figure 1g. Magnolia

Mill stream	Estimated cumulative ash %	Cumulative flour %
2RED	0.273	5.30
1RED	0.274	14.41
DUST	0.279	25.93
2BR	0.285	35.65
1BR	0.290	47.65
GRA	0.292	52.01
3RED	0.311	62.40
3BR	0.318	64.88
4RED	0.333	70.13
5RED	0.353	73.12

Figure 1d. NC Neuse

Mill stream	Estimated cumulative ash %	Cumulative flour %
2RED	0.309	7.17
1RED	0.310	18.22
DUST	0.319	32.31
2BR	0.328	44.92
1BR	0.331	49.48
GRA	0.337	58.31
3RED	0.361	67.26
3BR	0.369	69.59
4RED	0.388	73.27
5RED	0.412	74.95

Figure 1i. Pioneer 25R47

Mill stream	Estimated cumulative ash %	Cumulative flour %
2RED	0.276	5.66
1RED	0.279	16.37
DUST	0.286	27.87
2BR	0.290	41.59
1BR	0.294	51.57
GRA	0.295	55.79
3RED	0.313	66.02
3BR	0.319	68.86
4RED	0.333	72.67
5RED	0.351	74.35

Figure 1 (Continued). Milling ash curves for ten soft red winter wheat varieties, US Wheat Associates, 2007 Overseas Varietal Analysis.

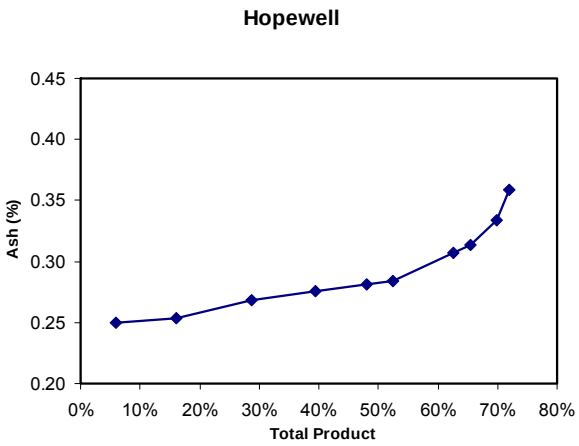


Figure 1j. Hopewell

Mill stream	Estimated cumulative ash %	Cumulative flour %
2RED	0.250	6.00
1RED	0.254	16.06
DUST	0.269	28.74
2BR	0.276	39.34
1BR	0.281	48.09
GRA	0.284	52.54
3RED	0.307	62.49
3BR	0.313	65.40
4RED	0.334	69.84
5RED	0.359	72.01

Figure 1 (Continued). Milling ash curves for ten soft red winter wheat varieties, US Wheat Associates, 2007 Overseas Varietal Analysis

Table 26. USDA ARS Soft Wheat Quality Laboratory wheat analytical values and milling data for ten soft red winter varieties, U.S. Wheat Associates, 2007 Overseas Varietal Analysis.

				Single Kernel Characterization System					
Sample no.	Variety	Wheat protein†	Test weight	hardness	Kernel diameter	Kernel weight	Wheat moisture	Grain alpha amylase	Falling number
		(%)	(lb bu^{-1})	(score)	(mm)	(mg)	(%)	(abs)	(sec)
701	Coker 9553	10.50	63.0	29.5	2.5	37.0	12.1	0.094	475
702	Tribute	8.82	63.1	29.0	2.4	35.2	12.7	0.093	397
703	USG 3665	9.10	59.2	12.5	2.2	31.2	12.7	0.096	469
704	USG 3350	10.95	61.5	34.0	2.3	33.8	12.0	0.101	359
705	Armor 260Z	10.94	63.2	29.8	2.4	33.8	11.6	0.095	482
706	McCormick	9.27	61.9	29.7	2.1	29.3	12.0	0.095	447
707	Magnolia	9.09	62.7	19.8	2.8	42.2	11.7	0.093	396
708	NC Neuse	9.77	60.1	23.2	2.4	30.3	12.2	0.094	410
709	Pioneer 25R47	8.85	60.8	13.5	2.3	35.6	11.6	0.091	391
710	Hopewell	10.75	59.8	23.1	2.4	36.0	8.4	0.111	385

† Values expressed on a 12% moisture basis.

Table 27. USDA ARS Soft Wheat Quality Laboratory flour analytical data for ten soft red winter varieties, U.S. Wheat Associates, 2007 Overseas Varietal Analysis.

Sample no.	Variety	Flour protein†	Flour ash†	Miag Multomat Break flour yield	Straight grade yield	Damaged starch	Alveograph measures††			
							P	L	W	P/L
		(%)	(%)	(%)	(%)	(%)	(mm)	(mm)	($x10^{-4}$J)	
701	Coker 9553	8.89	0.430	26.7	71.6	3.12	41	135	118	0.30
702	Tribute	7.39	0.380	28.1	72.6	2.87	57	73	150	0.79
703	USG 3665	7.53	0.354	34.2	73.4	2.60	34	112	95	0.30
704	USG 3350	9.18	0.358	27.4	74.4	3.16	39	131	142	0.30
705	Armor 260Z	9.40	0.386	28.1	75.6	3.68	34	171	104	0.20
706	McCormick	8.00	0.375	30.1	71.9	2.79	42	118	138	0.35
707	Magnolia	7.58	0.359	28.6	73.1	2.65	49	109	155	0.45
708	NC Neuse	8.43	0.414	28.3	75.0	2.91	21	179	79	0.12
709	Pioneer 25R47	7.25	0.362	30.8	74.4	2.95	23	139	74	0.17
710	Hopewell	8.66	0.365	28.8	72.0	2.60	29	162	89	0.18

† Values expressed on a 14% moisture basis, †† Alveograms for table data presented in Appendix 2

Table 28. USDA ARS Soft Wheat Quality Laboratory solvent retention capacity and cookie baking data for ten soft red winter varieties, U.S. Wheat Associates, 2007 Overseas Varietal Analysis.

	Variety	Solvent Retention Capacity†				Wire-Cut Cookies		
		Water	Sod. Carbonate	Sucrose	Lactic Acid	Diameter††	Stack ht. ††	Force
		%	%	%	%	(cm)	(cm)	(g)
701	Coker 9553	53.9	73.8	93.1	95.1	15.08	2.28	2953
702	Tribute	54.8	71.2	91.5	107.7	15.66	2.04	1975
703	USG 3665	52.6	69.2	84.7	91.8	15.95	1.99	2016
704	USG 3350	51.8	65.0	87.8	91.5	15.13	2.31	2473
705	Armor 260Z	53.2	68.9	88.4	89.8	14.62	2.34	3408
706	McCormick	53.0	70.1	89.7	102.5	15.97	1.94	2351
707	Magnolia	53.7	72.0	92.9	108.2	15.42	2.07	2391
708	NC Neuse	49.0	62.9	86.7	97.7	15.83	1.97	2078
709	Pioneer 25R47	51.4	66.9	80.5	93.1	16.65	1.75	1919
710	Hopewell	51.2	73.0	89.7	103.1	15.78	2.09	2083

† Explanation of solvent retention capacity test in Appendix, p. 71, †† Sum value of two cookies averaged over two bakes.

Table 29. USDA ARS Soft Wheat Quality Laboratory Rapid Visco-Analyzer flour pasting values for ten soft red winter varieties, U.S. Wheat Associates, 2007 Overseas Varietal Analysis.

ample number	Variety	Peak height	First trough	Break-down	Final visc.	Setback	Peak time	Peak to final
		(cP)	(cP)	(cP)	(cP)	(cP)	(min)	(ratio)
701	Coker 9553	3450	2154	1296	4019	1865	6.07	0.86
702	Tribute	3107	1791	1316	3360	1569	5.97	0.92
703	USG 3665	3541	1973	1569	3581	1608	5.94	0.99
704	USG 3350	3240	1892	1348	3579	1687	5.93	0.91
705	Armor 260Z	3345	2076	1269	3751	1675	6.04	0.89
706	McCormick	3723	2399	1324	4208	1810	6.17	0.88
707	Magnolia	3281	1810	1471	3413	1603	5.93	0.96
708	NC Neuse	3292	1864	1428	3572	1709	5.90	0.92
709	Pioneer 25R47	3286	1864	1422	3521	1657	5.87	0.93
710	Hopewell	1649	1047	602	2165	1118	5.53	0.76

Historic Perspective of Wheat Characterization

Compiled by Lon Andrew

Beginnings of Wheat Characterization

The following was excerpted from USDA Bulletin No. 1074, “Classification of American Wheat Varieties”, authored by J. Allen Clark and others published in 1922.

The existence of many different varieties of wheat has been recognized for more than 2,300 years. Theophrastus, a pupil of Plato, in his “Enquiry into Plants”, had written about 300 B.C. E., states:

> There are many kinds of wheat which take their names simply from the places where they grow, as Libyan, Pontic, Thracian, Assyrian, Egyptian, Sicilian. They show differences in color, size, form, and individual character, and also as regards their capacities in general and especially their value as food.

Theophrastus mentioned many of the differences between those kinds of wheat. In the writings of Varro, Pliny, and Columella, in the first century B.C. E. and the first century C.E., the observations of Theophrastus were repeated, rearranged, and amplified. Columella, who wrote about 55 C.E., presented those previous observations and his own, as follows:

Triticum, common bare wheat which has little husk upon it, was, according to Varro, a name given formerly to all sorts of grain beaten or bruised out of ears by trituration or thrashing; but afterwards, it was given to a peculiar species of grain, of which there are many sorts, which take their name from the places where they grow, African, Pontic, Assyrian, Thracian, Egyptian, Silician, etc., and which differ from one another in color, bigness, and other properties too tedious to relate. One sort has its ears without beards and is either of winter or summer. Another sort is armed with long beards and grows up sometimes with one, sometimes with more ears. Of these the grains are of different sorts: some of them are white; some reddish; some round; others oblong; some large; others small. Some sorts are early ripe; others late in ripening; some yield a great increase; some are hungry and yield little; some put forth a great ear; others a small. One sort stays long in the hose; another frees itself very soon out of it. Some have small stalk or straw; others have a thick one as the African. Some are clothed with few coats; some with many, as the Thracian. Some grains put forth only one stalk; some many stalks. Some require more, some less time to bring them to maturity. For which reason some are called trimestrian, some bimestrian; and they say that in Euboea there is a sort which may be brought to perfection in 40 days; but, most of these sorts which ripen in a short time are light, unfruitful, and yield very little, though they are sweet and agreeable to the taste and of easy digestion.

In the early Roman literature mentioned reference is found to two groups of wheat: namely, *Triticum* and *adoreum*, or *far*. Columella referred to the *far* as bearded wheat. The grain of *triticum* was separated from the chaff in thrashing, while that of the *far* was not, indicating that the former consisted of true wheats, while the latter was emmer or spelt.

Many centuries later, during the mid 1700's, Linnaeus divided the common wheat, *Triticum vulgare*, into two species, *Triticum aestivum* (awned spring) and *Triticum hybernum* (awnless winter), apparently believing that all spring wheats were awned and all winter wheats awnless.

Clark, in 1922, offered the following summary: the making of botanic species of wheat was carried to great lengths by the botanists of 100 to 200 years ago where 50 or 60 supposed species of wheat had been described. They did not recognize that the characters sufficient to separate species of wild plants were sufficient to separate only agronomic and horticultural varieties of domesticated plants.

Destontaines, in 1800, established the species *Triticum durum* for the group of wheats having long awns and long vitreous kernels.

Host, in 1805, described and named the species *Triticum compactum* to include the club wheats and in addition recognized 10 other species of the genus *Triticum*.

Hueze, in 1872, grouped the wheats into 7 species. He listed 700 varietal names of wheat, 602 of which belonged to the species *Triticum sativum*, which included both common and club wheats. He described 47 varieties in this species, while the remaining 555 names were considered as synonyms.

History of Several American-Grown Wheat Varieties

Descriptions of wheats were compiled by Lon Anderson using breeder and grower information and extractions from a publication entitled “Classification of American Wheat Varieties”, November 8, 1922, by J. Allen Clark, John H. Martin and Carleton R. Ball. Dr. David Smith, Beltsville, MD, and Dr. Harold Bockelman, Aberdeen, ID, were invaluable in their participation by providing seed for more than 200 historic varieties that were ultimately grown in conjunction with contemporary cultivars. The quality information was derived from the USDA Soft Wheat Quality Laboratory.

Armor 3235

The test weight for Armor 3235 will be about 1 pound higher than the reference cultivars found in the normalized test weight tables. Kernel weight was about average and the milling quality was very good. The break flour yield indicated the cultivar to be slightly below average in flour granulation. Gluten strength appeared to be above average.

Aubrey

Aubrey is a white cultivar that will likely be about .4 pound higher in test weight than Chelsea and about .4 pound lower than Frankenmuth. Kernel weight was slightly smaller than average. Aubrey had very good milling quality and the flour granularity was softer than the average for soft wheat. Cookie spread was on the smaller side but within the range of good soft wheat. The gluten strength was slightly above average with an Allis-Chalmers lactic acid SRC of 97%.

Aurora

This white cultivar has the same test weight characteristics as Aubrey, but the kernel weight will be above average. Aurora has good milling quality and average softness. The cookie spread was very large and would place among the top of all soft wheat cultivars. The gluten strength was low as revealed by a lactic acid SRC of 81%.

Bascom

Steyer Seeds marketed this cultivar and will be about 1.3 pounds higher in test weight than the zero-standard cultivars. Bascom had superior milling quality similar to Pioneer 25R47, Caledonia and FI 302. It has excellent cookie spread. The cultivar has weak gluten strength.

Beck 102
Beck 102 has many good quality traits. It will be about 2 pounds greater in normalized test weight similar to Coker 9803, Elkhart and Kaskaskia. It has good milling properties, possesses very fine flour granulation, good cookie spread and has weak gluten.

