QUALITY CHARACTERISTICS

OF

SOFT RED, SOFT WHITE,

EASTERN SEMI-HARD & HARD

WHEAT CULTIVARS

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Andrews, Lonnie
Physical Science Technician
andrews.132@osu.edu

Souza, Edward
Research Leader
souza.6@osu.edu

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United States Department of Agriculture
Agricultural Research Service
Soft Wheat Quality Laboratory
1680 Madison Avenue
Wooster, OH 44691
USDA Soft Wheat Quality Laboratory Website

Soft Wheat Quality Laboratory Staff:
Dr. Meera Kweon (kweon.11@osu.edu); Amy Bujag (bugaj.4@osu.edu); Sue Carson (carson.3@osu.edu); Sharon Croskey (croskey.6@osu.edu); Tom Donelson (donelson.7@osu.edu); Georgianna Kirchhofer (kirchhofer.3@osu.edu); Ron Martin (martin.744@osu.edu)

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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 2007 Report

For the first time, we have produced the annual report in electronic format, rather than as a printed book. We hope that this will make the report more user-friendly. The 830-cultivar Allis database is included as a file that can be searched and sorted. The electronic format also will facilitate posting the report on the web.

The report now includes the quality summaries of the Regional Nurseries provided to breeders each year. We also have returned to the report the quality targets generated some years ago by the SWQL. To complement these targets, we have added a list of cultivars in the Allis database that meet or exceed the targets.

We will appreciate your comments and suggestions on the 2007 Report as we begin planning for 2008!

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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. Most of the parameters are similar except the measure of gluten strength (lactic acid solvent retention).

The targets have remained relatively unchanged over the years with only updates on the incorporation of newer tests such as solvent retention capacity. The standards are included in this report for reference to interpret subsequent data. Most newer cultivars individually meet one or more of the standards. Slightly more than half of the cultivars released since 1990 meet all of the standards for either the pastry classification or the export/cracker classification. The most difficult target for most cultivars to meet is the break flour target.

What follows is a table of the targets, a comparison of the Allis milling cultivars to the targets, and a list of cultivar released since 2001 that meet either the pastry or export/cracker targets.

Questions appropriate for review by the industry concerning these targets follow:

Are these standards still relevant to current production values?

Is the ratio of cultivars meeting the pastry and cracker targets desirable (~1:2.5, pastry:cracker)?

Should there be a larger gap in lactic acid solvent retention values between pastry and cracker types?

What other rheology or bake tests should be added?

Should genetic information be added to these targets (glutenins, puroindolines, GBSS, rye translocations)?

Desired Ranges of Soft Wheat Quality Traits

Category / Method	Pastry Flour Desirable Parameter Range	Cracker and Export 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

Quality Targets

Category / Method	Pastry Flour Desirable Parameter Range	Cracker and Export 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

Comparison of Allis Milling Data to Soft Red Targets

Category / Method	Pastry Flour Desirable Parameter Range	Cracker and Export Flour Desirable Parameter Range	Average Allis database 1801 to 1990	Average Allis database 1991 to 2006	Cultivars after 1990 that meet pastry target (%)	Cultivars after 1990 that meet cracker target (%)
Test Weight / Grain Condition						
Test Weight	> 58 lb/bu	> 58 lb/bu	61.35	61.30	99.8	99.8
1000 Kernel Weight	> 27 g	> 27 g	36.16	36.20	99.8	99.8
Kernel Texture						
Milling, Allis-Chalmers Break Flour Yield	30 - 37 %	25 - 37 %	31.48	32.28	73.2	97.7
Milling Qualities						
Allis-Chalmers Flour Yield	> 75.7 %	>75.7%	76.94	77.21	93.3	93.3
Allis-Chalmers Flour Ash	< 0.430 %	< 0.430 %	0.40	0.40	86.7	86.7
Allis-Chalmers E.S.I.	< 11.5 %	< 11.5 %	10.21	9.67	93.3	93.3
Allis-Chalmers Milling Score	> 52	> 52	63.67	68.30	95.4	95.4
Allis-Chalmers Friability	> 27.2 %	>27.2%	28.02	28.67	87.3	87.3
Protein Content						
Flour Protein	8 - 10 %	9 - 14 %	9.92	8.93		
Protein Strength						
5% Lactic Acid	>87%	>87%	89.73	93.60	31.1	68.9
Baking Qualities						
Cookie, Sugar-Snap Method 10-52 Width	17.2 - 18.0 cm	17.2- 18.0 cm	17.48	17.56	79.2	79.2
Percent of cultivars released after 1990 that meet all parameters for texture, milling, protein strength, and baking quality					***16.1***	***41.8***

Table 1. Cultivars Released Since 2001 with Allis Milling Data Consistent with Soft Winter Wheat Pastry Standards.

Cultivar	Class	Origin	Release date
Abacus	SWW	MI	2005
AGI 535	SRW	OH	2001
Aurora	SWW	MI	2003
Bowerman	SRW	OH	2001
Choptank	SRW	MD	2004
Coker 9375	SRW	NC	2004
Coker 9436	SRW	AR	2004
Cooper	SRW	IN	2003
Emmit	SRW	CAN	2005
FFR 38247	SRW	VA	2002
INW 0304	SRW	IN	2004
INW 0315	SRW	IN	2003
INW 0316	SRW	IN	2003
Jentes	SRW	OH	2003
Mitchell	SRW	AR	2001
Pioneer 25R49	SRW	IN	2002
Richland	SWW	NY	2002
Rosco	SRW	OH	2001
RS 931	SRW	OH	2001
SC 1343	SRW	OH	2004
SS 550	SRW	VA	2002
Terral	SRW	AR	2002
USG 3342	SRW	VA	2005
Whitney	SRW	CAN	2002
Wonderly	SRW	OH	2001

Table 2. Cultivars Released Since 2001 with Allis Milling Data Consistent with Soft Winter Wheat Export and Cracker Standards.

Cultivar	Class	Origin	Release date
AGI 202	SRW	OH	2004
AGI 538	SRW	OH	2001
AGS 2485	SRW	GA	2004
Armor 3035	SRW	AR	2001
Besecker	SRW	OH	2004
Bess	SRW	MO	2004
Bouillon	SRW	OH	2001
Branson	SRW	IN	2006
Cecil	SRW	OH	2003
Coker 9152	SRW	NC?	2002
Coker 9184	SRW	NC?	2003
Coker 9312	SRW	NC	2004
Coyote	SRW	OH	2002
Croplan 594W	SRW	OH	2004
Cropland 514	SRW	VA	2001
Daisy	SRW	OH	2003
Dyna Gro 403	SRW	IL?	2001
E 1007W	SWW	MI	2005
Featherstone 176	SRW	VA	2005
FFR 38158	SRW	VA	2001
FFR 510	SRW	VA	2001
FFR 535W	SRW	VA	2001
FS 530	SRW	IL	2004
Genesis-D 8006	SWW	MI	2005
Hartman	SRW	OH	2004
HS 222R	SRW	MI	2003
HS 243R	SRW	MI	2003
Husky	SRW	OH	2004
INW 0102	SRW	IN	2001
INW 0302	SRW	IN	2003
INW 0303	SRW	IN	2003
INW 0411	SRW	IN	2005
Jacob	SRW	OH	2003
Marion	SWW	CAN	2002
MO 011126	SRW	MO	2006

Quality Targets

Cultivar	Class	Origin	Release date
Monarch	SRW	OH	2002
Natchez	SRW	AR	2003
Neuse NC	SRW	NC	2003
OH 708	SRW	OH	2005
Pat	SRW	AR	2003
Pearl	SWW	MI/VA	2002
Pioneer 25R42	SRW	IN	2002
Pioneer 25R44	SRW	IN	2001
Pioneer 25R47	SRW	IN	2003
Pioneer 25R54	SRW	IN	2003
Pioneer 25R78	SRW	IN	2002
Pioneer 25W41	SWW	IN/MI	2003
Pioneer 26R12	SRW	IN	2003
Pioneer 26R15	SRW	IN	2004
Renwood 3706	SRW	VA	2003
Savage	SRW	AR	2003
Smoke	SWW	MI	2003
SS 520	SRW	VA	2002
USG 3592	SRW	GA	2003
USG 3650	SRW	TN	2003
VA 97W-469	SRW	VA	2004
Venture	SRW	MI	2004
Vigoro 9412	SRW	OH	2004
W 120	SRW	OH	2004
W 126	SRW	IL	2001
Whitby	SWW	CAN	2002
Wilson	SRW	MI	2002
Wisdom	SRW	CAN	2003
Wonder	SRW	CAN	2002

Cultivars Added for 2007

Soft wheats as a class are defined by soft endosperm texture, low damaged starch from milling and flour with distinctly lower water absorption than flour from hard wheats. Soft wheat cultivars differ in gluten strength and products produced from the eastern soft wheat crop require diversity in gluten strength.

Strong-gluten strength cultivars may be useful for cracker production where "sheeting" is required and for tortillas. Strong-gluten strength does not interfere with sugar-snap cookie spread since there is a low percentage of water in the formulation. Other flour components such as starch damage, flour granularity and/or pentosan content would likely have the greatest impact in reduced sugar-snap cookie spread. Weak-gluten strength cultivars may be more be desirable in non-chlorinated formulations requiring higher percentages of liquid. The possible uses for varying gluten strength flours are stated here to avoid continued repetition.
The normalized test weight table categorized hundreds of cultivars/varieties. If all cultivars were grown together and the wheats were shriveled-free, then the actual test weight would correlate very well with the historic normalized data. "Reference" cultivars referred to in the following descriptions are those wheats that are considered to be equal to 60.0 pounds in normalized test weight.

Some quality data was extrapolated based on the best available information.

547W
This soft red cultivar may have been released by Westbred. 547W will likely have a genetically related test weight (normalized) that would be about 1.6 pounds higher than the reference cultivars. Kernel weight will be in the low 30's. This cultivar had good milling quality and about average flour granularity. Sugar-snap cookie spread may be slightly smaller than the average soft wheat. Gluten strength was weak-medium being similar to Armor 3235, Choptank, Natchez and Southern States MPV 57.

Abacus
Abacus is a soft white wheat that was released into Michigan. Normalized test weight will probably be similar to the reference cultivars. Abacus had large kernel weight approaching 40 grams per thousand kernels. It had good milling quality similar to Chelsea and Lowell. Gluten strength was fairly weak as has been common among most white cultivars.

AG 9346
The cultivar might be considered a semi-soft/hard wheat and may have been released or introduced by Westbred. Break-flour yield was very low and was similar to the semi-soft/hard cultivar Carlisle. Test weight of AG 9346 was slightly above the reference cultivars. Kernel weight was very small, but AG 9346 was outstanding in milling quality. It was the 5th best milling cultivar out of 830 soft and semi-soft wheats over the past 200 years. Cookie spread was on the small side as expected and flour protein was elevated about 1.5 percentage points. Gluten strength was about medium.

AGI 202
AGI 202, a soft red winter, was from Advanced Genetics. Based on limited data it had good test weight being about 2 pounds higher than the reference wheats. Kernel weight will be on the low side. AGI 202 had very high break-flour similar to Caldwell and Hopewell. Cookie spread may be slightly smaller than average and the gluten strength appeared to be slightly above average being similar to Caldwell, Monarch and Pioneer 25R47.

AGI 203
This wheat was another line from Advanced Genetics and had genetic normalized test weight about 1 pound greater than the cultivars in the 60 pound category (the test weight data was limited). Kernel weight was over 40 grams per thousand and the cultivar had typical softness. Cookie spread was about average and the gluten strength was average as well.

AGI 204
Advanced Genetics released this cultivar that may have test weight about 1.5 pounds greater than the reference wheats. Kernel weight was average and the flour granularity was below the average soft wheat; possibly similar to the coarse cultivars Arthur and Kristy. Cookie spread will likely be on the small side and gluten strength was above average being similar to Coker 9152, Kristy and Roane.

AGI 301
The test weight data was limited but this Advanced Genetics' wheat may be slightly greater in test weight than the reference cultivars. Kernel weight was about average for soft wheat and break-flour yield was typical. Cookie spread was good and gluten strength appeared to be very high with an Allis-Chalmers lactic acid SRC of 119% adjusted for 9% flour protein. Pioneer 25R26 will have lactic acid SRCs in the low 120% range.

AGS 2060
AGS 2060 apparently had its roots in Louisiana. Normalized test weight was 2.7 pounds, indicative of very high test weight. Kernel weight was slightly above average based on limited data. AGS 2060 had very good milling quality. Gluten strength was very high at 123% (Allis-Chalmers lactic acid SRC adjusted to 9% flour protein).

Alma
Steyer Seeds released this cultivar that had good genetic test weight of about 2 pounds greater than the reference cultivars in the test weight tables. Kernel weight, cookie spread and flour granularity were typical for soft wheat. Gluten strength was average.

Beck 117
Beck's Hybrids released this cultivar with test weight that will be about 2 pounds above the reference standards. Kernel weight and cookie spread were typical for soft wheat. Flour granularity will be coarse and gluten strength was slightly above average being similar to Coker 9152, OH 708, Patterson and Roane.

Branson
Branson was released by AgriPro and this soft red cultivar may have test weight similar to the reference wheats. Kernel weight, break-flour yield, cookie spread and flour protein were typical for soft wheat. Gluten strength was average.

Campbell 9455
This cultivar was introduced by Campbell Seed and had test weight similar to the reference cultivars. Kernel weight, cookie spread and break-flour yield were average for soft wheat. Gluten strength was above medium-strong. Cultivars that had similar gluten strength were: Elkhart, Pioneer 2643, Rachel and Warwick.

Cedar
This soft red wheat was from Michigan and had "reference table" test weight. Kernel weight was on the smaller side. Break-flour yield was above normal and cookie quality was typical for soft wheat. Flour protein may be low and gluten strength was average.

Coffman
Coffman belongs to Steyer Seeds and had test weight that will likely compare with the reference cultivars. Kernel weight was large and milling quality was good. Flour granularity and cookie quality were typical. Gluten strength was on the weak side.

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.

E 1007W
This soft white cultivar may not be released yet, but it had been used as a check sample for Michigan test lines. Test weight of E 1007W will likely be about 1.3 pounds higher than the reference cultivars. Kernel weight was very large at 41.6 grams. E 1007W 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%.

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.

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.

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.

GA 931233E17
The cultivar name for this line was unknown. The Georgia line had good genetic test weight that will be about 2 pounds higher than the reference standards. Kernel weight may be smaller than average, but the milling quality was very good having a mill score of 75. Coker 9436, Gore, Pioneer 26R15 and Wisdom had similar milling quality to GA 931233E17. Break-flour yield and cookie spread appeared to be typical. Gluten Strength was slightly above 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
This cultivar was from Genesis Brand and released 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%.

Harvard
Harvard appeared to be a hard red winter wheat and was released or introduced by JGL of Ohio. Harvard appeared to have genetic test weight that was very high; about 3.1 pounds higher than the reference cultivars of 60.0 pounds. Kernel weight was very large at 41 grams per thousand kernels. Milling quality was excellent and would be in the top 10% if compared with the soft wheat data base and if friability were ignored. The Allis-Chalmers break-flour yield was low (22.3%) and cookie spread was expectedly small being 15.3 cm. Flour protein was 9.5% which was typical for many soft wheats that were grown with Harvard in the SWQL plots. Gluten strength was very strong having a lactic acid SRC of 124%.

HS 222R
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.

HS 243R
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.

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.

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.

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.

MO 011126
The Missouri line from the University of Missouri was in the Soft Wheat Quality Council set and had been evaluated prior to 2006. Limited data suggested that MO 011126 might be 2 to 2.5 pounds higher than the reference cultivars. Kernel weight was very large averaging 44 grams per thousand grains. Flour granularity and cookie spread were typical for soft wheat. Milling quality was superior and ranked 3rd out of 830 soft cultivars. Only Pioneer 26R46 (mill score 97) and Argee (mill score 96) had slightly better milling quality. The University of Missouri also produced MPG 7921; another superior milling cultivar. The gluten strength for MO 011126 was slightly above medium with Allis-Chalmers 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.

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).

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.

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%.

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.

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 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.

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%.

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%).

Characterized Cultivars

AG 2020
This Ag Alumni soft red winter cultivar possesses very high test weight. Normalized test weight indicates that it will be about 3.1 pounds higher than the reference cultivars. It will have similar test weight genetically to cultivars such as; McCormick, Neuse NC, Pioneer 26R61, Roane and Spencer. There are only about 23 contemporary cultivars listed in this report that would exceed AG 2020 in normalized test weight. AG 2020 produced very large sugar snap cookies.

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.

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 Fl 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.

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.

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.

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.

Dawson
The AgriPro cultivar appeared to be a semi-soft cultivar since it produced very coarse granulating flour on the Allis-Chalmers milling system. Limited data suggests that Dawson may be, genetically, very high in test weight. The cultivar has weak to medium gluten strength. Our sample of Dawson was about 2.5 percentage points higher in protein compared to the reference cultivars. The name Dawson was known historically as a soft white winter wheat from Canada.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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%.

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%.

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 26R12
Pioneer 26R12 is a soft red winter wheat that possesses 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.

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.

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 was considered to be medium-strong in 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.

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.

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.

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.

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 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 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.

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.

Webster
Webster is a soft red winter cultivar from Canada. It appeared to have gluten strength that was about medium-strong.

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 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.

Wilson
Steyer Seeds will market 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.

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.

Historic Perspective of Wheat Characterization

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 latter, 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.

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.

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.

History of Several American-Grown Wheat Varieties

The following information concerning several historic American-grown varieties was excerpted 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.

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.

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.

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.

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.

Fulcaster (cont'd)
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.

Fulcaster (cont'd)

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.

Fultzo-Mediterranean (cont'd)
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.

Goens (cont'd)

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 (cont'd)

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.

Goldcoin (cont'd)
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.

Goldcoin (cont'd)
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.

Grandprize (cont'd)
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.

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.

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.

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.

Purplestraw (cont'd)
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.

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.

Red May (cont'd)

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 Red was weak in gluten strength.

Quality Characteristics of 830 Soft Wheat Cultivars

Milling quality is a highly heritable genetic trait. Milling-quality score consists of straight-grade flour yield, endosperm separation index (ESI)[e] and friability.[f] Other milling quality parameters also can be utilized from the Allis-Chalmers milling data. Data represents millings from a modified Allis-Chalmers mill of "shrivel-free" grain from various locations and/or crop years (1975-2006). Every effort has been adopted to insure that milling-quality data is 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-kernel weight[d] 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.

Materials and Methods

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.

Materials and Methods, Cont'd.
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 2005. The several remaining cultivars will be harvested in the summer of 2006.

Weather damaged cultivars that would 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. There are 18.6 standard deviations in mill score between the best and poorest milling cultivars.

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.

Allis-Chalmers 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%.

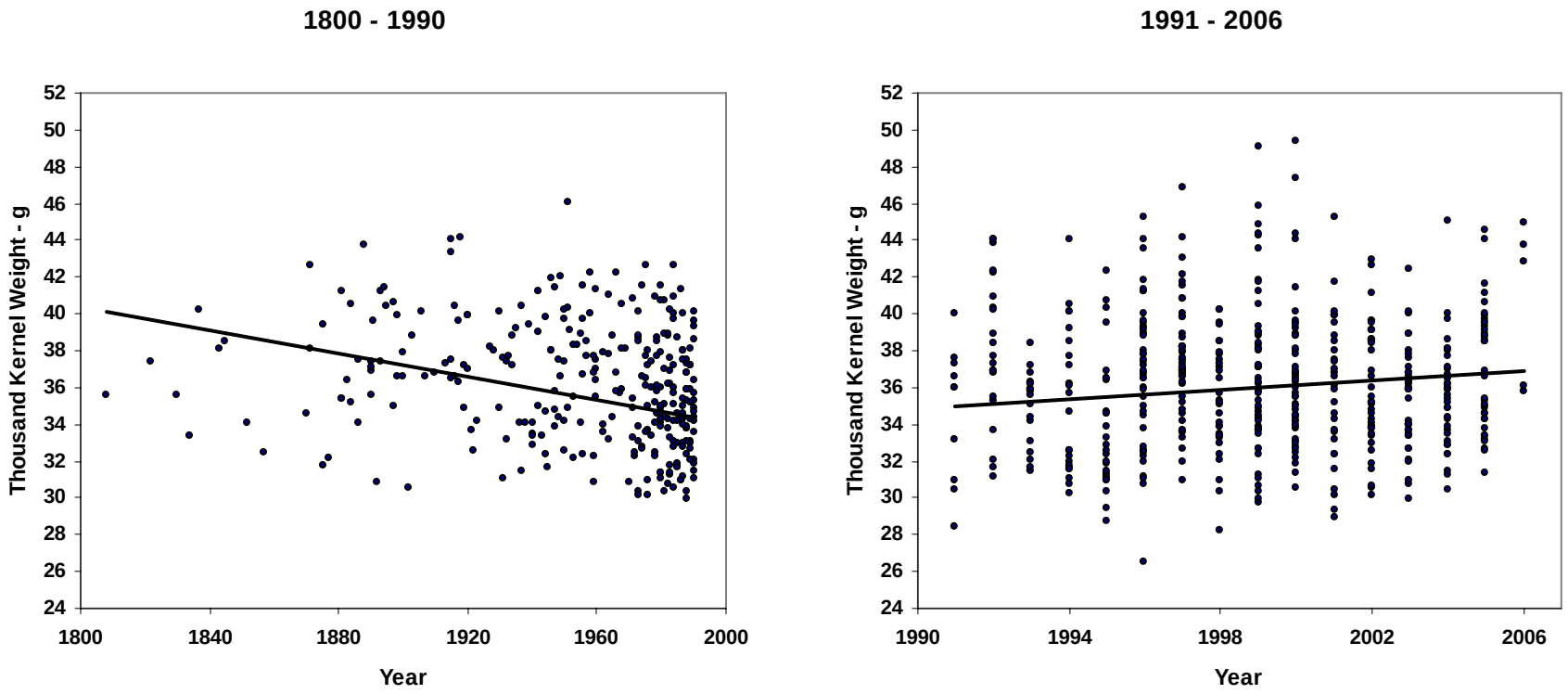
Materials and Methods, Cont'd.

Data Analysis and Interpretation

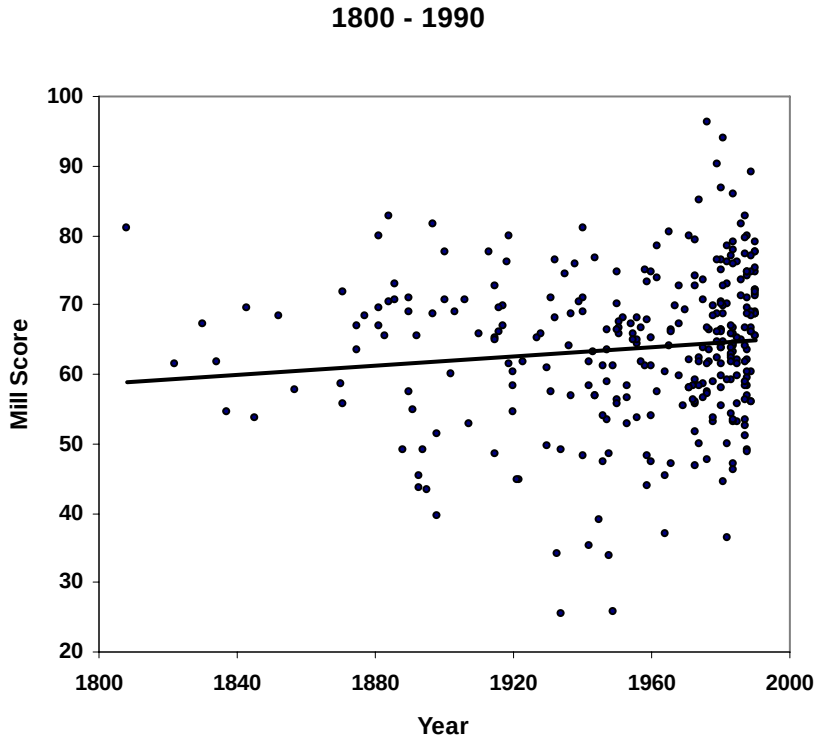
Since milling quality is a highly heritable genetic trait, excluding weather damaged examples; a single sample likely will produce representative milling yield, ESI and friability. Also, lactic acid solvent retention capacity values within a milling system is highly heritable in all published genetic 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 would be more representative of those traits that are less stable. The number of samples included in the computation of the average[(b)] is included for each cultivar. A cultivar that has been composited from several locations/crop years may produce quality data that would more nearly reflect its genetic nature. Cultivars listed in the tables that have a "c" beside the "number for the average" would indicate that a composite sample has been milled that generated the quality data. For each trait, the pooled standard deviation[(a)] was computed, and these are included in the attached data summaries.