Beck 110
This soft red cultivar has a 2.5 normalized test weight and would be similar to AGS 2000, Coker 9474 and Geneva. Beck 110 produced good cookie spread and was weak in gluten strength.

Bowerman
Bowerman was introduced by Steyer Seeds and possesses a number of good quality traits. The average normalized test weight was 2.4 pounds higher than the reference cultivars. The kernel weight was large at 38.8 grams and the milling quality was superior. Bowerman would be similar in milling performance to Cardinal, Superior (SWW) and Pearl (SWW). The granularity was very soft and has good cookie spread. The gluten strength was determined to be weak-medium.

Brazen
Brazen was released by Gries Seeds and has very soft flour characteristics, good cookie spread and was weak in gluten strength.

Bravo
'Bravo' is an awnletted, tan-chaffed cultivar with a dark green plant color at boot stage. Bravo's phenol reaction is "dark brown" Stems are hollow with 4 notes and show a slight waxy bloom under normal growing conditions.

Spikes are inclined, oblong in shape and middense, avergting 7.8 cm in length. The last rachis internode is glabrous. Glumes are tan, medium in length and width, glabrous with acute beaks and square shoulders. Kernals are elliptical in shape with rounded cheeks. The crease is narrow and mid-deep. The brush is medium and non-collared. Kernels average 7.3 mm in length and 3.9 mm in width. Seed weight is 41 mg.
Bravo appears similar to 'Freedom' (a Title V protected cultivar – PVP Certificate # 9200253). Bravo is similar in height to Freedom and is also similar to Freedom in straw strength as measured by resistance to lodging. However, at maturity, Freedom has a distinct yellow chaff color while Bravo is best described as tan. Bravo also averaged 6 d earlier in maturity than Freedom. In yield trials planted at Wooster, Ohio in 1997, 1998 and 1999, the average yield of Bravo was 739 Kg ha-1 greater than Freedom.

The USDA Soft Wheat Quality Lab at Wooster, Ohio evaluated Bravo in 1995 and 1996. It was shown to have both excellent milling and excellent baking quality. Baking quality was similar to Freedom in 1995 but milling quality exceeded Freedom in both 1995 and 1996. Straight grade flour yield is similar to Freedom. Tests for softness showed Bravo to be similar to Freedom in 1995 but in 1996, Bravo had a higher softness equivalence score than Freedom.

Bravo – PVPA 1994 – Title V- May be sold only as a class of Certified Seed. BRAVO is an exclusive release to Central Ohio Seed Testing as a proprietary, Certified cultivar.

Bravo is a very early heading cultivar, averaging 5 days earlier than Hopewell or Freedom. It has excellent test weight averaging about 2 lbs/bu above Hopewell. It is a beardless, white chaffed cultivar most closely resembling Freedom among current cultivars, but taller and much earlier. Bravo has shown good resistance to leaf rust and excellent resistance to powdery mildew. It aslwo appears highly resistant to soilborne mosaic virus and wheat spindle mosaic virus. Bravo has no resistance to Hessian fly. Milling and baking qualitiy scores for this variety have been excellent. No seed stock sales are permitted to non-licensed companies or to international firms without the permission of the owner of the variety. A license is required to produce seed of this variety.

Caledonia Resel-L (Dropped from release)

Pedigree: Tall off-type with a less dense spike selected out of Caledonia. Over 4 years, this line is slightly higher in grain yield than Caledonia, Richland, and Jensen. Four year means are 75, 74, 73, 72 b/a for CaledoniaResel-L, Richland, Caledonia, and Jensen, respectively. CaledoniaResel-L has excellent test weight averaging 57.7 lbs/bu over 2 years versus 56.3 lbs/bu for Caledonia and 57.1 for Richland.

Winter survival is similar to current varieties. CaledoniaResel-L is slightly less lodging resistant compared to Richland or Caledonia. CaledoniaResel-L is more resistant than current varieties to Fusarium Head Blight (scab). It is resistant to Wheat Spindle Streak Mosaic Virus and susceptible to Wheat Soil Borne Mosaic Virus. The powdery mildew resistance is better than most other current varieties except Richland and Jensen. Seedling tests at Virginia Tech show that CaledoniaResel-L is resistant to a powdery mildew composite with virulence for resistance genes Pm1,2,3,3a,3c,3f,4a,4b,5,6,7. CaledoniaResel-L is moderately susceptible to leaf rust race TNRJ. Reaction to other diseases is unknown.

CaledoniaResel-L has been evaluated for milling and baking quality over four years and produced satisfactory milling and baking scores slightly below Caledonia and Richland but acceptable. It is moderately susceptible to preharvest sprouting with a sprouting score higher than Jensen but lower than other current varieties.

Plant height is about 103 cm compared to 87 cm for Caledonia and 101 for Richland. This line is awnless and has white chaff color. Heading date about 2 days earlier than Caledonia or Richland.

Status of Breeder Seed: Breeder seed increases were produced in 2006 and 2007, however 3-5% red kernels were observed in the seed lots produced. NYSIP sent 20 Bu to the Engineering Research Unit at the USDA ARS Grain Marketing and Production Research Center in Manhattan, KS for kernel sorting. They sent back 13.2 bu that had an average of 0.6% red in the sorted sample.

China

There were several differing histories of the origin of China wheat that were recorded in literature, but the following was thought to be the correct history of the variety. In 1851 the Rural New Yorker gave the following account of the origin of China wheat, which appeared for the first time in the Niagara Democrat:
"The kernels from which they (specimens) grew were originally brought from China some six years ago (1845). The seed was handed to Mr. Caverns by O. Turner, the popular local historian, who obtained them from the then lately returned Minister to China, Honorable Caleb Cushing. From a small quantity received by Mr. Caverns for experiment, an amount sufficient to give it extensive and permanent culture has been received".

In 1919, China was grown on 63,900 acres in Illinois, Indiana, Kentucky, Maryland, New Jersey, Pennsylvania, Virginia and West Virginia. China occupied about 4,800 acres in 1939 and there was no reported acreage by 1949.

China was also known as Bluestem, Lebanon Valley, Mortgage Lifter and Pennsylvania Bluestem.

Bluestem and Pennsylvania Bluestem were names widely used for China in the various States where it was grown. A.H. Hoffman, seedsman, of Landisville, Pennsylvania, had distributed the variety in that state under the name 'Pennsylvania Bluestem.'

Lebanon Valley was the name under which a sample of China was obtained from R. Chester Ross, of Honey Brook, Pennsylvania, who stated that the variety "Originated in Lebanon Valley, Pennsylvania."

Mortgage Lifter was the name under which a sample of China was obtained from the Cornell University station in 1912.

A five-gram sample of China was acquired in the late 1980's from the National Collection. Thousand-kernel weight was very large at 39.5 grams. China had marginal milling properties with a mill score of 53.6. The range in mill score for all cultivars was 97.8 to 17.9. China had typical soft wheat softness, low AWRC and low flour protein, but produced a small cookie spread. Cultivars that have low milling quality usually yield reduced cookie spread. Gluten strength was medium weak. **Dawson**

Dawson, a soft white winter variety, was originated in 1881 by Robert Dawson, of Paris, Ontario, Canada. According to Mr. Dawson, "it was selected in a field of Seneca or Clawson, in which he found one plant quite distinct and much superior to the rest of the crop. Mr. Dawson sowed the grain from this plant and has continued to grow this wheat since. It was practically unknown over Ontario until tested at the experimental station along with many old and new varieties and the comparative results published. It has ranked first in yield from the beginning".

Dawson was synonymously known as American Banner, Dawson Golden Chaff, Golden Bronze, Golden Chaff, Improved Amber and White Winter in 1919.

American Banner was acquired from the National Small Grains Collection and was grown in Wooster, Ohio. American Banner had a similar appearance to that of Dawson, but it had different quality characteristics from those of Dawson.

Golden Bronze was simply the name under which a strain of this variety was being grown at the Cornell University Agricultural Experiment Station.

Golden Chaff was a shortening of the name Dawson Golden Chaff.

Improved Amber was the name under which a sample of Dawson was obtained from the Wisconsin station.

White Winter was a local description name used for Dawson by farmers.

Dawson was grown in Illinois, Indiana, Kentucky, Massachusetts, Michigan, Missouri, New York, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and Wisconsin at that time (1919). It was grown on 125,500 acres. By 1944, Dawson was grown on 461,000 acres; but, decreased greatly ten years later to the level of 2,960 acres in 1954.

Dawson was obtained from the National Small Grains Collection in the late 1980's by the SWQL. It was grown for a number of years in Wooster, Ohio, along with other historic varieties and today's contemporary cultivars. Dawson had excellent field yield which equaled the yield of many cultivars that were introduced as late as the 1960's. Dawson had about 75% of the yield of cultivars from the 1990's. Dawson had very good milling properties and had typical softness. It seemed to have genetically high test weight, normal flour protein (as compared to modern cultivars), good cookie spread and had low gluten strength.
AgriPro released a soft red winter cultivar about 2001 named Dawson, which is different from the historical variety Dawson.

Douglas
Douglas was released by AgriPro as a soft red winter wheat. The cultivar displayed very good milling properties and possesses low gluten strength, which may be desirable for formulations requiring high liquid levels.

Feck
Feck was released by Steyer Seeds and appeared to be about 1.3 pounds greater in test weight than the reference cultivars in the test weight data base. Kernel weight was average. Milling quality was good and flour granularity was normal. Cookie spread was good and flour protein may be a slightly elevated. Gluten strength was strong and had similar lactic acid SRC to Pioneer 25R26.

Flint
The origin of Flint wheat was undetermined. It was known to be an old wheat of the eastern U. S. The early names for the variety and the literature concerning them were very confusing. A White Flint, claimed to have been introduced from Spain in 1814, which became widely grown in the Eastern States from 1830 to 1850, was described by Harmon as awnless, with white glumes and hard white kernels. There was no winter wheat of that description grown in the early 1900's, and the Flint wheat that was in cultivation in the early 1900's had red kernels and was similar to wheat known as Little Red May, Early May and Rappahannock. These were all old names in American wheat literature.

Little Red May was brought into Tennessee by Joseph Jacobs from Missouri, no doubt having been taken there from Kentucky or Virginia. In some sectors of Missouri, Little Red May had become a very popular variety. Early May was listed as a variety grown in Iowa as early as 1852 which later became an important variety in that state. At least some of the wheat grown under that name was Flint. The same was true for Rappahannock, which also was synonymous with Red May and in 1875 was recorded as synonymous with Michigan Amber. Rappahannock and Red May were reported by J. J. Collins, Spartanburg, South Carolina, as synonymous names for a wheat similar to Flint which had been grown for 25 years in that vicinity. Rappahannock was also reported from Oregon County, Missouri.

J. Allen Clark reported in 1919 that Flint was also known as Early May, Little May, Little Red, Little Red May, May, Rappahannock, Red Davie and Red May. The name Early May had long been used for Flint wheat. It was reported under that name in Alabama, Arkansas, Illinois and South Carolina. Little May was reported from Platte County, Missouri, and Little Red from Arkansas, Georgia, North Carolina, Tennessee and Virginia. Little Red May and May were occasionally used for Flint wheat. Red Davie was a local name for Flint in Surry and Wilkes Counties, North Carolina. According to J.B. Fells, Red Davie had been grown for 50 years in the vicinity of Elkin, North Carolina.

Flint was grown on 97,200 acres of the east-central United States in 1919. It was distributed in Alabama, Arkansas, Georgia, Illinois, Missouri, North Carolina, Ohio, South Carolina, Tennessee, Virginia and West Virginia. Flint was grown on 3,185 acres in 1959. Flint was acquired from the National Small Grains Collection in 1986. A separate sample was received from North Carolina in 1991 (presumably obtained from the National Collection). Those samples of Flint were grown several years in Wooster, Ohio, where the yields were 50% lower than the yields of the contemporary cultivars.
Flint had very good milling properties. 1000-kernel weight averaged 34 grams. The baking quality (sugar snap cookie) was not very good. Protein content was about 2 percentage points higher than the modern cultivars which may have contributed to the reduced cookie spread. Flour granularity was a little coarser than most contemporary cultivars and corresponded to that of Arthur, Delta Queen and FFR 566W. Gluten strength was about medium.

FS 530

FS 530 was released by the Illinois Crop Improvement Association. Test weight may be about 1.5 pounds above the reference wheats. Kernel weight and cookie spread were average. Milling quality was very good having a mill score of 75. Flour granularity was extremely fine placing FS 530 in a group with other super-fine granulating cultivars possessing a trait that has been very uncommon. Gluten strength was about medium.

Fulcaster

Fulcaster was one of the most popular and widely grown varieties of soft red winter wheat in the United States. According to Carleton, "Fulcaster was produced in 1886 by S. M. Schindel, of Hagerstown, Maryland, and is a hybrid between Fultz and Lancaster," the latter being a synonym for the Mediterranean variety.

Fulcaster was grown on 2,600,000 acres in 1919 under the name of Fulcaster or as one of its many synonyms in Alabama, Arkansas, Delaware, Florida, Georgia, Illinois, Indiana, Kansas, Kentucky, Maryland, Mississippi, Missouri, Nebraska, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Virginia and West Virginia. By 1959, Fulcaster occupied 59,000 acres. Numerous synonyms for Fulcaster were identified in 1919 as Acme, Acme Bred, Bearded Bluestem, Bearded Purplestraw, Blankenship, Blue Ridge, Bluestem, Canadian, Champion, Corn, Cumberland Valley, Dietz, Dietz Longberry, Dietz Longberry Red, Ebersole, Eversole, Egyptian Amber, Farmers Friend, Georgia Red, Golden Chaff, Golden King, Greening, Improved Acme, Ironclad, Kansas Mortgage Lifter, Kentucky Giant, Lancaster, Lancaster-Fulcaster, Lincoln, Martha Washington, Michigan Red Line, Moore's Prolific, Number 10, Price's Wonder, Red Wonder, Turkish Amber, Tuscan Island and Winter King.