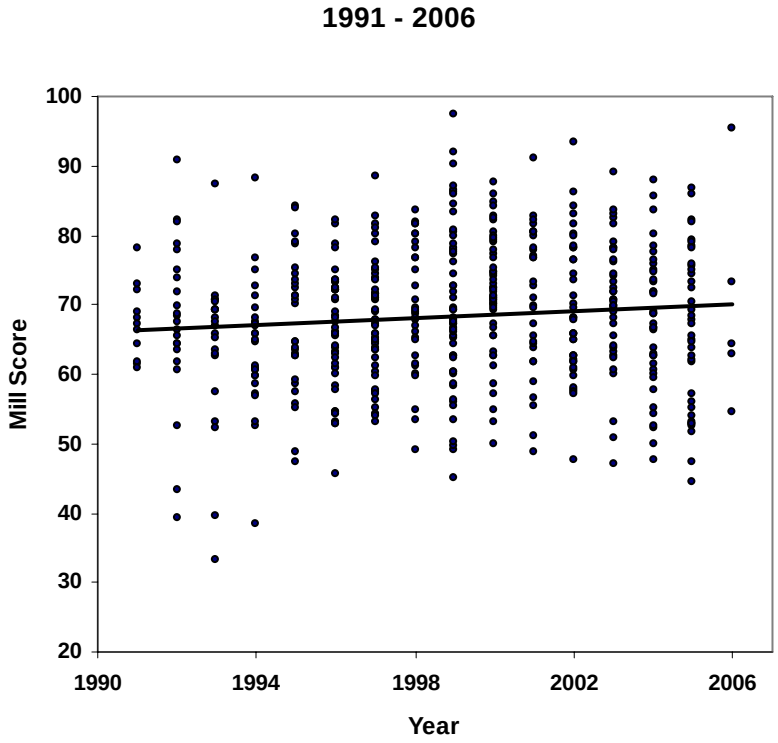
There are several graphs on the follow pages that were generated from several hundred soft wheat cultivars grown in the United States and Canada during the past 200 years. A separate graph on each page represents only those cultivars released since 1991.

Thousand Kernel Weight

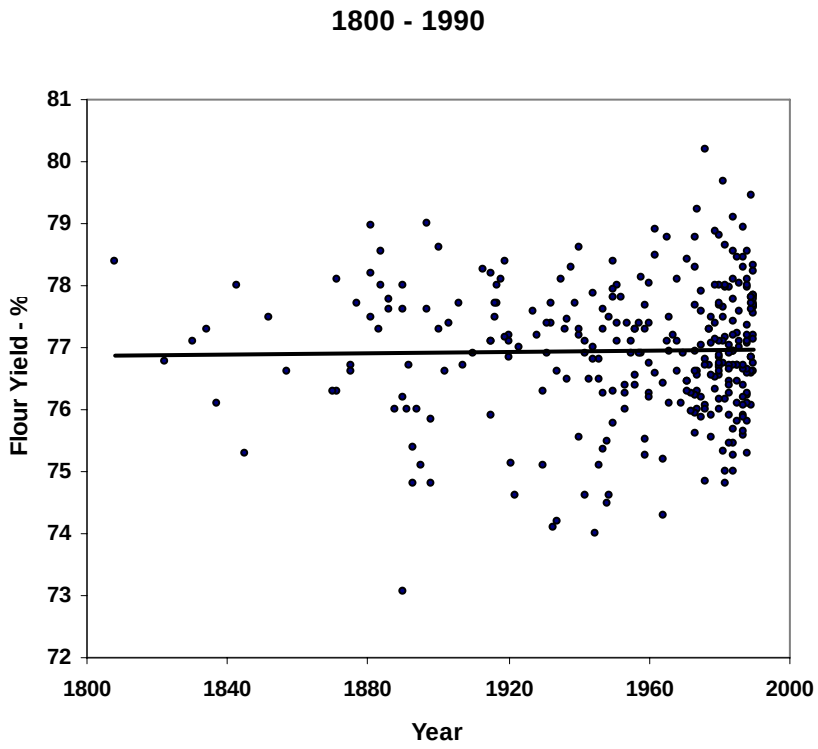


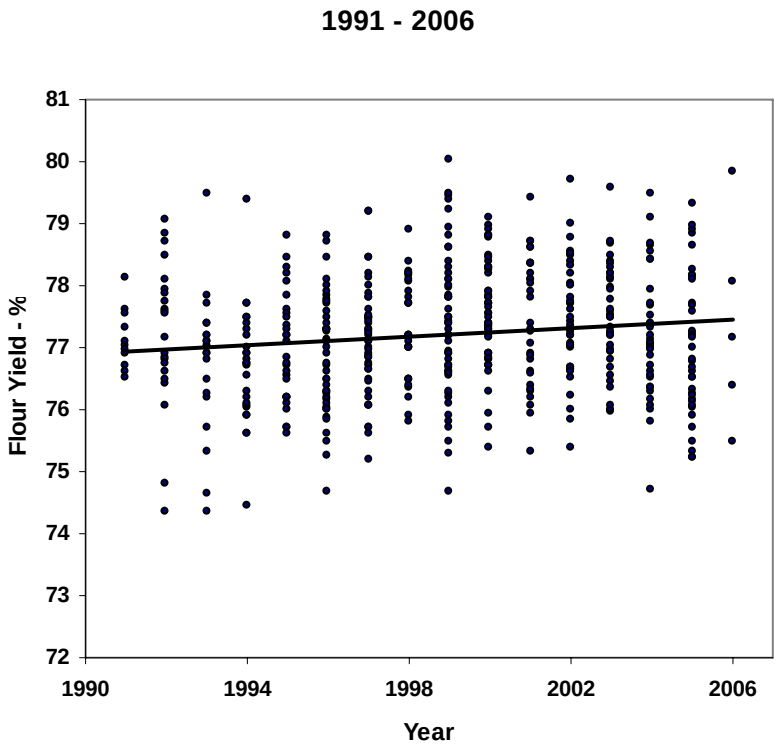
Mill Score


1800 - 1990
Mill Score
Year
100
90
80
70
60
50
40
30
20
1800
1840
1880
1920
1960
2000

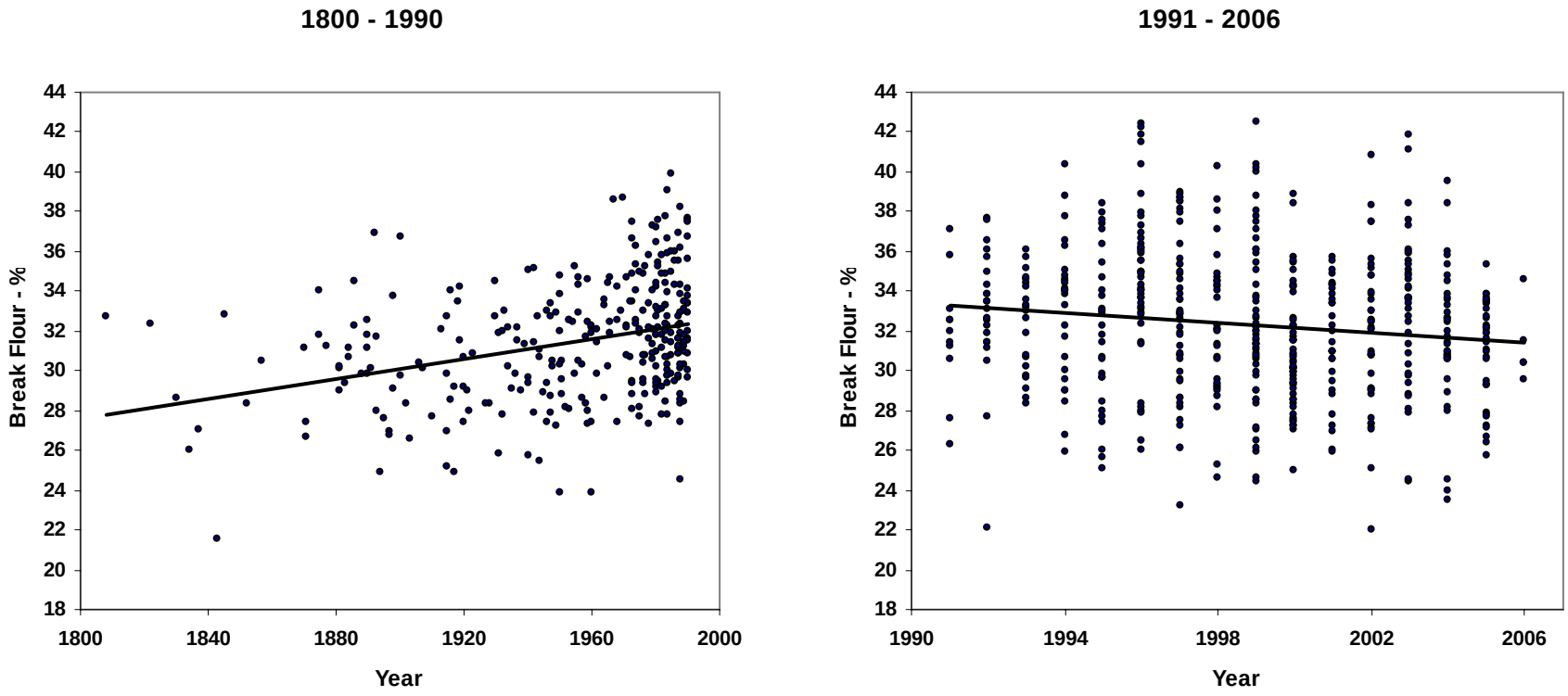

1991 - 2006
Mill Score
Year
100
90
80
70
60
50
40
30
20
1990
1994
1998
2002
2006

Flour Yield

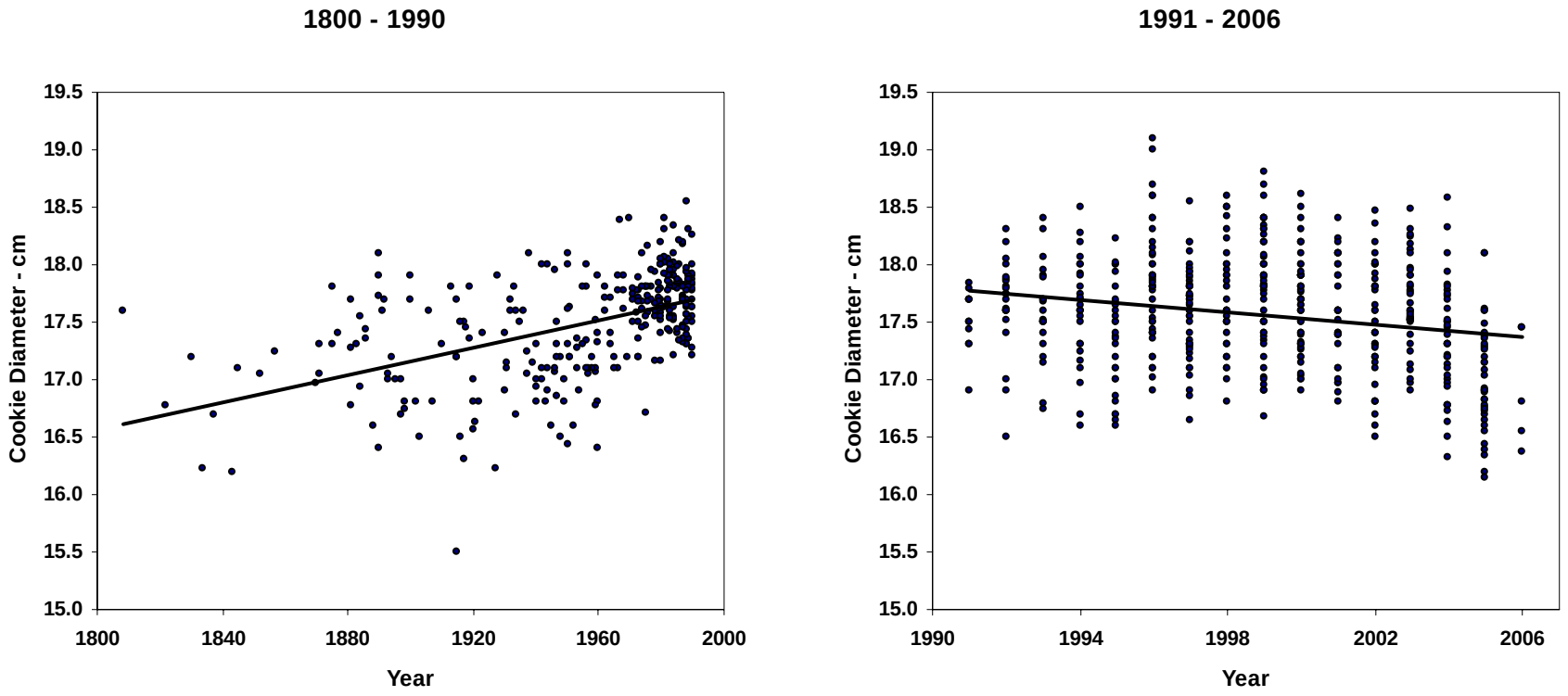

1800 - 1990
Flour Yield - %
81
80
79
78
77
76
75
74
73
72
1800
1840
1880
1920
1960
2000
Year


1991 - 2006
Flour Yield - %
81
80
79
78
77
76
75
74
73
72
1990
1994
1998
2002
2006
Year

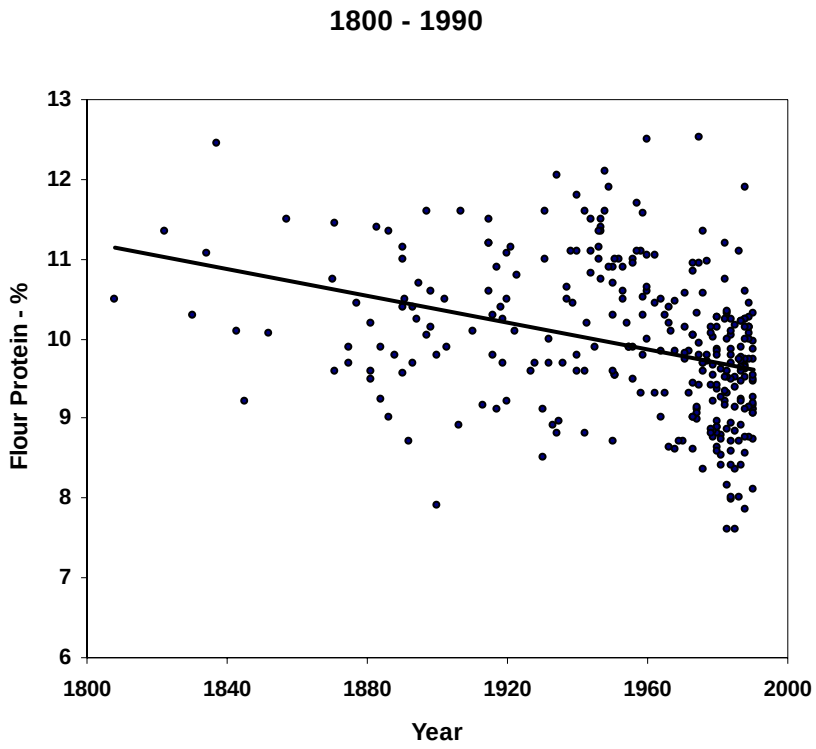
Break Flour Yield

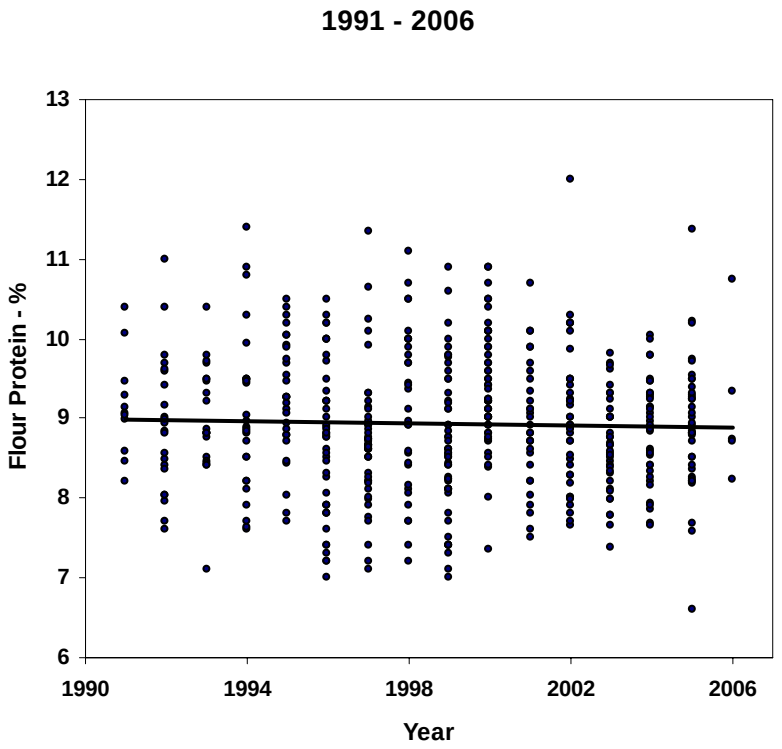


Sugar Snap Cookie Diameter (x2)[(g)]

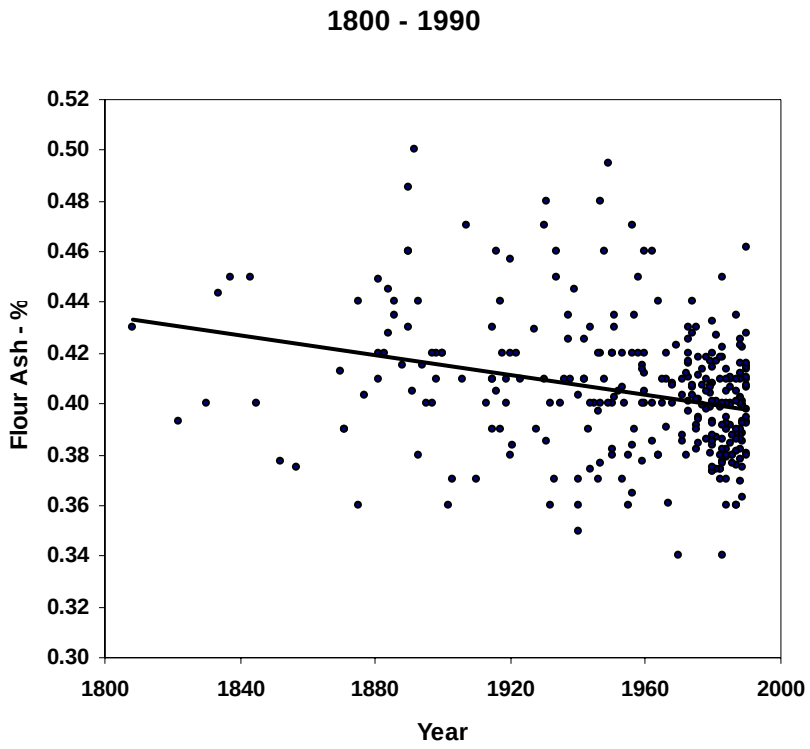


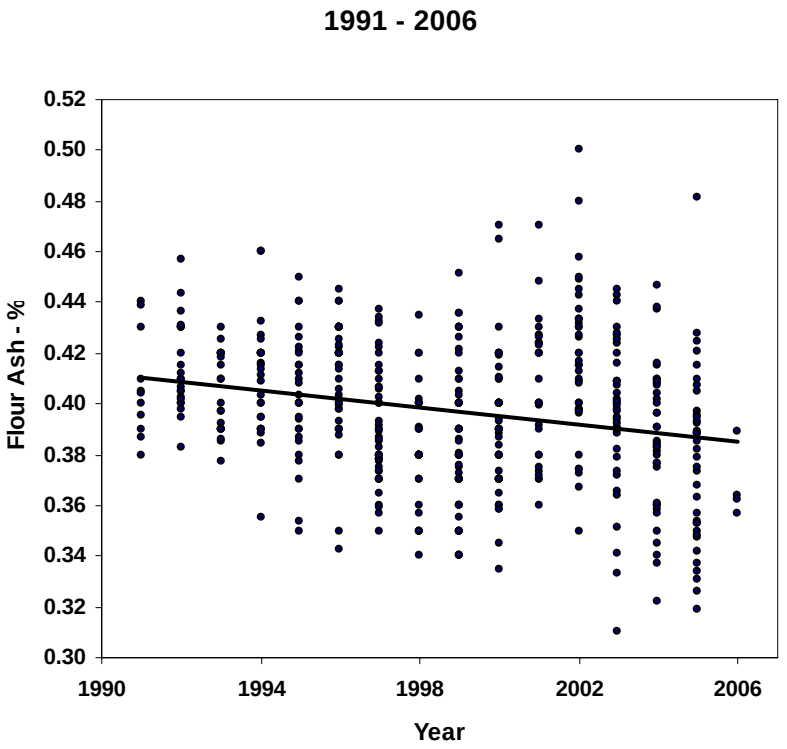
Flour Protein[(h)]





Flour Ash

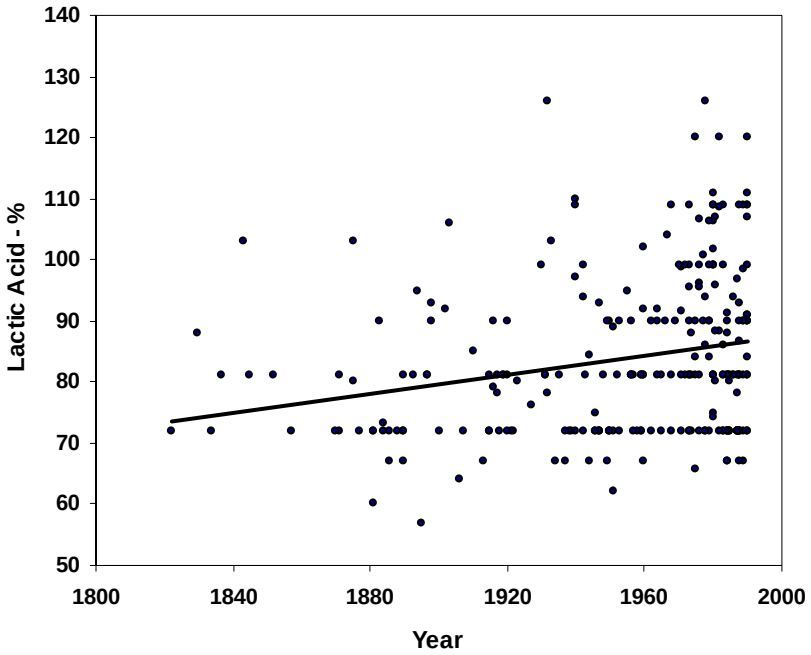

1800 - 1990
Flour Ash - %
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
1800
1840
1880
1920
1960
2000
Year


1991 - 2006
Flour Ash - %
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
1990
1994
1998
2002
2006
Year

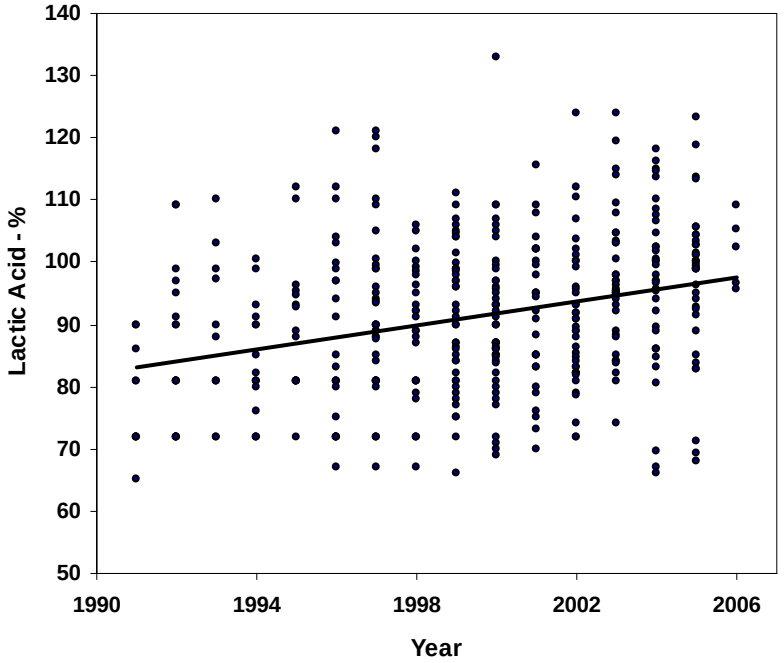
Gluten Strength[(i)]

(Lactic Acid SRC; Adjusted to 9% Protein)

1800 - 1990



1991 - 2006



Similarities Among Private-Brand Cultivars

A significant number of private-brand cultivars are available to growers. A breeding line can be purchased and then subsequently sold to various individuals and then made available to growers under many different names. If cultivars are grown together, quality characteristics such as test weight, 1000 kernel weight, milling parameters, ash, flour granularity, protein, sugar snap cookie spread and lactic acid SRC can be extremely beneficial in identifying cultivars that appear to have commonality. In addition, field observations can assist in confirming what the quality comparisons suggest. The following groupings of cultivars on the next page have displayed essentially identical quality traits in all categories.