Stoner was a variety introduced under suspicious circumstances. Because extravagant claims were made about it, there apparently was a desire from many to acquire Stoner and rename it; it became known under many different names. Stoner was identified in 1919 as being Fulcaster. An interesting historical account of Stoner follows near the end of brief descriptions concerning other synonyms. Stoner was also known as Eden, Famine, Forty-to-One, Goose, Half Bushel, Kentucky Wonder, Marvelous, Millennium, Millennium Dawn, Miracle, Multiplier, Multiplying, New Light, New Marvel, Peck, Russellite, Russell's Wonder, Stooling, Two Peck, Three Peck and Wonderful.

Acme and Acme Bred were names applied to strains of Fulcaster by S. M. Schindel, seedsman, of Hagerstown, Maryland, about 1911.

Bearded Bluestem, Bluestem and Bearded Purplestraw were names used for Fulcaster because the variety had purple stems.

Blankenship was reported in Missouri to be "very hardy", almost fly-proof, branched well and laid close to the ground in winter.

Corn was used for Fulcaster in Cumberland Valley, Pennsylvania. Corn wheat, however, usually referred to Polish wheat.

Dietz Longberry was reported to have been originated by George A. Dietz, of Chambersburg, Pennsylvania. The earliest record of the wheat was under the name "Dietz" and was included in variety experiments at the Ohio Agricultural Experiment Station in 1884. Dietz was later called Dietz Longberry and subsequently as Dietz Longberry Red. The true origin of Dietz and Fulcaster was somewhat obscure. The former had the earlier published history. However, according to N. Schmitz, formerly of the Maryland AES, Mr. Schindel claimed that Mr. Dietz merely gave the name Dietz Longberry to his Fulcaster wheat. Some wheat reported as Dietz was Mediterranean.

Georgia Red was the name under which Fulcaster wheat was distributed by H. G. Hastings & Co., seedsmen, of Atlanta, Georgia.

Lancaster was a name often wrongly applied to Fulcaster wheat. Lancaster-Fulcaster was a name of Pennsylvania origin applied by A. H. Hoffman, seedsman, of Landisville, Pennsylvania, to Fulcaster wheat grown in Lancaster County, Pennsylvania.

Price's Wonder was the name of a wheat identical to Fulcaster which was distributed for the first time in 1913 by A. H. Hoffman, of Landisville, Pennsylvania. Mr. Hoffman gave the following account of its origin: "Price's Wonder was originated by Prof. R. H. Price, of Virginia, who worked with it five years, during which it yielded one-third more wheat than other kinds of wheat growing under like conditions."

Red Wonder was the name under which Fulcaster wheat had been distributed by T. W. Wood & Sons, seedsmen, of Richmond, Virginia, since about 1903. The name Red Wonder, however, was recorded for a wheat of unknown character as early as 1892.

Stoner could not be distinguished from Fulcaster by any character. The history of Stoner was recorded by Ball and Leighty as follows: "Stoner originated on the farm of Mr. K. B. Stoner, of Fincastle, near Roanoke, Virginia. It was brought to the attention of the USDA through a letter from Mr. Stoner, dated June 8, 1906. In the spring of 1904 Mr. Stoner noticed a large bunch of grass in his garden; when headed, it proved to be wheat. It had 142 stems, or tillers, and he became impressed with the idea that it was a very wonderful wheat. Just how the kernel of wheat became sown in the garden or from just what variety it came Mr. Stoner does not know. The Fulcaster variety was commonly grown in that section of Virginia, however, and the Bearded Purplestraw less commonly. It is reasonable to suppose, therefore, that the Stoner wheat is a pure line from one of these varieties."

Mr. Stoner increased his seed during the two years, 1905 and 1906, and distributed it in 1907, usually under the name "Miracle". Many extravagant claims were made for it by Mr. Stoner and agents who handled the seed. Because of those claims it afterwards became known under many other names. During 1911 and 1912 the variety was advertised and sold at $1 a pound by the Watch Tower Bible and Tract Society of Brooklyn, New York, under the leadership of "Pastor" Russell. The names Eden, Famine, Millennium, Millennium Dawn, New Light, Russellite and Russell's Wonder were the result of the advertising and distribution by "Pastor" Russell, who claimed the wheat to be a creation in fulfillment of Biblical prophecy which would replenish the earth.

The name Eden was used to imply that the wheat came from the Garden of Eden. Forty-to-One was the name that became applied to Stoner wheat with the inference that that was the ratio of its increase from the seed sown. The names Half Bushel, Multiplier, Multiplying, Peck, Stooling, Two Peck and Three Peck became widely applied to the Stoner variety on account of the claims made by Mr. Stoner that the wheat had such remarkable tillering or stooling powers that only a small quantity of seed was necessary to sow an acre.

Marvelous was a name used for Stoner wheat by J. A. Everitt (O. K. Seed Co.), Indianapolis, Indiana, in 1908 and later. Wonderful was the name used for Stoner in Kansas.

Fulcaster was obtained from the National Small Grains Collection, Beltsville, Maryland, in 1987. Fulcaster yielded about 62% of the yield of the contemporary cultivars with which it was grown in 1999. Its genetic test weight would be about 2 pounds greater than the zero-reference cultivars listed in the normalized test weight tables. The one-thousand kernel weight was large with 37.5 grams. Fulcaster had very good milling properties and average softness. The flour protein was high at 11.4%, but baked sugar snap cookies were of descent spread. The gluten strength for Fulcaster was weak.

Fultzo-Mediterranean

The origin of Fultzo-Mediterranean was not definitely known. Many synonyms were used for the variety, one of which may be the original name. The variety was first distributed as Fultzo-Mediterranean by Everitt's O. K. Seed Store, Indianapolis, Indiana, in 1898. The variety was evidently named by that firm, and it was claimed by them to have originated from a cross between Fultz and Mediterranean. The following statement concerning its origin was made in their catalogue in 1899:

"Married.—Two Noble Old Families Joined in Wedlock—Mr. Fultz to Miss Mediterranean. Their first-born is well named, Fultzo-Mediterranean, and is a worthy offspring from Noble Stock."

Fultzo-Mediterranean showed no indication of having been derived from Mediterranean, although it had many of the characters of Fultz. Fultzo-Mediterranean was very distinct from Fultz in having very strong stems and erect, dense, clavate spikes. Neither of the alleged parents had the clavate spike of the Fultzo-Mediterranean.

Fultzo-Mediterranean was grown on 287,900 acres in 1919. In 1949, it occupied 2,010 acres and ten years later was not reported by growers. In 1919, the variety was grown in Delaware, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Missouri, North Carolina, Ohio, Oklahoma, Pennsylvania, Tennessee, Virginia, and West Virginia.

Synonyms for Fultzo-Mediterranean in 1919 were; Burrhead, Club, Club Head, Columbia, Double Head, Duck Bill, Early Ontario, Economy, Farmers Pride, Flat Top, Four-Row Fultz, Harper, New Columbia, Scott's Squarehead, Square Head, Square Top, and Stud Head. Of these, the names Burrhead, Club, Club Head, Double Head, Duck Bill, Flat Top, Square Head, Square Top, and Stud Head were names used for Fultzo-Mediterranean in several of the Eastern States, particularly North Carolina, Virginia, and West Virginia. In that section it was often wrongly referred to as Club wheat.

The names Columbia and New Columbia were known to be old names for the variety. In fact, New Columbia was used for the variety by Everitt in the same year he first distributed it as Fultzo-Mediterranean and evidently also before that time, as the following quotation was from the same catalogue as the quotation about the Noble Families:
"An Illinois production and first made public the year of the great World's Fair. Too much cannot be said in its praise for hardiness, vigorous growth, and productiveness. In short, it has great merit and is entitled to be called our national wheat, as it bears our national name. Smooth head, white chaff, plump red grains. Wherever sown it makes friends."

New Columbia was reported grown in Illinois, Indiana, Kentucky, Missouri, North Carolina, Ohio, and Tennessee.

Early Ontario was the name under which wheat similar to Fultzo-Mediterranean was obtained from the Ohio Agricultural Experiment Station in 1916. A wheat of unknown characters was obtained under that name by the United States Department of Agriculture in 1902 from William Rennie, seedsman, of Toronto, Canada. Early Ontario was not reported in the varietal survey of 1919.

Four-Row Fultz was a name under which Fultzo-Mediterranean was advertised and sold by A. H. Hoffman, seedsman, of Landisville, Pennsylvania, and was reported grown in that state. A sample of Four-Row Fultz was obtained from that source in 1913.

Scott's Squarehead was the name under which a sample of wheat similar to Fultzo-Mediterranean was obtained from the Kansas Agricultural Experiment Station in 1916. Its further history was undetermined and it was not reported in the survey.

In 1987, a 5-gram sample of Fultzo-Mediterranean (CI # 4811) was acquired from David Smith, curator of the National Small Grains Collection. The variety was grown in Wooster, Ohio, over six seasons. In conjunction with a private industrial research organization, Fultzo-Mediterranean was selected as one of 88 varieties/cultivars, because of specific quality traits, and was grown in three States for the 2003 harvest. The project will continue for at least two more years.

Fultzo-Mediterranean had fair milling properties similar to the milling quality of Ernie, Hoffman 14, Hopewell and Pioneer 25R18. The 1000-kernel weight averaged 36.6 grams. Flour granularity was typical for soft wheat and similar to that of Coker 9152, Foster and Mallard. Flour protein was about 1 percentage point higher than contemporary cultivars. Sugar snap cookie spread was about 1 cm smaller than most modern soft wheats. Flour protein was not great enough to account for the very small cookies, but there is a tendency for cookie spreads to be smaller as milling quality lowers. AWRC was higher than most soft wheat cultivars, which may, in addition to the lower milling quality, contribute to the small cookie diameter. The variety displayed medium gluten strength.

Gipsy

The origin of Gipsy wheat was undetermined. It was grown in Missouri as early as 1877 and at the Ohio Agricultural Experiment Station by 1888. There was a tradition that the name was given the variety because it was first obtained from a gipsy (British variant).

Gipsy was grown on 122,500 acres in 1919 and only occupied 1,255 acres by 1949. Gipsy was distributed in 1919 in Arkansas, Delaware, Illinois, Indiana, Kansas, Kentucky, Michigan, Missouri, New Jersey, Ohio, Pennsylvania, Virginia and West Virginia.

Synonyms for Gipsy were Defiance, Egyptian, Farmers Friend, Golden Straw, Grains o'Gold, Gipsy Queen, Lebanon, Niagara and Reliable.

Defiance was the name under which a wheat practically identical with Gipsy was obtained from the Missouri Agricultural Experiment Station in 1913. Defiance probably was wrongly applied to the acquired wheat as the writers were not able to find any other record of such application. Grains o'Gold was a name applied to a mixed lot of wheat by the J. A. Everitt Seed Co. (O. K. Seed Store), Indianapolis, Indiana, that was distributed about 1912. They stated it was originated by E. K. Adams, of Allendale, Illinois. The samples contained a considerable proportion of Gipsy with admixtures of Fulcaster, Fultz and Fultzo-Mediterranean.

Lebanon was similar to Gipsy though it appeared to have a slightly harder kernel. Its origin was undetermined but had been grown by the Ohio Agricultural Experiment Station since about 1893.

Reliable was a wheat of undetermined origin, practically identical with Gipsy. It was grown by the Ohio Station as early as 1888.

Gipsy was acquired from the National Small Grains Collection, Beltsville, MD, in 1987 and was grown a few different years with contemporary cultivars of the 1990's. Gipsy had unusually high test weight averaging about 4 pounds higher than the reference cultivars found in the normalized test weight table. The kernel size was fairly small with 32 grams per thousand kernels. It had very good milling quality with average softness. The cookie spread was respectable considering the average flour protein of 10.4%. Gipsy had weak gluten strength.

Gladden

In the publication "Ohio Farmer", in 1920, Professor C. G. Williams of the Ohio Agricultural Experiment Station stated that Gladden wheat originated from a single head of wheat selected from a field of Gipsy wheat in 1905, and was first grown in 1906 under the number 6100. 6100 was grown in head rows along with Gipsy, Fultz, Poole and other varieties. Head selection 6100 had many of the characteristics of Gipsy wheat, being bearded, having a white chaff and red kernels. Professor Williams consulted the old notebooks from 14 years earlier and found that 6100 was described as "very erect" in growth, the words were underscored, and given the highest rank for stiffness of straw of any of the Gipsy rows, and as high a rank as any row in the test. Williams indicated that photographs were taken in 1907, 1910, and 1915 which showed more than ordinary stiffness of straw. In-so-far as yield was concerned, Williams stated that it had to stand high from the start or be cast aside. A vast majority of the heads tested were weeded out each year due to ordinary yield.

In milling and baking tests in 1915 the Gladden showed superior qualities. (The milling test was likely carried out at the Ohio Experiment Station since they had purchased two Allis-Chalmers roll stands in 1909. Milling data gleaned from lab reports from the early 1940's of the Soft Wheat Quality Laboratory confirmed that Gladden was one of the best milling soft wheat varieties in the United States.)

Williams added that the variety passed along under the name 6100, until 1915, when it was thought best to give it a real name in order to prevent confusion, since it had been distributed quite a little over Ohio. It was named for Washington Gladden, a man who was not associated with agriculture particularly, but he was the most useful citizen Ohio had for many years.

In 1919, Gladden was grown on about 7,700 acres in Ohio. Gladden had reached its peak by 1924, but was an insignificant variety. By 1949, it was essentially gone from production while Gipsy was still being grown on about 1,255 acres in 1949.

Gladden was acquired from the National Small Grains Collection in 1986, but did not survive the Ohio winter when grown even though protected. It may be that due to favorable climatic circumstances in the early 1900's Gladden was not identified as being insufficient for winter hardiness and that may be the reason it did not become a more popular variety. Another request from the National Collection for Gladden in the late 1980's was not successful since there was limited seed. However, after a recent inquiry, Dr. Harold Bockelman was able to provide a 5-gram sample of Gladden for 2004 fall multiplication.