Table 3. Similar private-brand cultivars.

AGI 540 Beck 109 Benjamin Brandy Cobra Dyna Grow 426 GL 9240 L 15 Podach RS 927 RW 151 SC 1365 SG 1550 SR 204 Succession TS 4020	RW 1480 W 115 AGI 525 CM 577 Packard RS 987 Voris 8044 Chieftan Dyna Grow 246 Mountain AC Kent AC RS 919 SR 215 Pro 100 SR 203	Sunsation GR 9956 Beck 107 GR 983 LG 1433 Magers RW 1517 TS 8040 W 9830 Stine 455 W 9910 Wonderly FS 200 Reo RW 1505 TS 6020	Beck 105 GR 933 Hoppes RS 917 SG 1540 SR 205 Voris 8040 Anthony W 9710 Gregory Corn Belt X-15 CM 569 LG 1388 Stine 488 Autumn H 101	CM 539 W 9850 RW 1488 SR 216 Schultz 130 Wilkens 126 Stine 454 Excel 450 Jentes V 9412 DF 101R SC 1325	Falcon FS 309 Venture VA 97W-469 Cedar RS 947 Wilkens 111 Stine 902 Hoffman 37 FS 527 527 W	V 9212 SC 1343 Besecker AGI 301 MacMillian RS 949 TS 4040 AGI 101 Wiley Strike 205 Beck 117
Excel 200 Excel 300 Excel 400						

Table 4. Correlation (*r*) among traits in Allis database.

	Norm. Test Wt.	1000 Kernel Wt.	Mill Score	Flour Yield	ESI	Friability	Flour Ash	Break Flour	Cookie Diameter	Flour Protein
Normalized Test Wt.	1									
1000 Kernel Wt.	-0.06	1								
Mill Score	-0.05	0.05	1							
Flour Yield	-0.02	0.09	0.94	1						
ESI	0.02	-0.05	-0.96	-0.91	1					
Friability	-0.10	0.00	0.92	0.76	-0.81	1				
Flour Ash	-0.01	0.12	-0.16	-0.07	0.16	-0.21	1			
Break Flour	-0.27	-0.02	-0.02	-0.15	0.04	0.12	-0.01	1		
Cookie Diameter	-0.27	0.02	0.34	0.23	-0.31	0.41	-0.03	0.54	1	
Flour Protein	0.27	-0.05	-0.17	-0.04	0.17	-0.27	0.17	-0.42	-0.38	1
Lactic Acid SRC*	-0.02	-0.05	0.08	0.05	-0.07	0.10	-0.21	-0.01	-0.08	-0.18

*n=628 for lactic acid SRC only

Guide to Data Tables

Quality Characterization of 830 Soft Wheat Cultivars
Alphabetical List of 830 Soft Wheat Cultivars
(2007 ALPHABETICAL SOFT RED WINTER.XLS)

Excel File of 830 Soft Wheat Cultivar Quality Data
(2007 DATABASE SOFT RED WINTER.XLS)

Quality Characterization of 200 Newer Soft Wheat Cultivars
Alphabetical List of 200 Newer Soft Wheat Cultivars
(2007 ALPHABETICAL 200 NEWER CULTIVARS.XLS)

Excel File of 200 Newer Soft Wheat Cultivar Quality Data
2007 DATABASE 200 NEWER CULTIVARS.XLS

Quality Characterization of Hard Wheat Classes
Excel File of Hard Wheat Cultivar Quality Data
(2007 DATABASE HARD WHEAT.XLS)

Interest by the milling industry in hard wheat in the Eastern United States recently has increased. Some soft wheat breeding programs in the United States and Canada have produced hard cultivars. C & M Seeds, Canada, reported that hard wheat production was on the rise in Indiana, Michigan, New York and Ohio. C & M Seeds indicated that Royster Clark of Ohio and Agriculver Seeds of New York were two companies that initiated hard wheat production in their respective states.

The data that is attached was generated by way of the Soft Wheat Quality Laboratory Allis-Chalmers milling system. There was some non-milling data that was not available, but the milling quality may be of interest and has been sorted according to milling score. Hard wheat will produce greater quantities of middling stock for the smooth-reduction rolls. That stock weight increase influences the amount of total stock that passes through the milling system resulting in lower friability percentages in contrast to that of soft wheat. Some of those hard winter and spring cultivars were grown in New York and Ohio.

Lactic acid SRC was adjusted to 9% flour protein. There has been conflicting information concerning the validity of lactic acid SRC predicting hard wheat gluten strength. Limited studies at the SWQL suggested that lactic acid SRC does predict hard wheat gluten strength when compared to the mixograph; but the lactic acid SRCs seem to be shifted downward when compared with those of soft wheat. An adjustment for flour ash may be necessary.

Quality Characterization of Western White Wheat Cultivars
2007 DATABASE WESTERN WHITE.XLS

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.

The summary tables for the quality evaluations of the Regional Nursery trials are included with this document:

Uniform Eastern Red Nurs.pdf
Gulf Atlantic Wheat Nurs.pdf
Uniform Southern Nurs Coastal.pdf
Uniform Southern Nurs Inland.pdf
USN Summary.pdf

Milling Studies

Can Milling Quality Relationship be Altered?

Adjustments of the intermediate break-roll spacings on the Allis-Chalmers mill were intended to assist in producing a final bran percentage of 9%. If that goal were accomplished, flour, ESI material and middling stock for every wheat would be represented by 91% of the remaining fractions where ESI material and middling stock would be exposed to reduction milling. In that way every cultivar and test line would have equal opportunity to yield as much straight-grade flour as possible. The adjustments of the third, fourth and fifth break-roll spacings precipitated occasional questions regarding the end effect that process might have on milling quality. Some had suggested that adjusting those intermediate break-roll spacings might favor the flour yield of some cultivars while negatively impacting others. A study was undertaken many years ago to determine what influence, if any, there would be upon milling quality if the intermediate break-rolls were adjusted. The conclusion was that there was no effect.

Another limited study investigated the possibility of improving the milling quality of a poor-milling cultivar by increasing the number of breaks from six to nine on the Allis-Chalmers mill. The second through eighth break-roll gaps were adjusted appropriately to be as delicate on the bran stock as possible. Between the two millings there was no difference in the shorts yield, red dog, break-flour yield and ESI. Flour yield increased by 0.27 percentage points and mill score increased from 61.3 to 62.2. Mill score would have needed to vary by 1.43 to be even slightly statistically different. Milling quality could not be changed even by increasing the number of breaks by 50%.

Various extreme treatments unassociated with break-roll adjustments or numbers of break passes were incorporated in the milling process to determine what effect, if any, there would be upon milling quality represented by break-flour yield, straight-grade flour yield, endosperm separation index (ESI) and friability. The SWQL Allis-Chalmers milling standard wheat was used. That standard was a composite of several cultivars with marginal milling quality. Two non-extreme methods were employed and three extreme methods were utilized. A summary of those five methods and their effect upon milling quality is briefly discussed.

The scalp screen for the first five breaks on the six-break Allis-Chalmers milling system utilizes a 16 mesh stainless steel screen (1359 micron opening). Only the scalp screen for the first break was changed to 20 mesh (1041 micron opening) and the mill standard was milled. Break-flour yield, total flour yield and friability were unaffected. ESI was lowered 5.4% or 0.6 percentage points from 11.2% to 10.6%. Even though ESI had lowered, indicative of slightly improved milling quality, there was no real improvement in milling.

Can Milling Quality Relationships be Altered? (cont'd)

The second study involved changing the 16-mesh scalp screen used for the first two breaks to 20-mesh scalp screen. That resulted in an additional lowering of the ESI and an increase in break-flour yield of 1.5 percentage points. The ESI had dropped a total of 14% from the control or 1.6 percentage points from 11.2% to 9.6%. Again, the lower ESI suggested increased milling quality; but there was no improvement in straight-grade yield or friability.

Thirdly, a tempered mill standard was passed through the first reduction rolls of the Miag Multomat at a roll gap of 0.088" or 2235 microns. The Miag first reduction roll differential was 1.36. The barely-noticeable slightly-crushed grain was immediately milled on the Allis mill beginning with the first-break and was milled in the normal manner. That effectively increased the Allis six-break system to an Allis seven-break system. Break-flour yield increased about 1.6 percentage points. Other milling parameters paralleled the traditional mill standard data.

The fourth treatment involved tempering to the normal 15% level and then subjecting the tempered wheat, capped in a glass jar, to -20 °F for two days. The jarred sample was removed from the freezer and allowed to warm to room temperature prior to Allis milling. There was no effect upon any of the milling parameters.

Finally, a milling standard was tempered to 35% moisture. The sample was tumbled in the tempering unit for 12 hours. The tempering unit was in a refrigerated room set at 34 °F. After 12 hours, the sample was dried for two days at 94 °F to a moisture level of 9.2% and then tempered to 15% moisture. The tempered mill standard was milled the following day on the Allis mill in the normal way. Break-flour yield increased about 4 percentage points above the control. However, there was no change in the other three milling variables.

The five studies indicate that milling quality cannot be easily altered even when grain is subjected to extreme measures. That is particularly true when milling cultivars and test lines on a consistent and highly reproducible milling system.

Milling Quality: Primary Factors and Their Responses to Various Treatments

When considering milling quality on a genetic basis, environmental influences must be eliminated sufficiently to negate those interactions. Environmental issues may include shriveled kernels, greater number of smaller sound kernels, sprouting, decreased test weight and density due to weathering. Weathering of the grain does not necessarily equate to reduced milling quality. The Soft Wheat Quality Laboratory has found that smaller sound kernels possess the same quantity of endosperm on a per weight basis as do larger sound kernels. In reality, though, the mill roll corrugations and fixed roller mill spacing are likely the limiting factors in extracting flour yield from the smaller sound kernels that would equal the flour yield from the larger kernels of the same sample. On the SWQL Miag Multomat, Allis-Chalmers and Brabender Quadrumat Jr. mills, there was a decrease of about 0.75% flour yield for thousand-kernel weight of around 26 grams. There was no increase in flour yield from 30 grams per thousand-kernel weight to the largest kernels at 52 grams per thousand-kernel weight.

The SWQL has identified two main factors associated with milling quality:

1. Separation of bran and endosperm varies widely among cultivars. There is poor separation between bran and endosperm associated with poor millers. Conversely, excellent millers have improved separation between bran and endosperm. That identified trait has been labeled as endosperm separation index (ESI). As the ESI increases there will be a reduction in the quantity of middling stock that is produced in contrast to the amount of middling stock generated from excellent millers. (Flour granularity expressed as break-flour yield would need to be considered when comparing middling stock quantity.)
2. The other major factor is the inability of the middling stock conglomerates to fracture into smaller particles with ease. Additionally, the middling stock from poorer-type milling wheat responds more negatively to roller action when finer finishing screens are utilized. The middling stock would also reduce with increased difficulty if temper level were increased.