Goens

The Goens variety, under the names Red Chaff and Red Chaff Bearded, had long been known in the United States. According to John Klippart, who wrote in 1857 an essay on the origin, growth, diseases and varieties of the wheat plant, Goens was "cultivated in Clermont County, Ohio, for upwards of 50 years." He further stated that the origin of the name Goens was undetermined. Wheat under the name Goens was first obtained by the United States Department of Agriculture in 1912 from Indiana Agricultural Experiment Station through Cornell University.

Goens was said to have been introduced into Muskingum County, Ohio, by John Dent in 1808. The Red Chaff wheat mentioned earlier, however, may have actually been the Mediterranean variety as Goens had been said to be a cross between Mediterranean and Gipsy made by a man named Goens in Ohio and afterwards developed by his son.

The authors apparently wrote to Russell G. East who was the Shelby County agent located in Shelbyville, Indiana, concerning the introduction of the Goens variety (but synonymously named Shelby Red Chaff) into Shelby County, where it was the leading variety. Russell G. East responded: "Answering your inquiry regarding Shelby Red Chaff wheat. In 1887, a man named Hall (J.M.Hall) living at Fountaintown, in this county, purchased a carload of seed wheat in Paulding County, Ohio.

From this start this variety has become the common variety grown throughout the county and has been known locally as Hall, Red Hall, Red Chaff, and Red Chaff Bearded." Goens has purple straw and the spikes tend to shatter more easily.

In 1919, Goens was grown on 132,600 acres in Indiana, Michigan and Ohio, and under names of synonyms in Illinois and Pennsylvania. Goens was still being grown on more than 110,000 acres in 1949. By 1959, nearly 150 years after its beginnings, Goens was occupying about 7,000 acres.

Goens, around 1919, was also known as Baldwin, Cummings, Dunlap, Dunlop, Going, Hall, Miller's Pride, Owen, Red Chaff, Red Chaff Bearded, Red Hall and Shelby Red Chaff. The name Baldwin was used locally for Goens wheat in Madison, Pickaway and Union Counties in Ohio.

Cummings was the name of a wheat apparently identical with Goens which had been grown for two years in the vicinity of Tippecanoe City, Miami County, Ohio, and constituted 50 per cent of the wheat of that vicinity, according to C. A. Studebaker, of that place.

Dunlap was the name under which a sample of wheat identical with Goens was obtained from the Indiana Agricultural Experiment Station in 1913. Dunlap or Dunlop was also grown under that synonym for Goens in Indiana, Ohio, and Pennsylvania. In Fayette and Rush Counties, Indiana, Dunlap was extensively grown.

The names Going and Owens were commonly used on Ohio farms for Goens.
Hall and Red Hall were names used for a wheat identical with Goens in Indiana, particularly in Hancock and Shelby Counties, where it was extensively grown and had been grown for 10 to 15 years. According to J. E. Barrett, of Fortville, Indiana, the variety was named Hall for J. M. Hall, the man who first took the wheat into Hancock County.

Miller's Pride was identical with Goens and was grown in Berks County, Pennsylvania. A sample of Miller's Pride was first obtained by the United States Department of Agriculture in 1912 from Cornell University, which in turn obtained it from the Indiana station.

Red Chaff and Red Chaff Bearded are old names and were most commonly used for Goens wheat in Indiana, Illinois and Ohio in the early 1900's. Red Chaff had been reported from several other States, but as that name was used for other varieties, the distribution of Goens wheat as Red Chaff could not be definitely determined.

Shelby Red Chaff was the name adopted by the farm bureau executive board of Shelby County, Indiana. Goens (CI # 4857) was acquired in 1986 from the National Small Grains Collection when it was located at Beltsville, Maryland. Goens was grown in Wooster four different years with a few hundred contemporary cultivars. The yield was about 60% of the modern cultivars. The 1000-kernel weight was quite typical at 35.6 grams. Test weight seemed to be similar to AGS 2000, Century II, Coker 9663 and Pioneer 26R24. Goens displayed superior milling properties similar to Beck 108, Daisy, Southern States 520 and Pioneer 25R23. Flour granularity was similar to the cultivars AGS 2000, MacKinnon, McCormick and Roane. Flour protein appeared to be very typical in comparison to modern cultivars even though the field yield was lower. AWRC values were also typical for soft wheat and Goens produced sugar snap cookies with spread diameters that were very large.

Gold Drop

Gold Drop was apparently the old English variety usually referred to as Golden Drop. Koernicke and Werner stated that that variety was bred in 1834 by a Mr. Gorrie, at Annat Garden in Great Britain. It had been grown in the United States for many years, being mentioned by Rawson Harmon, of Wheatland, Monroe County, NY, in 1843.

The wheat was obtained for testing sometime prior to 1919 from Izard County, AR, where farmers stated that it had been grown for at least 25 years. An improved strain of Golden Drop, called Hallet's Pedigree Golden Drop, was used by Cyrus G. Pringle as one of the parents of Defiance.

Gold Drop was still being grown in 1919 on about 1,600 acres, nearly 80 years after its introduction to the United States. It was distributed in Arkansas, Missouri and Pennsylvania.

The only other names for Gold Drop were Golden Drop and Littleton. Littleton was found only in Humphreys County, Tennessee. A bearded spring wheat called Gold Drop was reported in Iowa.

Gold Drop was acquired from Dr. David Smith, curator, National Small Grains Collection, in 1986. In comparison to contemporary cultivars from the late 1990's, Gold Drop yielded slightly less than 50%. The normalized test weight placed it in the same category as Roane. It had good milling properties but produced coarse granulating flour. The cookie spread was small likely due to the coarse flour granulation and high average flour protein of 11.1%. Gold Drop had very low gluten strength.

Sometime during the 1990's, a Canadian museum curator, who was responsible for restoration of early to mid 1800's paintings, approached the SWQL concerning the unlikely possibility of acquiring historic wheat varieties that would have been grown during the early to mid 1800's. They had already exhausted their search in Great Britain and Canada. Flour of that era was utilized in making artists' paint. The museum had hoped, although they had not expected, to find varieties that were common to the era. Gold Drop was one of the varieties given to the museum by the SWQL. Locating those historic varieties enabled them to formulate paint for "authentic" restoration purposes.

Goldcoin

Goldcoin was probably a descendant from the Redchaff or Redchaff Bald wheat mentioned in early agricultural literature. Redchaff was also known as Genesee Redchaff. Genesee Redchaff was a bald, white wheat, first cultivated in the Genesee Valley region in 1798, and for a long time, was the decided favorite. After 1820, however, it was reported to have been very subject to rust and blast, but when circumstances were favorable it was found to be highly productive. Its transfer to other localities was thought to be attended with great success.

Soules was an early name applied to Goldcoin. Soules was described in the first edition of the New Genesee Farmer in 1840 as being discovered in a field of White Flint by Jonathan Soule, of Perrington (Monroe County), New York. The wheat became well established in New York in the late 1840's and by 1857 was an important variety in Ohio. About 1897 that wheat or a selection from it became known as New Soules. Soules and New Soules were reported in 1919 from Michigan.

Clawson, or White Clawson, had been found to be identical with Goldcoin, but the name had a much earlier origin. In 1900, according to Carleton, Clawson was said to have originated in Seneca County, New York, in 1865 through the selection of certain superior heads from a field of Fultz by Garrett Clawson. On planting the grain from the selected heads, both a white-and red-grained sort resulted. A pint of the white wheat produced 39 pounds the following season. Three years later 254 bushels were harvested and distributed to other farmers. In 1871 that variety took first premium at the Seneca County Fair. Though judged inferior by millers at times, this variety had become a very popular one.

The Goldcoin variety itself was reported by Carlson (1900) to have been produced by Ira M. Green, at Avon, New York, about 1890 in the following manner: "Mr. Green grew a field of Diehl Mediterranean, a bearded, red-grained wheat, and while passing through the field one day found a bald head possessing white grains. Planting every grain of this head, he found as a result next season that he had heads with very long beards, some with short beards, and others with none at all. The grain also was mixed, some red and some white. He desired the bald wheat—hence, only the grains from the bald heads were again planted. From this as a beginning, a practically new variety resulted. Various names had been given to it by different seedsmen, but it is best known by the name Gold Coin."

By 1919, Goldcoin occupied 947,000 acres in California, Colorado, Connecticut, Idaho, Illinois, Indiana, Kentucky, Michigan, Montana, Nevada, New Jersey, New York, North Carolina, Ohio, Oregon, Pennsylvania, Utah, Virginia, Washington, West Virginia, Wisconsin and Wyoming. Goldcoin was grown on 892,371 acres in 1929. In 1984, Goldcoin was still being grown on 2,248 acres in Oregon.

Goldcoin was a popular and widely adapted variety. By 1919, Goldcoin was identified as Abundance, American Banner, Clawson, Eldorado, Fortyfold, Golden Chaff, Gold Bullion, Gold Medal, Goldmine, Improved No. 6, International No. 6, Junior No. 6, Klondike, New American Banner, New Soules, Niagara, Number 6, Oregon Goldmine, Plymouth Rock, Prizetaker, Prizewinner, Rochester No. 6, Soules, Superlative, Twentieth Century, White Century, White Clawson, White Eldorado, White Rock, White Russian, White Soules, White Surprise and Winter King.

Abundance was a variety apparently identical with Goldcoin, which was introduced by L. P. Gunson & Co., Rochester, New York, about 1894. The variety had been purchased from A. N. Jones.

American Banner and New American Banner were names under which Goldcoin was best known in Canada. American Banner was identified by J. Allen Clark as being synonymous with Goldcoin.

American Banner (CI # 6943), Dawson (CI # 3342) and Goldcoin (CI # 4156) were grown together in the Soft Wheat Quality Laboratory plots. American Banner was very large-kernelled in contrast to Goldcoin and Dawson. The tip awns of American Banner were quite long while the tip awns for Goldcoin were very short. Goldcoin exhibited a clavate spike but American Banner did not.

Fortyfold was the name under which Goldcoin was distributed by Peter Henderson & Co., seedsmen, of New York City, as early as 1899. Klondike was the name under which the same wheat was distributed by J. M. Thorburn & Co., New York City, in 1908. No. 6 was applied to this wheat by Hickox-Rumsey Seed & Co., Batavia, New York. It was claimed by Mr. Rumsey that the name No. 6 antedated Goldcoin. International No. 6, Rochester No. 6, and possibly Improved No. 6, are names under which the variety was distributed by the International Seed Co., of Rochester, New York. The distribution of the variety under these names seems to date from about 1908. The Junior No. 6 was said to be an improved strain of No.6, but was identical with Goldcoin. It was named and distributed by the Hickox-Rumsey Seed Co.Prizetaker was the name used for the variety by the John A. Salzer Seed Co., of La Crosse, Wisconsin, as early as 1897, and possibly prior to that time.

Goldcoin was acquired in 1986 and eventually grown with contemporary cultivars in Wooster, Ohio, over several years and was also grown one year by Dr. Mark Sorrells at Cornell University. It was a very good-milling and -baking variety of medium size grain according to 1000-kernel weight. The granularity seemed to be similar to Pioneer 26R46, Mountain AC, AGS 2000, Century II and Sisson. Flour protein was about 1.5 percentage points higher than contemporary cultivars. Even though the flour protein tended to be somewhat high, the sugar snap cookie spread diameter was very large. The gluten strength was very weak.

Grandprize (St. Louis Grand Prize)

Grandprize was originated by A. N. Jones, of Le Roy, New York, between the years 1900 and 1908. It was distributed by Peter Henderson & Company, seedsman, of New York City, in 1910. The wheat derived its name from the fact that Mr. Jones received a grand prize for his cereal exhibit at the St. Louis Exposition in 1904. Grandprize was said to have strong stems and had an unusual characteristic in having pubescent glumes.

The variety was grown on 34,100 acres in 1919 in Georgia, Illinois, Indiana, Kentucky, Michigan, New York, Ohio and Pennsylvania. There were about 7,300 acres in 1939 and no reported acreage by 1949.

Synonyms for Grandprize were Bull Moose, Golden Chaff, New Genesee and Velvet Head.

Bull Moose was a name used only in Crawford County, Illinois.

Golden Chaff was a name used for Grandprize in Indiana. New Genesee was the name under which a wheat similar to Grandprize was obtained from the Wisconsin Agricultural Experiment Station, Madison, Wisconsin in 1917. Its origin was not known and was not pure. New Genesee was not known to be commercially grown. Velvet Head was a name used for Grandprize in Kentucky.

A sample of Grandprize was acquired from the National Small Grains Collection and multiplied. Milling quality was very good and similar to Caldwell, Douglas, Sisson and Stine 454. Grandprize had very soft kernel texture, low protein, low AWRC and good cookie spread. The gluten strength was not able to be ascertained on the mixograph since flour protein was low.

Greeson

The history of the soft white variety Greeson had been recorded by J. T. Wagoner, county agent of Guilford County, North Carolina. It stated that George Greeson of that county found a plant of wheat growing beside an old stump in his apple orchid in 1896. He increased the seed and distributed it under the name Wild Goose. After Mr. Greeson's death in 1899, the variety was called Greeson.

Another account by W. H. McLean, of Whitsett, North Carolina, stated the variety originated by a man whose name was Greeson, and had been grown in Guilford County for a number of years and was very popular. He reported that it constituted 40 per cent of the wheat grown near Whitsett, Guilford County, North Carolina, in 1919. Greeson, in 1919, was grown in Chatham, Randolph and Guilford Counties, North Carolina on about 5,100 acres. Its peak was between 1924 and 1944 likely averaging around 10,000 acres each year. In 1959, Greeson was grown on about 300 acres.