A superior milling cultivar, Foster, was contrasted with a poor milling cultivar on the Allis-Chalmers. (The Allis mill employs finishing screens that are 120 mesh stainless steel (145 micron opening) and the number of passes through the smooth rollers can be increased, if necessary, to meet certain fixed requirements.) The paired samples were milled as described in Materials and Methods. The number of reduction passes was equal between Foster and the poor miller. The finishing screens were changed from 120 mesh to 165 mesh stainless steel (107 micron opening). The second set was milled so that flour yields equaled those of the first set. That was accomplished by increasing the number of reduction passes. The poor miller required three additional reduction passes compared to Foster. During the early reductions, the poor miller displayed greater difficulty in the ability of the middling stock particles to reduce to flour fineness. There was greater improvement in the reduction of middling stock to flour on the later reductions for the poor miller. Likely, that was due to the fact that the middling stock was subjected to repeated exposure to the rollers. Therefore, the particle size of the stock continued to become smaller until, finally, the particles were able to pass through the finishing screen. Production mills do not have the luxury of increasing reduction passes. Flour yield from poor-type millers will be negatively impacted to a greater degree in contrast to the flour yield of good millers when finer finishing screens are employed.

In another study, the superior miller Argee was contrasted in a temper series with a cultivar possessing marginal milling quality. Temper levels were 13%, 14%, 15% and 16%. As the temper level increased, the marginal miller increased in ESI and the middling stock quantity decreased disproportionately in contrast to Argee. However, as the temper level was increased for Argee, there was a decrease in ESI. Yet, the increase in break flour percentage was similar between the two. The marginal miller, in comparison to Argee, exhibited a significant increase in the amount of carryover of middling stock to subsequent smooth rollers and a significant decrease in the percentages of flour extracted from the first four reductions. Increasing temper level for poor to marginal millers may prove detrimental in the production mill, but good millers may only be slightly impacted.

The first graph on the following page illustrates, essentially, the entire range of milling quality for soft wheat. Twenty-five cultivars were chosen for their similarity in break-flour yield. Vertical bars display the percentage of middling stock produced by the first and second break rolls on the Allis-Chalmers mill. The first two break rolls produced about 93% of the middling stock for the entire system regardless of milling quality. There was a strong correlation between first and second break middling stock and mill score when comparing cultivars possessing similar break-flour yield. Cultivar identifications for the letter codes can be found on the page following the graph.

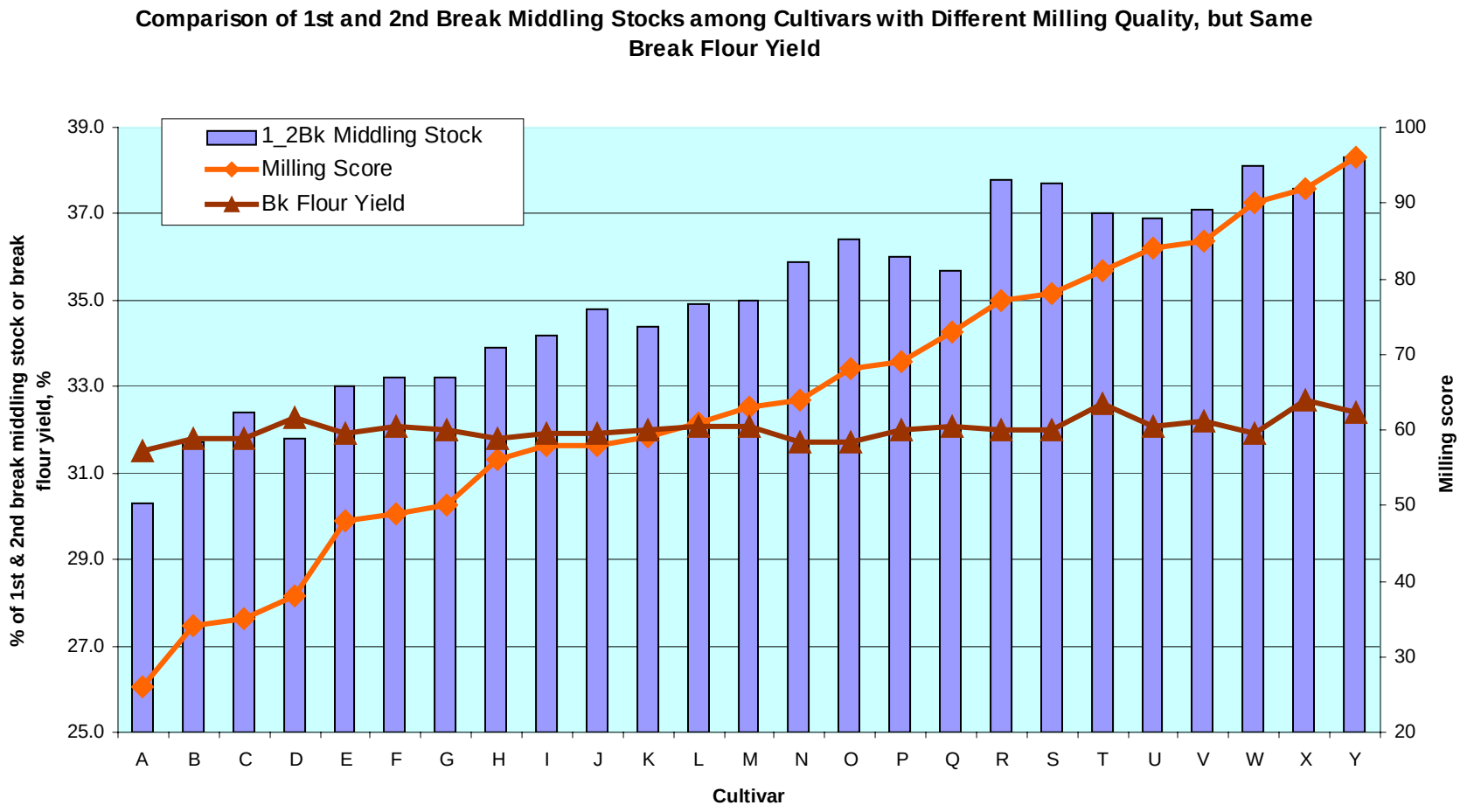


Figure 1. Middling Stock Comparison

Cultivar Code	Cultivar	Lab No	Class	AMS	Description
A	Kan Queen	945249	srw	26	non-contemporary
B	Rex(o)	99530	sww	34	historic western sww
C	Fairfield	98508	srw	35	non-contemporary
D	Clemson 201	96216	srw	38	contemporary
E	Jackson	92161	srw	48	contemporary
F	Pioneer 2545	96068	srw	49	contemporary
G	Pioneer 2580	93216	srw	50	contemporary
H	Harus	97151	sww	56	Canadian sww
I	Coker 9663	955325	srw	58	contemporary
J	Holley	4722	srw	58	non-contemporary
K	Panola	5602	srw	59	contemporary
L	Pioneer 2540	4726	srw	61	contemporary
M	Coker 9474	945224	srw	63	contemporary
N	Pioneer 26R24	2022	srw	64	contemporary
O	Potomac	4563	srw	68	non-contemporary
P	Pioneer 26R61	4717	srw	69	contemporary
Q	Coker 9184	1408	srw	73	contemporary
R	Century ll	3033	srw	77	contemporary
S	Coker 68-15	5510	srw	78	non-contemporary
T	Cardinal	4709	srw	81	contemporary
U	USG 3650	3032	srw	84	contemporary
V	Coker 9152	1407	srw	85	contemporary
W	MPG 7921	97097	srw	90	contemporary
X	Argee	89404	srw	92	non-contemporary
Y	Pioneer 26R46	98420	srw	96	contemporary

The second graph illustrates seventeen paired cultivars that contrast greatly in milling quality. The break-flour yield within each pair was equal and there was a gradual increase in break flour yield from paired-set #1 to paired-set #17. The first and second break middling stock percentage varied within each paired set because of the differences in milling quality. The first two paired groups compared the superior-milling hard red spring cultivars Anza and Senra with the lower-milling hard red spring cultivars Olaf and Katepwa. The third paired set contrasted the superior miller semi-hard Kristy with the inferior miller semi-hard Kelo. The fourth set represents the superior miller western soft white winter cultivar Hill 81 and the poor miller western soft white spring cultivar Penewawa. In conclusion, the seventeen paired comparisons exemplified that factors affecting milling quality are not unique to any specific class of wheat. The cultivar identifications for each letter designation are located on the page following the graph.

Code	Cultivars and Class
A	Anza (HRS) vs Olaf (HRS)
B	Senra (HRS) vs Katepwa (HRS)
C	Kristy (semi-hard) vs Kelo (semi-hard)
D	Hill 81 (Western SWW) vs Penawawa (SWS)
E	Arise W33 (SRW) vs Wakeland (SRW)
F	Pioneer 26R46 (SRW) vs Bradley (SRW)
G	Mallard (SRW) vs Lewis (SRW)
H	Severn (SRW) vs Atlas 66 (SRW)
I	AGS 2000 (SRW) vs Mammoth Red (SRW)
J	Argee (SRW) vs Clarkan (SRW)
K	Mountain AC (SWW) vs Pioneer S-78 (SRW)
L	Mallard (SRW) vs Fairfield (SRW)
M	Pioneer 2555 (SRW) vs Roane (SRW)
N	Florida 302 (SRW) vs CM 544W (SRW)
O	Monarch (SRW) vs AG 2020 (SRW)
P	Mallard (SRW) vs Warwick (Canada SRW)
Q	Caldwell (SRW) vs Beretta (SRW)

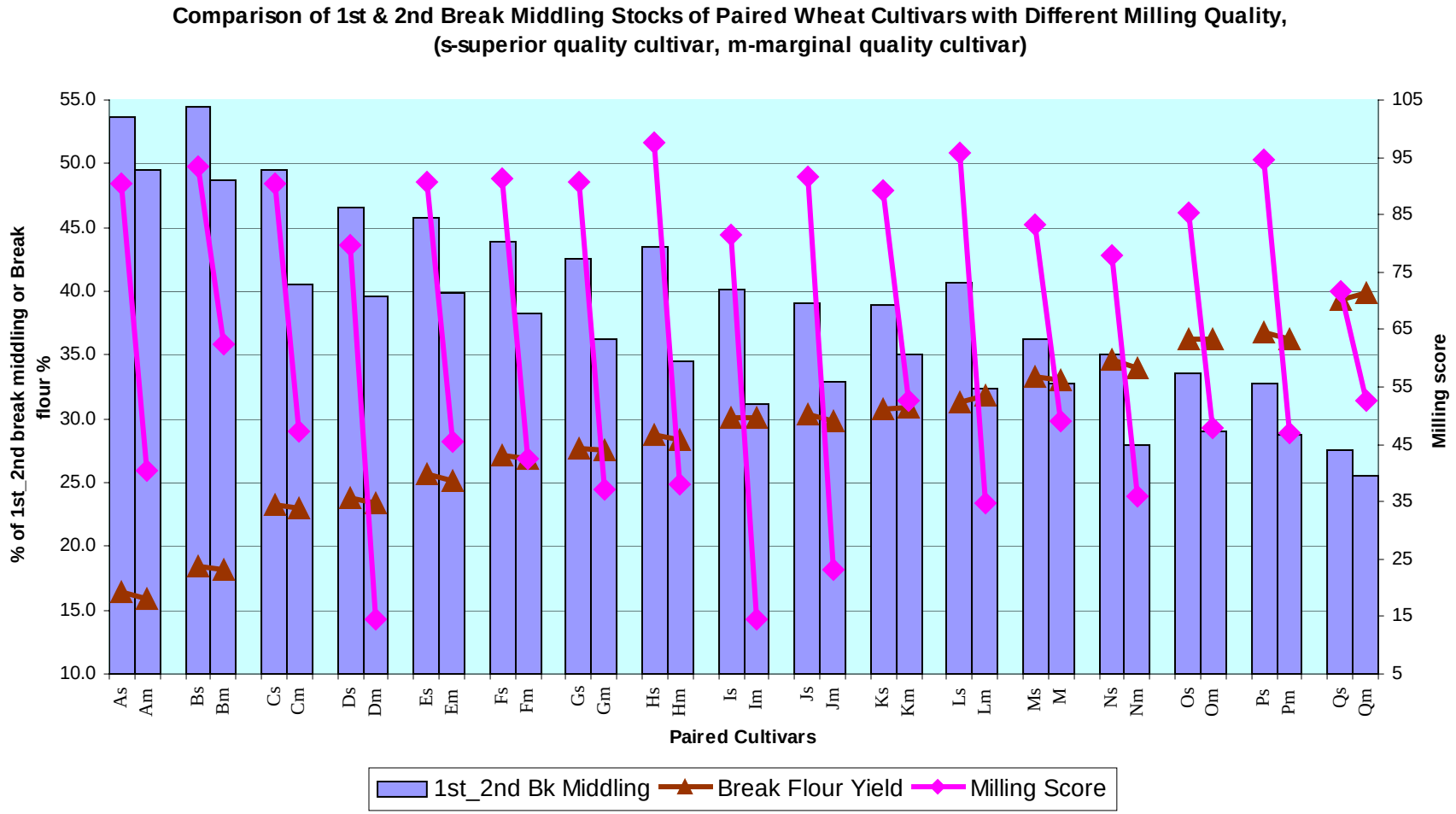


Figure 2. Superior vs. Poor Miller Middling Stocks

Production Milling: Can it be Predicted, or is it too Unique?

The SWQL has three distinctly unique roller mills: Miag Multomat, Allis-Chalmers and the modified Brabender Quadrumat Junior.

The Miag has a pneumatic conveyance for transporting stock, eight ten-inch diameter paired rollers and ten sieving units. Straight grade flour mean volume diameter (MVD) averages 45 microns.

The Allis-Chalmers milling system is a manual batch-type mill that produces thirteen to fourteen flour streams on six-inch diameter rolls and produces flour particle size with an approximate MVD of 65 microns.

While the modified Quadrumat Jr. has four rolls, it is essentially a triple-headed system. Roller diameters are less than three inches. The modified Quadrumat Jr. mill produces a middling stock-like material and fine flour.

Roll speeds, roll differentials and roll corrugations are similar between the Miag and Allis-Chalmers mill. However, the modified Quadrumat Jr. corrugated rolls are much finer and the roller rpm's are three to four times faster than either the Miag or Allis mills.

Milling quality correlation between the Allis-Chalmers and modified Quadrumat Jr. has been r = 0.95. Break-flour yield between the two mills has been r = 0.97. Ten kilograms (22 pounds) each of 38 cultivars was milled on the Miag mill and 80 grams of each was milled on the modified Quadrumat Junior mill. Correlation for milling quality was r = 0.93 while the correlation for break flour between the Miag and modified Quadrumat Jr. was r = 0.97.

The Miag and modified Quadrumat Jr. mills are at opposite ends of the spectrum with respect to their operation and yet there was a strong correlation between the two. A production mill likely would not be so unique so as to preclude prediction by much simpler milling systems.

Damaged Starch and Quality Traits

For the most part, superior milling cultivars produce sugar snap cookies that are very large in spread, while poorer milling varieties yield much smaller cookie diameters. Since significantly lower quantities of middling stock are exposed to the roller mills for a superior milling wheat, and with poorer type cultivars greater quantities of stock pass through the rollers due to increased difficulty in reduction of middling stock, it was deduced that increased levels of damaged starch would be associated with the poor millers, resulting in higher water absorption and therefore smaller cookie spread. Pentosan content may also be elevated for poorer millers and contributing to reduced cookie spread due to increased water absorption.

Eleven cultivars were selected from a group of samples that were Allis-Chalmers milled. All cultivars were grown in the same ½ acre field in Wooster, Ohio, and harvested in 2002. The environment induced the wheat to produce coarser granulating flour than would normally occur. The eleven entries are considered to be typical soft wheat. It was deemed essential to choose cultivars possessing practically the same flour granulation (break flour) and nearly identical flour protein. The milling quality represented 50% of the entire range of soft wheat. The findings of the limited set of eleven cultivars suggested there likely is no or little relationship between damaged starch and quality parameters given that the soft wheat cultivars are milled in like manner. The procedure reference for damaged starch can be found in Cereal Chemistry 39: 460-462 (1962).

Table 5. Damaged starch and quality traits.

Cultivar	Test Weight	1000 KW	Mill Score*	Break Flour	Flour Protein	Lactic Acid SRC **	Gluten Strength***	Cookie Dia. X 2	Damaged Starch
	(# per bu)	(grams)		(%)	(%)	(%)	(mixograph)	(cm)	(%)
Pioneer 26R46	66.4	43.6	105.8	26.3	9.6	104.4	5.5	18.4	2.23
FFR 566W	64.4	37.6	92.2	27.7	9.9	91.1	4	18.2	2.21
AGI 525	64.0	35.2	82.9	27.3	9.5	71.8	2	17.5	2.74
Stine 482	63.5	36.4	82.7	27.8	9.4	94.2	4.5	17.5	2.61
Wellman 115	62.9	34.0	82.3	27.4	9.5	72.1	2	17.8	2.68
Pioneer 25R23	64.7	38.0	81.7	27.1	8.9	82.2	3	17.8	3.52
Honey	62.6	37.0	77.3	26.8	8.9	72.8	2	18.0	2.81
Arise W34	63.0	33.8	74.1	27.5	9.0	133.1	8	17.0	2.69
Pioneer 25R78	65.1	36.6	73.5	27.0	9.0	93.1	4	17.6	3.37
FFR 535W	66.3	36.8	61.6	26.9	9.7	97.8	5	17.3	2.51
FFR 36803	64.7	34.3	59.8	27.3	9.5	124.2	7.5	16.6	2.51

* Mill score standard deviation is 11.54 within a set.
** Lactic acid SRC adjusted to 9% flour protein basis.
*** Mixograph strength: 1=weak to 8=strong.

Figure 3. Frequency Distribution of Allis Break Flour for Four Cultivars.

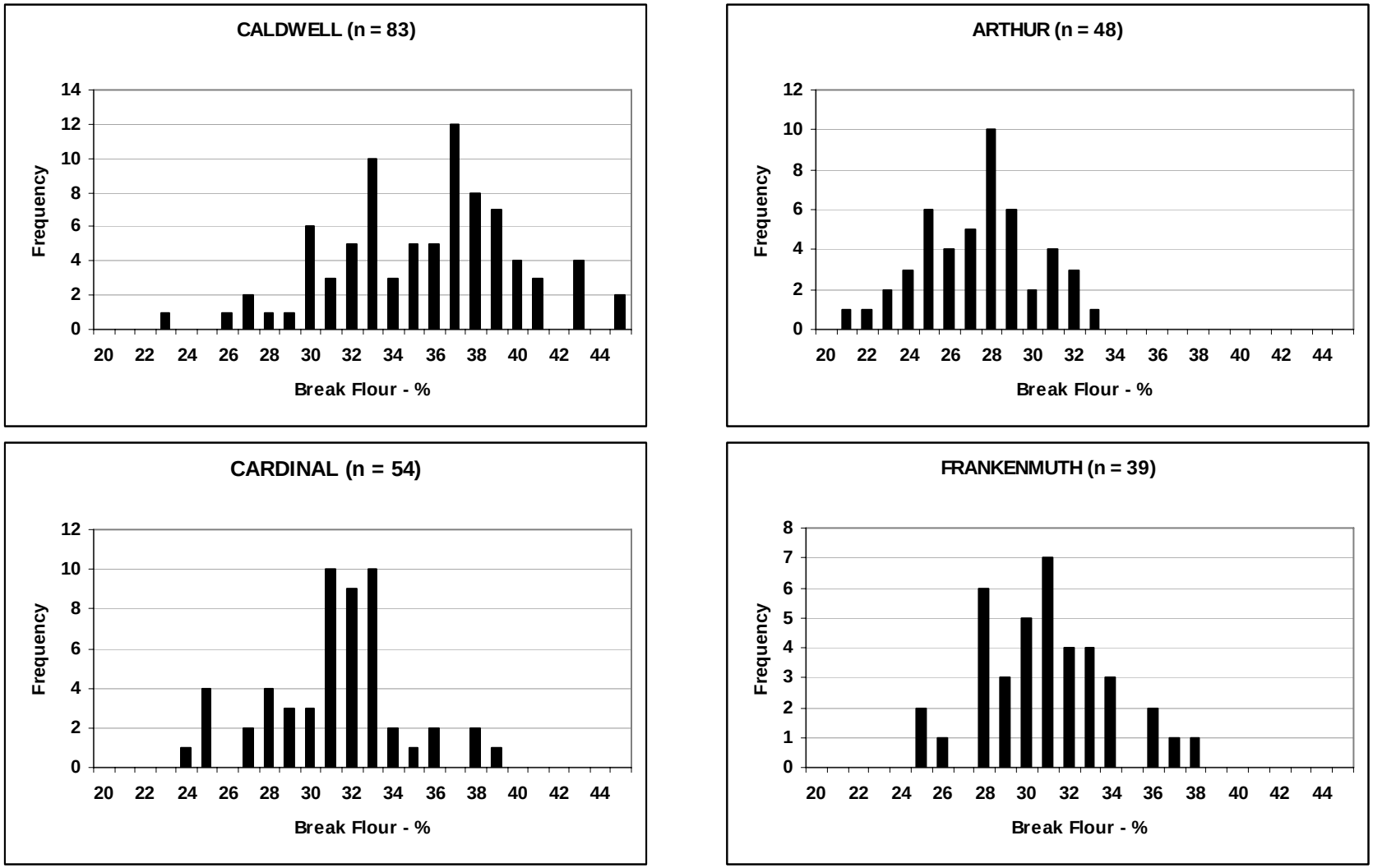
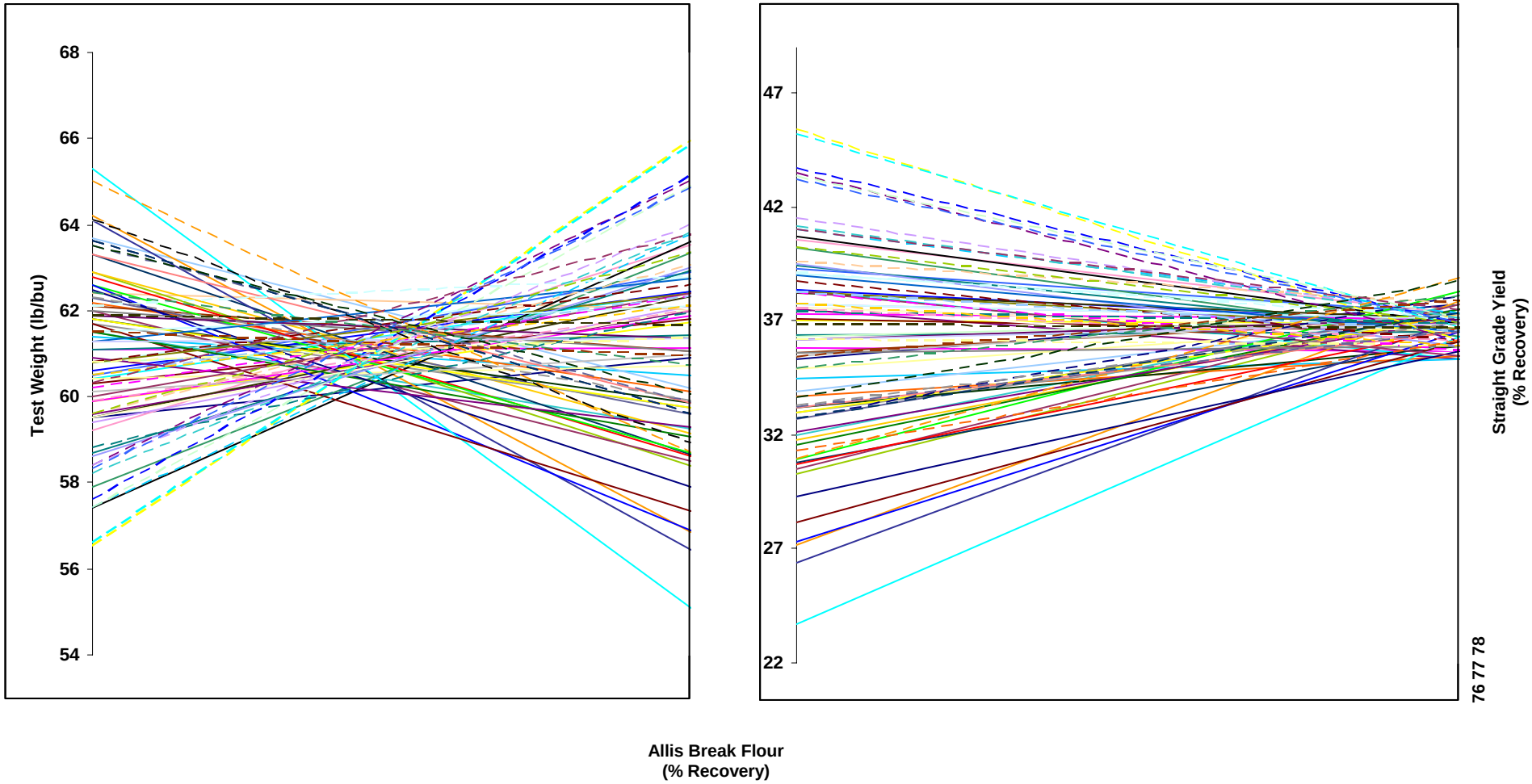
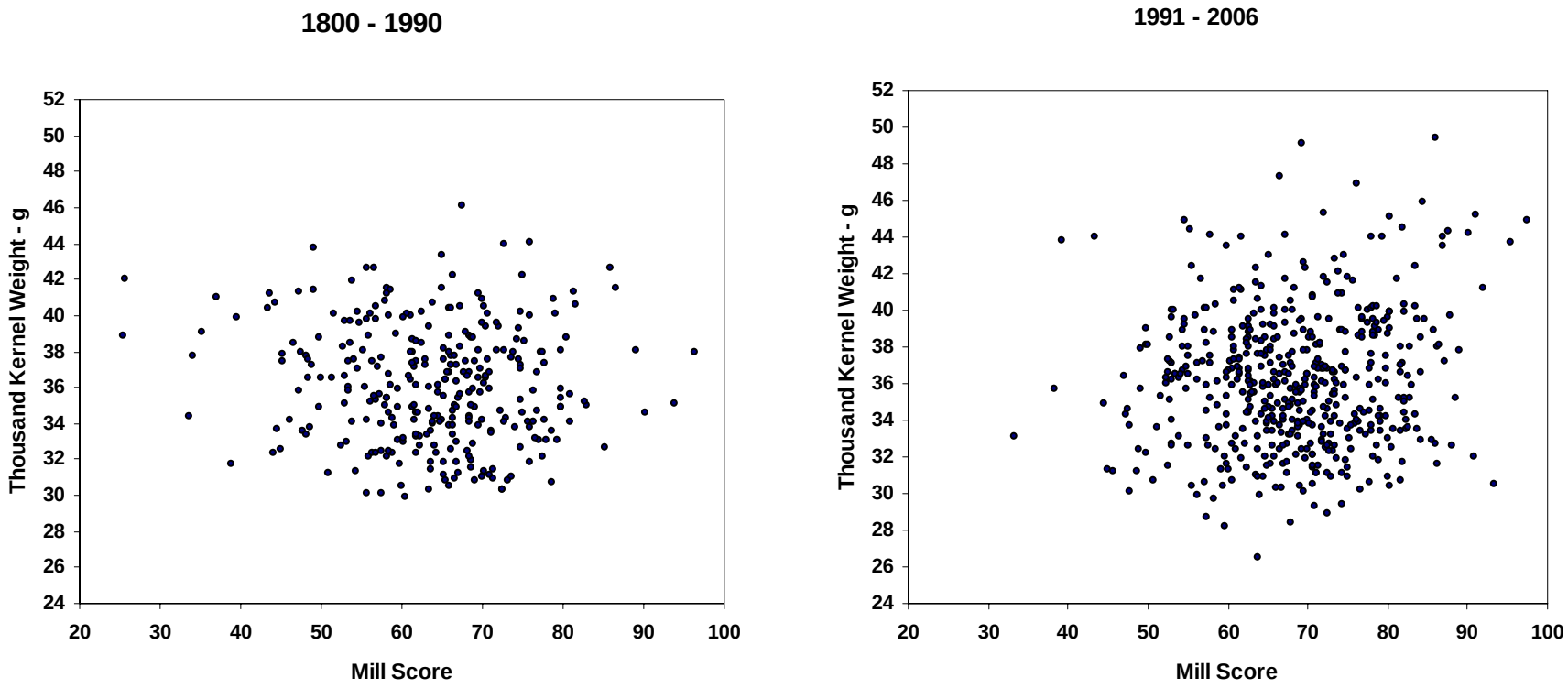