Synonyms for Greeson were Greensboro and Gleason. Seed of Greeson was obtained at a fair held at Greensboro, North Carolina, and therefore became known as Greensboro. Greensboro became widely grown in Randolph County, North Carolina.

No information could be found concerning Gleason but was likely a mispronunciation of Greeson.

In the late 1980's, Greeson was acquired from the National Small Grains Collection. It was very large-kernelled at 40.6 grams. Mean quality data for two crop years indicated that Greeson had superior milling properties.

Greeson was rather coarse in granulation and had flour protein of 10.1%. Nearly always, superior milling cultivars/varieties produce large cookie spread even though flour protein may be elevated. However, Greeson yielded small sugar snap cookies. AWRC was typical for soft wheat. Gluten strength was medium weak.

Hanover
This cultivar would seem to be a hard red winter wheat after milling evaluation at the Soft Wheat Quality Laboratory. Hanover has outstanding milling characteristics and appeared to be about medium-strong in gluten strength based on lactic acid evaluation. Hanover was about 2 percentage points higher in protein than the reference cultivars.

Hopewell
HOPEWELL is a soft red winter wheat variety developed by the Ohio Agricultural Research and Development Center. It was released in 1994 because of its high yields, diverse genetics, disease tolerance, standability and medium maturity. Hopewell is beardless and has red chaff at maturity. It is moderately resistant to Septoria nodorum, but carries no Hession Fly resistance gene.

HS222R
This soft red cultivar was from Harrington Seeds. Genetic test weight will likely be about 1.0 pound above the reference cultivars. Kernel weight was above average and milling quality was excellent having a mill score of 78. Caledonia, Coker 9375, Renwood 3706 and Southern States 8404 were cultivars that had similar milling quality. Flour granularity was extremely high at 38.4%. Very few cultivars had that kind of softness. The average soft wheat Allis-Chalmers break-flour would be about 32%. Cookie spread was very good and gluten strength was slightly above medium.

HS243R
This Harrington Seeds cultivar had a test weight that would be similar to those cultivars in the 61.0 pound normalized group. Kernel weight and cookie spread were about average while break-flour yield was coarse at 27.9%. Milling quality was excellent and nearly paralleled HS 222R, Coker and Renwood 3706. Gluten strength was medium-strong and was similar to Coker 9553, Pioneer 25R54 and Roane.

Husky
Husky, a soft red winter wheat, has high test weight genetically that will average about 1.8 pounds above the reference cultivars. This cultivar was about medium in gluten strength.

INW 0101
INW 0101 was released into Indiana and has a normalized test weight of 2.3 pounds and would be similar to AGS 2000, Ariss and Featherstone 520. The gluten strength was medium.

INW 0123
This cultivar was small kernelled at 30.4 grams and has medium gluten strength.

Illini Chief
Illini Chief was reported to be similar in appearance to Red May having brown glumes but being slightly taller and later. Illini Chief was said to be very resistant to Hessian fly injury. Illini Chief was first distributed in the fall of 1915, by E. L. Gillham, Edwardsville, Illinois. He advertised the variety as resistant to Hessian fly, stating "that it does practically resist Hessian fly attack." Further history of Illini Chief wheat recorded that Ed Gillham, who was the first man to grow the wheat, bought the seed in 1906 from a neighbor by the name of Finley, and it was still known as Finley wheat in Madison County. However, a second article in the Prairie Farmer by Dr. S. A. Forbes, State Entomologist of Illinois, stated "Mr. Gillham has traced his original stock to an Ohio farmer, who called it Early Carlyle."

Illini Chief, in 1919, was grown on about 21,300 acres in Illinois, Kansas, Missouri and Ohio. Very little acreage was reported in 1924. Illini Chief was known as Finley in 1919 and historically as Early Carlyle.

Finley was reported in 1919 from Kansas, Missouri and Ohio. The name Finley had been in use in the early 1880's for an awnless variety with white glumes and red kernels. That particular wheat had disappeared from cultivation by 1919.

Early Carlyle was not able to be acquired in 1919 and it was presumed to be out of production.

Illini Chief was obtained from the National Collection, multiplied with contemporary cultivars and its quality traits determined. Milling quality was not very good. Additionally, flour granulation was very coarse so one would have expected the sugar snap cookie spread to be poor. Flour protein was relatively high at 11.2% which would also limit cookie spread. However, the cookie spread was not that small.

Jones Fife (Jones Winter Fife)
Jones Fife was originated by A. N. Jones, of Newark, Wayne County, New York, in 1889. According to Carleton, in 1916, "it descended from Fultz, Mediterranean, and Russian Velvet." Jones Fife was said to make comparatively weak flour for bread making.

The variety was grown as Fife, Jones Fife, or Jones Winter Fife on 476,100 acres in 1919, in Idaho, Illinois, Indiana, Iowa, Kentucky, Michigan, Missouri, Montana, Ohio, Pennsylvania, Utah, Virginia, Washington, and West Virginia. It was grown as Silver King and under other names in Colorado and Wyoming. Jones Fife had occupied 20,064 acres in 1949. By 1959, it was grown on only 2,059 acres. Jones Fife, in 1919, was also known as Burbank's Super, Canadian Hybrid, Crail Fife, Fife, Fishhead, Silver King, Super, Velvet Chaff, and Winter Fife.

Burbank's Super, or Super wheat, was distributed by Luther Burbank, of Santa Rosa, California, in the fall of 1917. The following was Mr. Burbank's first statement regarding that variety, published in August, 1917, in his catalogue under the title The New Burbank Wheat:

"It is with unusual satisfaction that I now offer for the first time a limited quantity of my new wheat; the best result of 10 years of most careful and expensive experiments. It has been tested alongside of 68 of the best wheats of the world, and has excelled them all in yield, uniformity, and other desirable characteristics; the growth is strong, 4 feet on good ordinary soil, tillers unusually well, and on ordinary valley soil, without special cultivation, care, or fertilizing, this summer produced at the rate of forty-nine and 88-100 bushels per acre, every plant and every kernel uniform, as this wheat was originally all grown from one single kernel.

Even at present prices of ordinary wheat for milling purposes, it will be readily seen that the crop of each acre would purchase an acre of the best wheat land. The small field of this new wheat has been the wonder and surprise of thousands who have seen it, nothing like it in uniformity and beauty ever having been seen before. The cut shows the exact size and appearance of the long, smooth, white, well-filled heads.

Every kernel is guaranteed uniform and correct to type. This, like all other wheats grown in California, is a winter wheat and should probably be generally treated as such, and will, no doubt, thrive better in new localities after it becomes acclimated by one or two seasons' growth…….The best successes of my customers are also my own, and the whole wheat crop of America will soon be enormously increased if this new "Burbank" wheat is generally sown."

Mr. Burbank further advertised and distributed the wheat as Super wheat in 1917 and 1918. Apparently most of his wheat stock was purchased and resold by the State Seed & Nursery Co., of Helena, Montana, at the price of $5.00 per pound. They advertised it as a wheat adapted for both spring and fall sowing. It was then distributed in many sections where it was not adapted. East of the Rocky Mountains, Burbank wheat generally winterkilled when fall sown and remained prostrate on the ground throughout the growing season when spring sown, thus resulting in failure.

Burbank was not reported in the varietal survey of 1919. Luther Burbank's Super wheat was found to be identical with Jones Fife in all taxonomic characters, as well as in yield and in milling and baking quality.

Jones Fife (Jones Winter Fife) (cont'd)
Canadian Hybrid was similar to Jones Fife, except that it sometimes had a slightly longer and laxer spike. It was listed by John A. Salzer, seedsman, of La Crosse, Wisconsin, as early as 1895. John Salzer stated that it originated in Canada, on the farm of Clark Parker. Mr. Parker claimed to have the best crops of winter wheat in his section for a long time. He would acquire the best specimens of different sorts, and plant them together, and, thus, continuously improve his yield. He stated that he could not call any of those sorts pure, but could call the Canadian Hybrid enormously productive. It was reported grown in Illinois, Indiana, Michigan and Missouri.

Crail Fife was a local name applied to Jones Fife wheat in Montana. Frank Crail of Bozeman, Montana, was the name of the farmer who grew and distributed the variety under that name.

Fishhead was a wheat similar to Jones Fife. Samples were obtained from the Cornell University Agricultural Experiment Station.

Silver King was a name used for Jones Fife in Colorado and Wyoming. According to J. B. Hill, of Westridge, Colorado, it had been grown in that vicinity for 16 or 18 years.

Winter Fife, a part of the original name, often was used by growers to distinguish it from the well-known spring wheat called Fife.

Jones Fife (CI# 4468), was acquired from the National Small Grains Collection in 1986, from Beltsville, Maryland. The field yield was one of the better ones of the older varieties at about 67% of the field yield of the contemporary cultivars.

The 1000-kernel weight was about 35.0 grams. Jones Fife had excellent milling quality, but had granularity similar to a hard red winter wheat. Flour protein was approximately 1.0 percentage point above the modern cultivars. AWRC was very high for a soft wheat at 61%, but, not as high as a HRW wheat would be. The sugar snap cookie diameter (x 2) was 2 cm smaller (15.8cm) than the typical soft wheat. The slightly elevated flour protein was not high enough to account for the reduced cookie spread. In 1919, it was stated that Jones Fife was weak for bread baking. SWQL analysis of Jones Fife for gluten strength indicated that it was one of the weakest ever evaluated.

Kelley
The semi-hard white cultivar Kelley has slightly higher test weight than the reference cultivars. It has excellent milling quality and very coarse flour granulation. Flour protein was similar to typical soft wheat and the flour water absorption was low. Gluten strength was about average.

Leap (Leap's Prolific)
Leap was reported to have originated from a single plant found in a field of Mediterranean by the oldest son of J. S. Leap, of Virginia. From the five heads gathered in 1901, Mr. Leap increased the wheat until 1905, when he thrashed 190 bushels grown from 10 bushels of seed. T. W. Wood & Sons, seedsmen, of Richmond, Virginia, first distributed the variety as Leap's Prolific. General distribution of the wheat started about 1907 and became very popular.

Leap was grown on 513,000 acres in 1919 and reached its peak around 1929 with 673,000 acres. By 1959, Leap was still grown on 21,000 acres. The variety was distributed in Alabama, Connecticut, Delaware, Georgia, Illinois, Indiana, Kentucky, Maryland, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, South Carolina, Tennessee, Virginia and West Virginia.

Other names for Leap were Hastings Prolific, Woods Prolific and Woolf.

Hastings Prolific was a name used for Leap wheat in Alabama, Georgia and South Carolina.

Woods Prolific was used for the variety in Tennessee and Virginia. (Hastings Prolific and Woods Prolific were probably derived from the names of the seed firms selling it.)

Woolf was a name used for the Leap variety in Muhlenberg County, Kentucky.

Leap "selection" was obtained as a five-gram sample from the National Small Grains Collection in 1989 and another sample of Leap was acquired from North Carolina State University in 1992. Eventually, both samples were grown together where they seemed to be the same appearance-wise in the field and yielded the same quantity of wheat. The field yield was about 50% of the modern cultivars that were available in the 1990's. The quality data from both plots also seemed to be the same. Leap had moderately sized grain with 37 grams per thousand kernels. It had good milling quality with slightly below-average softness. Cookie quality was good considering the high flour protein. Gluten strength was below average.

MacMillian
Steyer Seeds of Ohio introduced this cultivar that will likely be about 1.5 pounds above the 60 pound category in the test weight tables. Kernel size may be slightly below average and break-flour yield was slightly above average. Cookie quality may be on the smaller side and gluten strength was slightly above medium.

Mediterranean
Reference to the Mediterranean variety in American literature began in 1842, when the variety was widely grown, with the statement that it had been introduced some years before. One writer said it was introduced into Maryland from the Mediterranean Sea region in 1837. However, in 1863 it was recorded that it was introduced in 1819 from Genoa, Italy, by John Gordon of Wilmington, Delaware. It came into prominence in New York between 1845 and 1855, from which time its culture spread rapidly westward.

Its early popularity, apparently, was gained because it was more resistant to Hessian fly damage than other varieties. It was found also to be several days earlier than the commonly grown wheats, such as the Flint, Bluestem, Red Bluestem, Golden Straw and other wheats grown at that time. It was called rust resistant probably because of its earliness, and was commended as a high yielder of especially heavy grain and adapted to poorer soils than most varieties.

White wheats being the standard, it was vigorously criticized, especially by millers, because its red kernels yielded a dark flour and because of the thickness of the bran. This disapproval persisted for at least 25 years, but after the introduction of roller mills it became recognized as a good milling wheat.

In the earlier years it became known under many different names, as Bearded Mediterranean, Red Mediterranean, and Red Chaff Mediterranean, to distinguish it from other and different varieties to which the name Mediterranean became attached. Other synonyms were Columbian and Quaker in Pennsylvania and German in Maryland. By 1919, those names apparently had gone out of use. That early confusion in names probably was the result of repeated introductions.

In 1919, nearly 100 years after its introduction from Italy, Mediterranean was grown on 2,558,900 acres in Alabama, Arkansas, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Michigan, Mississippi, Missouri, Nebraska, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, Tennessee, Texas, Virginia and West Virginia. Mediterranean was grown on 46,329 acres in 1959.

Mediterranean, in 1919, was also known as Acme, Bluestem, Farmers Trust, Great Western, Key's Prolific, Lancaster Red, Lehigh, Miller, Miller's Pride, Missouri Bluestem, Mortgage Lifter, Red Chaff, Red Sea, Red Top, Rocky Mountain, Standby and Swamp.

Bluestem was a name commonly used by farmers in the eastern United States for Mediterranean, as well as for many other wheat varieties.
Farmers Trust was a name used in the central United States for Mediterranean wheat beginning about 1900.
Lehigh was used for Mediterranean from about 1900 to 1920. The name was abruptly dropped by growers around After about 1920 only experiment stations continued to use the name Lehigh
Lancaster Red was reported by Dietz in 1869 as "a variety of the Red Chaff Bearded Mediterranean". It was obtained by selecting from the field in Lancaster County, Pennsylvania.
Red Sea was a name long used for Mediterranean wheat. How and when its use became established was not known.
Rocky Mountain was a wheat identical to Mediterranean. Rocky Mountain was grown at the Federal and State Experiment Stations at Arlington Farm, Virginia, and College Park, Maryland, beginning in 1908. The original sample had originated in Maryland about 1900.

Swamp was a name commonly used for Mediterranean primarily in Indiana. It was advertised by J. A. Everitt's Seed Store, of Indianapolis, Indiana, in their fall catalogue of 1899, and was likely distributed for several years prior to 1899. In 1919 it was reported grown in Illinois, Indiana, Kentucky, Ohio, Tennessee, and West Virginia.

Comparison to Contemporary Cultivars
A sample of Mediterranean (CI # 5303) was acquired from the National Small Grains Collection in 1986 and was multiplied with contemporary cultivars. Mediterranean was similar in kernel weight to Coker 9803, Foster, Goldfield, Kaskaskia and Pioneer 25W33.

Its milling quality was similar to Ramrod, Howell, Cayuga and Coker 9474, while it displayed rather coarse flour granulation being much like Arthur, Delta Queen, FFR 566W and USG 3209.

Flour protein averaged about 3 percentage points higher than contemporary cultivars. Mediterranean produced very small sugar-snap cookies. Those were likely due to high flour protein. Alkaline water retention capacity (AWRC) was low, which suggested that Mediterranean had genetically good soft wheat baking potential. (There has not been a correlation between flour protein and AWRC.) The gluten strength was about medium-weak.

Purplestraw

The origin of Purplestraw wheat was undetermined. It was, however, one of the earlier varieties of wheat grown in the United States. Concerning its early culture, Edmund Ruffin recorded in 1851 that from 1822 until the present time the same kind of wheat had been cultivated, first known as Mountain Purplestraw and more lately designated Early Purplestraw. Alternate information suggested that Mountain Bluestem was the name under which the variety was first grown. That name was still being used in some sections in the early 1900's, although the prefix "Mountain" had generally been dropped many years before. J. Allen Clark wrote in 1919 that the variety had continued to be an important wheat in the southeastern United States for about 100 years.

In 1919, Purplestraw was grown on 273,800 acres in Alabama, Arkansas, Connecticut, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas and Virginia. Purplestraw continued to be grown on 11,796 acres in 1959.

By 1919, Purplestraw was synonymously known as Alabama Bluestem, Bluestem, Early Purplestraw, Georgia Bluestem, Georgia Red, Mountain Purplestraw and Ripley.

Alabama Bluestem was a name commonly used for Purplestraw wheat in Alabama.

Bluestem was the general name used as a synonym for Purplestraw by many growers of the variety in the Southeastern States.

Early Purplestraw was used for the variety, but by the early 1900's, the word "Early" had been dropped.

Georgia Bluestem and Georgia Red were names commonly used by growers of Purplestraw wheat in Georgia.

Ripley was a local name used for Purplestraw in York County, South Carolina.

Purplestraw possesses facultative characteristics. Since it does not require vernalization, it can be grown as a spring wheat; or, because of its winter hardiness, can be fall sown even in the northern soft wheat states. Its principle advantage over other varieties in the early 1900's was its early maturity, which was said to be due in part to its spring habit. Purplestraw will produce intensely reddish or purple stems that will disappear if wet weather conditions occur at harvest time.

A five-gram sample of Purplestraw (CI # 1915) was obtained in 1986 and was grown several years in Wooster, Ohio. It was multiplied one year by Dr. Mark Sorrells at Cornell University and was also grown one year by Dr. Jerry Johnson in Georgia. The 1000-kernel weight averaged 37 grams. Milling quality was good and was comparable to Delta Queen, Patton and Dyna Gro 411. Granularity was similar to Foster, Pioneer 25R49 and Superior. AWRC values were very low which indicated that it had good soft wheat flour characteristics. However, the flour protein averaged about 3 percentage points higher than practically all of the contemporary cultivars; thus, the cookie spread was very small. Purplestraw was characterized by weak gluten strength.

Quantum 9723

This cultivar was released some time ago and has average test weight with small kernel size. Milling quality was good and had above average break flour yield. Cookie spread was slightly smaller than the average soft wheat and the gluten strength would be slightly above average.

Raven (SWQL designated #2)

Raven was introduced by Ebberts Field Seeds of Ohio. There was a Raven (SWQL designated #1) from Illinois (2000) but the two did not appear to be identical. Raven (#2) had test weight that will be about 1 pound above the 60 pound test weight of the reference cultivars. Kernel weight was large being 41 grams. Break-flour was somewhat below the average of all soft wheat of 32% and cookie spread was about average. Gluten strength was fairly strong having an adjusted lactic acid SRC of 113%. Elkhart, Pioneer 2643, Rachel and Warwick had gluten strength similar to Raven (#2).

Red May

Red May was believed to be identical with or descended from the Red or Yellow Lammas. Several writers suggested the identity. S. M. Tracy, in 1881, mentioned Yellow Lammas as being a synonym of Red May. The Lammas was mentioned by Friedrich Koernicke and Hugo Werner, in 1885, as being a very old English wheat grown previously to 1699. Both the Red and Yellow Lammas were grown in Virginia many years before the Revolutionary War. A White May wheat of a latter period, according to N. F. Cabell in his publication “Early History of Agriculture in Virginia”, was grown in that state as early as 1764. A more recent history of Red May indicated that it was originated by General Rawson Harmon from the Virginia May (a white-kerneled wheat) about 1830. That wheat had been grown quite widely under the name Red May since 1845.

By 1919, Red May occupied 1,165,900 acres in Alabama, Arkansas, Georgia, Illinois, Iowa, Kansas, Kentucky, Louisiana, Mississippi, Missouri, Nebraska, North Carolina, Tennessee, Texas, and Virginia, and was grown under many synonyms in Connecticut, Indiana, Michigan, Minnesota, Ohio, Pennsylvania, West Virginia, and Wisconsin. Red May occupied 1,922 acres in 1959.

Red May, in 1919, was also known as Beechwood (in part), Canadian Hybrid, Early Harvest, Early May, Early Ripe, Enterprise, Jones Longberry, May, Michigan Amber, Michigan Wonder, Orange, Pride of Indiana, Red Amber, Red Cross, Red Republic and Republican Red. Other synonyms were used but their use had been discontinued by the first part of the 1900's. Those synonyms were Whig, Kentucky Red, Carolina and Rappahannock.

Beechwood usually was a mixed wheat containing some Red May. Beechwood was a synonym for the Poole variety.

Early May was commonly used as a synonym for both Red May and White May from 1843 to 1857. In 1854 a different White May was claimed to have been originated by Charles H. Boughton, Essex County, Virginia. That variety was also known as Boughton and Tappahannock, but was not Red May.

Early Ripe was recorded as having been introduced into Darke County, Ohio, in 1840. During the next 18 years, it became distributed over the State as Whig, Kentucky Red, and Carolina.

Samples obtained from the Ohio and Missouri Agricultural Experiment Stations were identical with Red May.

Jones Longberry was wrongly applied to Red May since the two varieties of Longberry put out by A. N. Jones, of New York, were awned varieties, and Red May was awnless.

Orange wheat was reported as having been introduced into Monroe County, New York, from Virginia in 1845. In 1857 Klippart reported Orange wheat to be a beardless, white-grained winter wheat grown in Ohio. The Orange variety in the early 1900's had red kernels and was identical to Red May. Orange (Red May) was one of the excellent-yielding beardless varieties of wheat for Missouri in 1910.

The name Red Cross was sometimes wrongly applied to Red May wheat. In the early 1900's the John A. Salzer Seed Co., seedsman, of La Crosse, Wisconsin, reported that they had been selling a wheat under the name Red Cross since 1893. It was identical with Red May. They bought the seed from a J. J. Barron, who claimed to have originated it. J. J. Barron stated that it was done by crossing three varieties. There was no evidence given to prove that the crosses were made.

Pride of Indiana was acquired from the Indiana and Missouri Agricultural Experiment Stations and was the same as Red May. It may have been a name used for wheat through error, as it was a name of an important variety of corn in Indiana.

In 1986, Red May (CI # 5336) was acquired from the National Small Grains Collection and, once multiplied, was grown with hundreds of contemporary cultivars. The field yield was about 50% of the more recent cultivars. The kernel weight of Red May seemed to be similar to Armor 4045, Coker 9474, Julie IV and Pennmore. Milling evaluation placed it with Goldfield, Mackinnon, Patterson and Wakefield. All were good milling cultivars. Flour granularity was similar to that of Mediterranean. Contemporary cultivars with similar softness included Arthur, Delta Queen, FFR 566W and USG 3209. Flour protein appeared to be about 2.5 percentage points higher than the modern cultivars. The cookie spread baking test revealed Red May to be very small. That could be attributed to the high flour protein since the AWRC was one of the lowest of all soft wheat varieties. Gluten strength was about medium.

Russian Red

Russian Red usually was grown under the name "Red Russian", but there were other distinct varieties that were also called Red Russian that were grown primarily in the Pacific Northwest. Those Red Russian and associated synonym varieties had clavate spikes while Russian Red did not. It was decided that the two similar names would remain intact.

E. H. Collins offered the seed for sale in 1898 and reported the history of Russian Red: "In answers to questions, allow me to say that the Red Russian (Russian Red) wheat I advertise in the Farmer was selected by an agent sent by the American Seed Co., of Rochester, New York, to Russia to secure their best wheat. It was introduced in this section by a prominent mill in Indianapolis at $1.50 a bushel. They paid 1 cent extra for a few years to encourage its more general introduction. It has of late years sold at the seed stores at a 2-cent premium and does this year. It is hardy, smooth, medium hard, and very productive. The only fault I found in growing it 12 years is that it shatters when cut dead ripe, so that I often grow half of my crop Fultz, which can wait. Lately, however, I grow all Russian." Red Russian (Russian Red) was grown by the Ohio Agricultural Experiment Station as early as 1888. It was distributed widely by Peter Henderson & Co., seedsmen, of New York City, and J. A. Everitt & Co., seedsmen, of Indianapolis, Indiana, in the early 1890's. In 1919, Russian Red occupied 172,100 acres in Illinois, Indiana, Kentucky, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Texas, Virginia, and West Virginia. Russian Red was grown on 3,408 acres in 1954. Russian Red was only known by one other name in the eastern part of the United States, Red Russian.

In the late 1980's a sample of Russian Red was acquired from the National Collection and multiplied several years. The 1000-kernel weight was one of the largest in comparison with all other soft wheats at 43.8 grams. It had fair milling properties similar to those of Clark, Ernie, INW 9824 and Pioneer 2545. Flour granularity was quite typical for soft wheat. Flour protein was about .5% higher than most soft wheat while AWRC was normal. Cookie spread (sugar snap diameter x 2) was very small averaging about 1 cm less on diameter than the average soft wheat. Russian

SG 1560

Shur Grow 1560 has a high genetic test weight at 2.7 pounds and would be similar to AGS 2000 and Geneva. It has superior milling quality similar to FL 302. SG 1560 had good cookie spread and the gluten strength was medium.

Smoke

This soft white wheat appeared to have good test weight. The milling quality was very good and possessing very soft flour granulation. Cookie spread was above normal for soft wheat and the gluten strength was below average.

Watford
This soft white wheat was from Hyland Seeds, Canada, and was small in kernel size at 30.6 grams. Preliminary testing suggested that the flour protein may be moderately elevated. The gluten strength was about medium.

Wilson
Steyer Seeds markets this soft red cultivar that has test weight about 1 pound higher than the reference cultivars. Wilson has extremely soft flour granulation capabilities and may be very useful for cake baking purposes. Cookie spread was very good and the lactic acid SRC of 111% would be indicative of medium-strong gluten strength.

Recent Cultivars Developed for the Eastern US Characterized by the SWQL

Descriptions by Lon Anderson

AG 2012
This Ag Alumni soft red wheat had test weight that will average about .5# higher than the reference cultivars and would be similar to Douglas, Patton and Pioneer 25W33. AG 2012 may be higher in protein compared to most cultivars. Gluten strength was medium-strong.

AGI 201
AGI 201, from Advanced Genetics, had a very high normalized test weight of 3 pounds greater than the reference cultivars. Cultivars similar to AGI 201 in normalized test weight would be Coker 9184, Roane and Pioneer 26R61. The cultivar has good milling properties and weak gluten strength.

AGI 538
This cultivar will be about 1 pound higher in test weight compared to the reference cultivars. AGI 538 produced excellent sugar snap cookie size. Gluten strength was average.

AGS 2485
This cultivar was developed jointly by the University of Georgia and the University of Florida and will be available through the Georgia Seed Development Commission. AGS 2485 appeared to have genetically related test weight slightly lower than the high test weight cultivar Roane. Kernel weight will likely be about average. The cultivar had very good milling properties. Flour granularity will be typical for soft wheat and the sugar snap cookie quality was below average in spread. Gluten strength was slightly above average.

Benton
The AgriPro cultivar had a large kernel size of 38.0 grams and had very weak gluten strength.

Beretta
AgriPro produced this soft red cultivar and has test weight that would be similar to the reference cultivars. Reference cultivars would be about 60.0 pounds normalized test weight; Beretta would be about 60.3 pounds normalized. Beretta produced very large sugar snap cookies and the lactic acid SRC (110%) indicated the cultivar may be medium-strong in gluten strength. Additional analysis on other Berettas should be performed since there was no standard cultivar associated with the sample we evaluated.

Besecker
Steyer Seeds released this soft red that will probably average about 1.3 pounds higher in test weight than the 60-pound reference cultivars. Besecker has smaller than average kernel weight and had very good milling quality. Break flour yield was average and cookie spread was good. The lactic acid SRC of 107% was indicative of medium-strong gluten strength.

Bess
Bess was released by the University of Missouri and has test weight that would be about 1.8 pounds greater than the reference cultivars. Daisy, Ernie and Pioneer 25R26 would be examples of reference wheats. Bess has average kernel weight and good milling properties. Break flour yield was average and cookie spread was typical for soft wheat. The lactic acid SRC of 86% would indicate lower than average gluten strength.

Carlisle
C & M Seeds, Canada, released this semi-hard red cultivar. Carlisle has very high test weight that will likely be about 3.5 pounds higher than the reference cultivars which average about 60.0 pounds. Carlisle has extremely large kernel size around 45.1 grams per thousand. Milling quality was superior with an ESI of 7.2%. Very few cultivars of the 767 evaluated by the SWQL will fall into that category. The flour granularity was very coarse and produced small cookie spread. Flour protein may be about 1 percentage point greater than the typical soft wheat. Gluten strength was strong as indicated by the 115% lactic acid SRC. Flour water absorption (57%) was higher than soft wheats.

Cecil
Ohio State University introduced this cultivar that has many good quality traits. Cecil has genetically been about 1.1 pounds higher in test weight when compared to the reference cultivars. The kernel weight was very large at 40.0 grams. Cecil has good milling quality; good cookie spread and was about medium in gluten strength.

Choptank
The University of Maryland released Choptank and this cultivar likely will be about 1.3 pounds high in normalized test weight. The cultivar has good cookie spread factor and weak gluten. Preliminary testing indicated that Choptank may be slightly elevated in protein.

Coker 9312
This cultivar would be similar in test weight to Choptank, Cecil and Coker 9663. Coker 9312 has good milling quality and weak gluten. This cultivar may be slightly higher in protein when compared to most cultivars.

Coker 9375
Coker 9375 has a normalized test weight similar to the reference standards. The cultivar has a very large kernel weight of 40 grams. It has very good milling quality and weak gluten.

Coker 9436
This cultivar was released by Syngenta Seeds and limited data suggested that the test weight would be similar to the 60-pound reference cultivars. Coker 9436 has superior milling quality and very coarse flour granularity being similar to Coker 9663, Kristy and Spencer. Sugar snap cookie quality was very good even though the flour was very coarse. Very coarse granulating cultivars can produce excellent cookie spread if the milling quality is excellent. The lactic acid SRC of 80% indicated weaker gluten strength.

Coker 9553
Syngenta Seeds produced this very large kernelled soft wheat cultivar. There was not enough information to evaluate the test weight. It will likely be a very soft granulating cultivar similar to Coker 9184, Hopewell and Pioneer 25R47. Cookie spread may be slightly smaller than the average soft wheat but certainly within the soft wheat range. The lactic acid SRC of 105% would suggest medium-strong gluten.

Cooper
This AgriPro cultivar possesses superior milling properties similar to Honey, Pioneer 25R23 and Southern States 520. Cooper has good sugar snap cookie spread and weak gluten.

Coyote
Coyote was released by J. G. Limited and has a normalized test weight of 2.4, which would be similar to Coker 984, INW 0101 and USG 3408. Coyote has good milling and the gluten strength was medium.

Crawford
This soft winter wheat was released by the University of Georgia and has a normalized test weight about 1.3 pounds. The gluten strength was about medium.

Croplan 594W
The sample evaluated had been "weathered" resulting in a reduced test weight and increased break flour yield. Croplan 594W had good milling quality and produced a very large cookie spread, possibly enhanced by the "weathering". The lactic acid SRC was 90%, indicative of average gluten strength.

Cumberland
This cultivar was developed by the University of Kentucky. There was not enough information in the SWQL test weight data base to accurately assess the test weight, but it may be 2 pounds higher than the 60.0 pound cultivars. The 1000-kernel weight was large at 38.5 grams. Break-flour yield, and cookie spread were normal. Flour protein may be low and the gluten strength appeared to be slightly above average.

Declaration
Declaration was also developed at the University of Kentucky and had normalized test weight that was 2.3 pounds greater than the reference wheats. Kernel weight, break-flour yield and cookie spread appeared to be typical. Declaration may have gluten strength slightly above the average.

Dominion
This Virginia line has not been named yet. It has a 1.7 pound normalized test weight and possesses superior milling properties similar to Pioneer 25R47, Jaypee, Pocahontas and Caledonia. The gluten strength was about medium.

Featherstone 176
This new release from Virginia Polytechnic Institute will be about 1.5 pounds higher in test weight than the reference cultivars. It has good milling quality, good cookie spread and the gluten was about medium in strength.

FFR 558
This cultivar had its beginnings at Virginia Polytechnic Institute. Test weight will likely average about 1.3 pounds greater than the reference standards. Flour granularity was average and cookie spread may be slightly smaller. Gluten strength was very weak and had an Allis-Chalmers lactic acid SRC of 66%. The weakest soft wheats probably won't fall below 60% on average.

Gator
Gator was produced by the Sunbeam Extract Company. The normalized test weight will likely be about 2.2 pounds higher than the reference cultivars. The gluten strength was medium-strong and limited testing revealed that the flour protein may be slightly elevated.

Genesis 9511
This cultivar possesses many good quality traits. The kernel weight was large at 39.5 grams. It had superior milling properties similar to Pat, Foster and USG 3650 and the flour granularity was very fine. The cookie spread was good and the gluten strength was medium.

Genesis 9821
Genesis 9821 was released by Genesis Brand around 1998. Limited test weight data indicated it may be slightly higher in test weight than the reference cultivars. Kernel weight, break-flour yield, sugar-snap cookie spread and gluten strength were equal to the average for soft wheats. Flour protein may be lower than protein for most soft wheats.

Genesis 9959
Genesis 9959 was released from Genesis Brand about 1999. Limited test weight history indicated the cultivar may be genetically 1.5 pounds greater in test weight than the standard cultivars designated as “0” or normalized to 60.0 pound test weight. Kernel weight, flour granularity and cookie spread were on average for soft wheat. Milling quality was excellent with a mill score of 80.0. Only 10% of the 830 soft cultivars had mill scores that were at least 80. Gluten strength was slightly above average with Allis-Chalmers lactic acid SRC of 99%.

Hartman
Hartman was introduced by Steyer Seeds and will likely have test weight that will be about 1.4 pounds greater than the reference cultivars. The kernel weight appeared to slightly larger than average and Croplan 594W has very good milling quality. The flour granularity will be about average and the cookie spread was typical for soft wheat. Gluten strength will probably be medium-strong.

Hondo
Hondo, an AgriPro wheat, has been on the market for a few years but may not be available for general production. It seemed to have high test weight that would place it in the same category as Coker 9184, McCormick and Roane. Hondo has very good milling properties and very coarse flour granulation. Flour protein may be about 1 percentage point higher than soft wheat. Flour water absorption was 62% as measured by the water retention capacity test. Lactic acid SRC was 120% indicating the gluten strength to be strong.

Hopewell
HOPEWELL is a soft red winter wheat variety developed by the Ohio Agricultural Research and Development Center. It was released in 1994 because of its high yields, diverse genetics, disease tolerance, standability and medium maturity. Hopewell is beardless and has red chaff at maturity. It is moderately resistant to Septoria nodorum, but carries no Hession Fly resistance gene.

INW 0302
This cultivar was released by Purdue University and has test weight similar to Choptank, Coker 9663, Pioneer 26R24, Sisson and Emmit. The kernel weight may be slightly smaller than average. INW 0302 has good milling properties and seemed to be very soft as measured by break flour yield. Cookie quality was normal and the gluten strength may be slightly above average.

INW 0303
This cultivar has some very unique quality traits. Test weight, genetically, may be low. Kernel weight will likely be above average and the milling quality was good. INW 0303 had extremely high break flour yield placing the wheat in a category with only 26 others out of nearly 800 soft cultivars. INW 0303 may be valuable for contract growing because of its very fine granulation, which would suit well for cake baking needs. The cookie spread was good and the lactic acid SRC (101%) was indicative of medium-strength gluten quality.

INW 0304
INW 0304 will likely be about one half pound lower in test weight compared to the reference cultivars. It has very large kernel weight of about 40 grams and has very good milling properties similar to Coker 9184, Geneva and Pioneer 26R15. The gluten strength appeared to be weak.

INW 0315
INW 0315 from Purdue University may have test weight similar to the 60-pound reference cultivars. It has excellent milling quality and produces above average break flour yield. The cookie spread was very large and the gluten strength would likely be below average.

INW 0316
The test weight characteristics would be similar to INW 0315. INW 0316 has good milling properties and average softness. Cookie spread was typical for soft wheat and the gluten strength was low as measured by lactic acid SRC (74%).

INW 0411
INW 0411 possesses excellent milling properties and has medium gluten strength.

INW 0412
This Indiana release has an unusually high normalized test weight of 3.3 pounds. There have been about 700 soft cultivars analyzed by the SWQL for genetically associated test weight. There were only 21 cultivars that would be greater than INW 0412 and 32 cultivars that would be similar in test weight to this cultivar. The gluten strength was medium-strong and preliminary evaluation suggested that the flour protein may be elevated slightly.

Jack
This Gries Seed cultivar appeared to have semi-hard attributes. Jack may be about 2 pounds greater in test weight from the reference cultivars. The very coarse flour granulation produced cookie spread that was below average. Water absorption was 56% in contrast to soft wheat, which would usually be in the low 50% range. Flour protein was not elevated and the lactic acid SRC of 94% would suggest average gluten strength.

Jacob
Jacob will probably be about 1 pound higher in test weight than the 60-pound reference cultivars and has below average kernel size. Jacob has good milling quality and produces very fine granulating flour. Cookie spread was normal for soft wheat and the gluten strength was medium-strong.

Jentes
Jentes, a soft red winter from Steyer Seeds of Ohio, will probably be about 1 pound above the reference cultivars for test weight. Jentes had very good milling properties and break-flour was average. Cookie spread was above average and gluten strength could not be assessed.

Jewel
This soft white cultivar was released from Michigan State University to the Michigan Crop Improvement Association. It was tested under the designation E 1007W. Test weight of Jewel will likely be about 1.3 pounds higher than the reference cultivars. Kernel weight was very large at 41.6 grams. Jewel had excellent milling quality with milling score in excess of 75. Break-flour yield was normal while cookie spread may be a little small. Gluten strength was about average having an Allis-Chalmers lactic acid SRC of 94%.

Magic
Magic will be marketed by John Gerard Limited. This hard wheat cultivar has excellent test weight and very large kernel weight. The milling quality was superior with an ESI of 6.6%. Flour granulation was typically coarse for hard wheat. Flour protein was about 1.5 percentage points greater than the average soft wheat. Water absorption was 59% as measured by the water solvent capacity test. The gluten strength was strong with a lactic acid SRC of 120%.

Magnolia
Magnolia was released by AgriPro in Arkansas. Limited test weight data suggested it would be about 1.5 pounds above the reference standards. The Magnolia sample from Arkansas had very large kernel weight of 42.8 grams per thousand grains. Milling quality was very good. This sample had a rather high flour protein of 10.7% which would have suppressed the cookie spread. Gluten strength may be medium-strong having a lactic acid SRC of 105% adjusted to 9% flour protein. The lactic acid SRC was 117% at 10.7% protein.

Merrell
This was another cultivar from Steyer Seeds and the genetic shrivel-free test weight will be about 1.6 pounds greater than the reference wheats. Kernel weight, break-flour, cookie diameter and gluten strength were average. The milling quality was very good. The ability of the middling stock to efficiently reduce to flour size was exceptional.

Monarch
Gries Seeds introduced this cultivar that possesses many good quality attributes. The normalized test weight was about 2.0 pounds higher than the reference cultivars. Monarch had premier milling quality being similar to AGS 2000, Coker 9152, Mountain and Pat. Out of 734 soft wheat cultivars, there were only 19 cultivars that were considered to have better milling quality than Monarch. The cultivar produced fine granulating flour on the break rolls and had large cookie spread. Monarch was about medium in gluten strength.

Natchez
AgriPro released Natchez, which has good test weight, about 1 pound lower than Coker 9184, McCormick and Roane. Break flour yield was average and the gluten strength was about average with lactic acid SRC of 92%.

Oasis (OH 708)
Ohio State University produced this cultivar that has test weight about 1 pound higher than the reference cultivars. The kernel size was large at 39 grams per thousand. It has excellent milling quality and slightly above average flour granulation. Cookie spread was above average and the gluten strength appeared to be average.

Panola
This AgriPro cultivar has above average kernel weight and normal flour granularity. The lactic acid SRC was 97% suggesting medium-strong gluten strength.

Pioneer 25R35
This soft red winter cultivar will likely be about 1 pound higher in test weight than the normalized reference cultivars. The gluten strength appears to be about medium.

Pioneer 25W41
Pioneer 25W41 is a soft white wheat that will average about 2 pounds greater than the 60-pound reference cultivars. Kernel size was average and milling quality was good. It seemed to have very soft flour characteristics and with normal cookie size. The cultivar will likely be about average in gluten strength.

Pioneer 25R54
This cultivar will likely be in the same category as the reference cultivars for test weight. It has excellent milling properties and very fine flour granulation. The cookie spread was larger than the average soft wheat. Gluten strength was medium-strong with lactic acid SRC of 103%.

Pioneer 25R63
Pioneer Hi-Bred International released this soft red cultivar that will likely be about 1.5 pounds greater than the reference cultivars. It had large kernel size of nearly 40 grams per thousand grains. Milling quality was good and break-flour yield was about average. Flour protein may be slightly low and gluten strength will apparently be slightly above medium.

Pioneer 26R12
Pioneer 26R12 is a soft red winter wheat that has very good milling properties. The normalized test weight seems to be about 3 pounds higher than the reference cultivars listed in this report. Examples of cultivars similar to Pioneer 26R12 in test weight are: McCormick, Neuse NC, Pioneer 26R61, Roane and Spencer. There are about 660 cultivars listed in this report that have been evaluated for their genetic test weight relationship and only about 23 contemporary cultivars would exceed Pioneer 26R12. Some of those "23" are the same cultivar with different brand names. This cultivar produced large sugar snap cookies and was about medium in gluten strength.

Pioneer 26R15
This soft red wheat has very good milling quality. It seems to be strong in gluten strength.

Pioneer 26R31
The test weight would mirror the reference cultivars in the normalized test weight tables. Kernel weight was very large. Pioneer 26R31 displayed superior milling properties evidenced by the 7.6% ESI. Very few cultivars will have that type of milling performance. Flour granularity seemed to be about average and cookie spread was good. The gluten strength will probably be slightly above average.

Rachel
Rachel appeared to have a very high normalized test weight of 3.3 pounds. The data for Rachel was limited but very few cultivars possess test weight of this magnitude. An example of cultivars that have that type of test weight would be Coker 9184, Hoffman 89 and Tribute. Rachel appeared to be very strong in gluten strength (7.5 mixograph number).

Renwood 3260
Renwood 3260 was from the Virginia Polytechnic Institute and State University and has a normalized test weight of 1.6 pounds. It has very good milling quality and has strong gluten strength.

Renwood 3706
This Virginia cultivar has a normalized test weight of 2.0 pounds, possesses excellent milling and has medium-strong gluten characteristics.

RS 931
Rupp Seed 931 will be similar to the reference cultivars in normalized test weight. It has superior milling quality similar to Pioneer 25R23 and Southern States 520. RS 931 has good sugar snap cookie quality and the gluten strength was weak.

RS 947
Rupp Seeds introduced this cultivar that had normalized test weight of about 60.5 pounds. Kernel weight was small. Break-flour yield and cookie spread were average. Flour protein may be slightly low and gluten strength was medium.

RS 949
RS 949 was another Rupp Seeds cultivar and had test weight that would be about 2 pounds greater than the reference cultivars. Flour granularity was average and cookie spread will likely be on the smaller side. Gluten strength was about medium.

Santee
It is not known when Santee was released but likely has been available for a few years and may be considered a semi-hard cultivar. Santee has above average kernel size very coarse flour granulation. Flour protein for this single sample was about 10%, but that may not have been representative. Gluten strength may be about medium-strong.

Savage
The 1000 kernel weight for Savage was 30.6g. This smaller kernelled cultivar would be similar in grain size to: Ag-Alumni 9112, Caldwell and Mitchell. Limited data indicated the test weight of Savage to be very high. The correlation between test weight and 1000 kernel weight for 690 cultivars (shrivel-free) was r = .09. Savage may be about medium-strong in gluten strength.

SC 1325
Seed Consultants introduced SC 1325 that will probably be about 2 pounds greater than the 60 pound reference wheats. Kernel size was average. Flour granularity appeared to be coarse and cookie quality was slightly below average. Flour protein may be elevated slightly and gluten strength was a little above medium.

SC 1330
There was not enough test weight data for proper evaluation of this Seed Consultants' soft red wheat. Milling quality was very good having a mill score of 75. Break-flour yield was above average and cookie quality was larger than the average soft wheat. Gluten strength was very weak having an Allis-Chalmers lactic acid SRC of 69%. The lactic acid SRC range for soft wheat from the Allis-Chalmers mill has been about 60% for the white cultivar Genesee to 133% for the soft red cultivar Arise W34 adjusted to 9% flour protein.

SC 1343
SC 1343 was another line from Seed Consultants and had very good milling quality. The 1000-kernel weight was 36 grams. It was softer than the average soft wheat and the cookie spread was slightly below average. Gluten strength was weak-medium having a lactic acid SRC of 86%.

SC 1352
This Seed Consultants cultivar had normalized test weight around 62.0 pounds. The kernel weight was large being 38 grams per thousand grains. The milling quality was very good and the flour granularity was slightly coarser than the average for soft wheat. Cookie quality may be on the smaller side while gluten strength was medium-strong having a lactic acid SRC of 105%.

Soissons
Soissons, semi-hard wheat, was introduced into the United States from France. Soissons seemed to be slightly lower in test weight from the reference cultivars and slightly smaller than average kernel weight. Soissons had one of the highest milling scores of any soft wheat or hard wheat cultivar evaluated at the SWQL. The soft cultivars Argee, Pioneer 26R46 and Severn have had milling scores of 100 for an individual sample. The ESI of 4.9% was unequalled and the friability of 30.9% was most unusual for a very coarse granulating cultivar. The cookie baking potential was similar for good quality soft wheat. Flour protein was similar to the soft wheats and water absorption was low at 54%. The lactic acid SRC of 109% indicated Soissons to be medium-strong in gluten strength.

Southern States 8302
This cultivar has a normalized test weight of 1.5 pounds and large kernel weight of about 39 grams. It has very soft characteristics, good cookie spread and medium gluten strength.

Southern States 8308
Preliminary evaluation indicated that SS 8308 has unusually high genetic test weight at 3.3 pounds (normalized). Out of about 700 cultivars analyzed over many years and numerous locations for genetically associated test weight, there were only about 21 cultivars that would have a higher test weight than SS 8308. It also produced good cookie spread and was medium in gluten quality.

Southern States 8404
This cultivar may have very large kernel weight and had excellent milling quality. The flour granularity will likely be above average and had good cookie diameter. The lactic acid SRC was 83% and would suggest below average gluten strength.

Stine 480
Stine 480 may be a hybrid wheat. Normalized test weight was .7 pounds meaning that it would average about .7 pound higher in test weight than the reference cultivars. It had very good milling quality and appeared to have weak gluten.

Strategy
Strategy seemed to originate at the Virginia Polytechnic Institute and released through a Canadian seed company. There was limited test weight data that suggested the test weight may be about 2.5 pounds greater in test weight than the reference cultivars. The kernel weight appeared to be fairly large being 39 grams. Break-flour yield, cookie and gluten strength were about average.

Strike 205
Burtch Seed Company introduced Strike 205 and had a normalized shrivel-free test weight of 61.6#. Flour granularity was average and had good cookie baking potential. Gluten strength was slightly above medium.

Terral LA 422
This cultivar originated in Arkansas. Kernel weight was 38 grams per thousand. Milling quality was excellent having a mill score of 81.4. Only 10% of the 830 soft cultivars had mill scores exceeding 80. Flour granularity and sugar-snap cookie spread were average. Gluten strength was weak-medium having a lactic acid SRC of 85%.

TS 4040
Thompson Seeds introduced TS 4040 and it had good normalized test weight of 62.0 pounds. Reference cultivars are 60.0 pounds. Kernel weight was about average and Allis-Chalmers break-flour yield was very coarse. Cookie quality may be slightly smaller than the average soft wheat and gluten strength was weak-medium.

Truman
The University of Missouri released this soft red winter cultivar that has a high level of resistance to Fusarium Head Blight. The test weight will likely be about 1.1 pounds higher than the reference cultivars on a "genetic" basis. The gluten strength appeared to be about medium.

TS 3060
TS 3060 was introduced by Thompson Seed and will likely be similar to the reference cultivars in test weight. It possesses excellent sugar snap cookie spread and was about medium in gluten strength.

USG 3342
USG 3342 (VAN 98W-342) was from the Virginia Polytechnic Institute. Its normalized test weight will be about 1.2 pounds. USG 3342 has large kernel weight of about 39 grams. The flour granularity was softer than most cultivars and produced good cookie spread. The gluten was very weak.

USG 3592
This cultivar is from Unisouth Genetics and has very high test weight. It would be similar to AGS 2000, Coker 9474 and Traveler. The flour granulation was very fine and was an unusual characteristic for a high test weight cultivar. USG 3592 produced good cookie spread and was medium in gluten strength.

USG 3650
This soft red winter cultivar was released from Unisouth Genetics. It possesses very large 1000 kernel weight. The test weight may be about 1.3 pounds greater than the reference cultivars listed in the test weight tables. The one sample evaluated indicated that it has superior milling quality. USG 3650 appeared to be about medium to medium-strong in gluten characteristics.

VA 97W-469
The cultivar will likely be sold for private branding and has test weight that will probably be 1.5 pounds greater than the numerous cultivars found in the normalized reference list. This cultivar has superior milling properties possessing an ESI of 7.7%. Very few cultivars have that type of milling quality. Flour granulation was very soft being similar to Coker 9184, Hopewell and Pioneer 25R47. Cookie spread was quite large. The gluten strength appeared to be medium-strong with lactic acid SRC of 110%.

Venture
Genesis Brand introduced this soft red cultivar that had smaller than average kernel size. Kernel size has not proven to be a factor in milling quality until the kernel weight falls to the mid 20 gram range. Venture had superior milling properties with an ESI of 7.6%. Break flour yield suggests very fine granulating flour with very good cookie spread. Lactic acid SRC was 114% indicative of medium-strong gluten.

Vigoro 9211
This cultivar was introduced by Royster-Clark, Inc., and limited test weight information suggested Vigoro 9211 will be about 1.5 pounds higher than the reference cultivars. Kernel weight was 34 grams per thousand grains. Milling quality was good and flour granularity was about three percentage points below average. Cookie spread may be below average and gluten strength not able to be ascertained.

Vigoro 9212
The cultivar has high test weight similar to Pioneer 2552, Renwood 3706, Richland and Saluda. It has large kernel weight of nearly 40 grams. V 9212 possesses Superior milling quality similar to Caledonia, Daisy and FL 302. The cookie spread was good and has weak gluten strength.

Vigoro 9510
Vigoro 9510 was released by Royster-Clark, Inc. Kernel weight will probably be above average and break-flour yield was about one percentage point softer than average. Cookie baking quality was slightly below average being similar to Gore, Mason and Tribute. Gluten strength may be medium-strong but there was uncertainty due to “weathering”.

Vigoro 9512
This cultivar was another Royster-Clark Inc. introduction and test weight analysis indicated the cultivar will likely be about 1.1 pounds greater than the reference cultivars. Vigoro 9512 had above average kernel-weight size. Break-flour yield was of average softness. Cookie spread may be small and gluten strength was medium.

Vigoro 9222
V 9222 has good test weight with average-size kernels. The flour granulation seemed to be very soft and cookie spread was typical for soft wheat. The gluten strength was strong as measured by the lactic value of 124%.

Vigoro 9412
This cultivar likely will have a normalized test weight that will be about 2 pounds higher than the zero-reference cultivars. The gluten appeared to be of medium strength.

Warwick
Warwick is a soft red winter from C & M Seeds, Canada, and may have a normalized test weight of 1.9 pounds. It appeared to be very soft as revealed by the Allis-Chalmers mill. Warwick had good cookie spread and may be on the strong side for gluten strength.

Weaver
Steyer Seeds will market Weaver which possesses many good quality traits. Its normalized test weight may be about 1.0 pound higher than the reference cultivars and has large kernel weight of about 39 grams. Weaver possesses superior milling properties similar to Caledonia, Pocahontas and FL 302 and has very soft flour granulation. The cookie spread was good and the gluten strength was weak to medium.

Wellman 111
Wellman Seeds, Inc., of Ohio, introduced this cultivar that had normalized test weight that was 2.2 pounds higher than the reference cultivars that equal about 60.0 pounds normalized test weight. Thousand-kernel weight was 35 grams. Flour granularity was very coarse, similar to Kristy. Cookie spread will likely be smaller than typical for soft wheat. Gluten strength was about medium-strong having Allis-Chalmers lactic acid SRC of 104%.

Wellman 120
Introduced by Wellman Seeds. Genetic test weight will probably be about 2.0 pounds above the reference cultivars. Kernel size was slightly below average. Wellman 120 had very soft flour granulation and cookie quality was good. Gluten strength was slightly above medium having lactic acid SRC of 100%.

Wellman 121
Wellman Seeds owns the rights to this new soft red cultivar and the normalized test weight will likely be about 1.3 pounds greater than the 60-pound reference cultivars. Kernel weight was about average and flour granularity was average for soft wheats. Milling quality was good having mill score of 76 and unusually good middling-stock-reduction friability above 30%. Cookie spread will probably be average and gluten strength was about medium having lactic acid SRC of 93%.

Wellman 130
Wellman 130 has very high normalized test weight of 3.9 pounds and practically unparalleled compared to nearly 700 soft cultivars. There are around 10 cultivars that would have higher genetic test weight. Cultivars similar in test weight to Wellman 130 are AGI 540 and Cayuga. Gluten strength was about medium.

Wellman 150
Wellman 150 has a normalized test weight of .8 pounds. The cultivar appeared to be very soft in flour particle size and produced a large sugar snap cookie spread. The gluten strength was medium.

Whitby
Hyland Seeds, Canada, released this soft white cultivar that has test weight that would parallel the reference cultivars. It has very large kernel weight in excess of 40 grams. Break flour yield was slightly below average and cookie spread was typical for soft wheat. The lactic acid SRC was 88% and would suggest average gluten strength.

Wiley
Wiley was introduced by Steyer Seeds and had normalized test weight about 2.2 pounds higher than the reference cultivars. Allis-Chalmers break-flour was coarse and cookie spread will likely be on the smaller side. Gluten strength was slightly above medium having lactic acid SRC of 103%.

Willcross 795
Limited test weight data suggested that this cultivar will be a reference cultivar having normalized test weight of 60.0 pounds. Willcross 795 had good milling quality and slightly above average flour softness. Cookie spread may be on the smaller side and gluten strength was weak-medium (Allis-Chalmers lactic acid SRC 84%).

Wisdom
Hyland Seeds, Canada, released this soft red wheat that had test weight similar to the reference cultivars. Wisdom has very good milling quality and displayed extremely high flour granulation properties. This cultivar could be valuable for contract growing because of its extreme softness and usefulness for cake baking. The cookie spread was very good and the lactic acid SRC of 108% would suggest medium-strong gluten strength similar to Tribute.