Figure 4. Caldwell Samples (1979 - 2006).



Graph of 85 different Caldwell entries grown between 1979 and 2006 illustrating the environmental influence upon test weight and softness while milling quality remains relatively stable. Locations represented were: Atlantic UERN composites, Illinois, Indiana, Kentucky, Maryland, Michigan, Missouri, New York, Northern UERN composites, Ohio, Southern UERN composites, Texas, Washington and Wisconsin.

Figure 5. 1000-Kernel Weight versus Mill Score.



Frequency Distribution of 1000-Kernel Weight for Two Cultivars

Figure 6. Frequency Distribution of 1000-Kernel Weight for Two Cultivars.

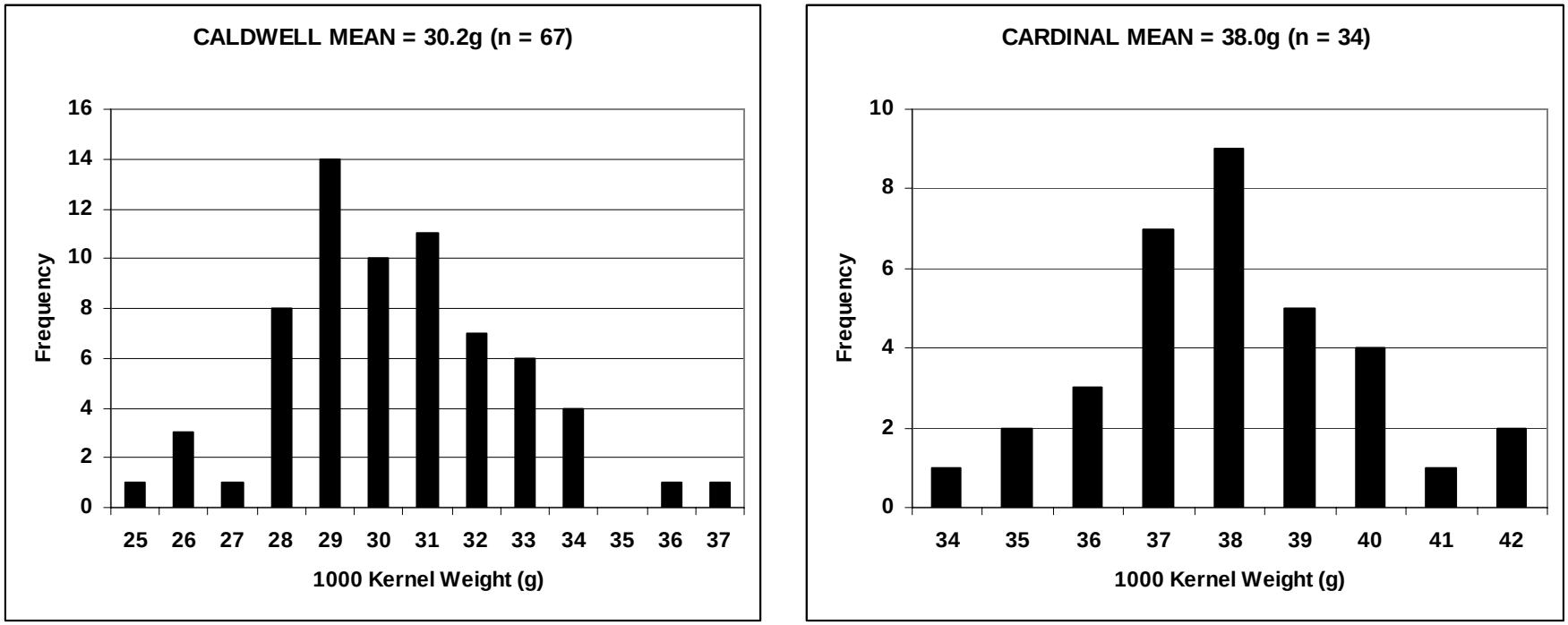


Table 6. Small 1000-kernel weight cultivars.

Cultivar	1000 KW (g)	Test Wt (normalized, lb/bu)	Mill Score	Cultivar	1000 KW (g)	Test wt (normalized, lb/bu)	Mill Score
SR 211 (Terra)	26.5	61.2	63.7	L 15 (Leader)	30.4	63.3	80.2
RW 1487 (Classic - Nosco)	28.2	61.6	59.7	Wiley (Steyer Seeds)	30.4	62.2	59.4
Coker 9105	28.4	62.0	68.0	INW 0123	30.4	60.4	55.5
RS 917 (Rupp Seeds)	28.7	61.0	57.3	Coker 9543	30.4	62.0	69.0
Dyna Gro 403	28.9	61.5	72.6	AG 9346 (Westbred?)	30.5	60.8	93.4
W 126 (Wilkens)	29.3	61.4	70.9	Stine 454	30.5	61.0	70.6
W 9140 (Wellman)	29.4	63.3	74.4	Gluten (B86)	30.5		60.0
Anthony (Steyer Seeds)	29.7	61.0	58.2	Adena	30.5	60.1	65.9
Pacer (Hybritech)	29.9	60.4	60.4	AGI 540 (Advanced Genetics)	30.6	64.0	77.7
W 9710 (Wellman)	29.9	61.1	56.3	Watford (Hyland Seeds)	30.6		57.2
Savage (AgriPro)	30.0	61.1	63.9	Emily	30.7	63.0	81.7
Mitchell (AgriPro)	30.1	60.9	69.6	Nelson	30.7	60.5	78.5
Downy	30.1	60.7	57.5	Ag-Alumini 9112	30.7	62.1	60.6
AG 2020 (Ag Alumni Seed)	30.1	63.1	47.8	Cedar	30.7	60.9	50.7
McNair 4823	30.2	61.5	55.7	Coker 68-19	30.8		69.1
GL 9240 (Greenland)	30.2	63.0	76.7	Windsor	30.8	60.0	65.5
Caldwell	30.3	60.2	72.6	Monon	30.9	60.8	73.2
Arrow	30.3	60.0	72.6	Absolut	30.9	62.0	80.2
Beck 103	30.3	60.2	66.7	Dyna Gro 426	30.9	63.7	75.0
PS 1359 (Arone?)	30.3	60.8	66.0	Glacier	30.9	60.0	72.9
Brandy	30.3	63.5	63.3	Hartzler 2400	30.9	60.5	71.3

Average (n = 42): 30.1 g, 61.5 lb/bu, 67.2

Table 7. Large 1000-kernel weight cultivars.

Cultivar	1000 KW (g)	Test Wt (normalized, lb/bu)	Mill Score	Cultivar	1000 KW (g)	Test wt (normalized, lb/bu)	Mill Score
AGS 2000	49.4	62.4	85.9	Genesis-D 8006	44.0	61.2	86.9
Pioneer 26R61	49.1	62.9	69.3	VPI 112 *	44.0		72.7
Pro 202	47.4	61.5	66.5	FFR 544W	44.0	60.5	43.3
Dyna Gro 422	46.9	59.6	76.2	CM 544 (Country Mark)	43.8	60.9	39.3
Pennoll *	46.1	64.0	67.4	MO 011126	43.8		95.4
Hoffman 37	45.9	61.0	84.4	Russian Red *	43.8	63.3	49.2
Randal (Steyer Seeds)	45.3	61.5	72.1	MPG 7921 (Midwest Premium)	43.5	60.6	87.0
Kristy	45.3	61.4	91.0	Zavitz (OAC)	43.5	60.5	59.9
Carlisle (C&M Seeds)	45.1	63.5	80.2	VPI 131 *	43.3	64.0	65.0
Vigoro 9510 (Royster-Clark)	44.9	60.7	54.5	Dexter (AC)	43.0	58.9	65.1
Pioneer 26R46	44.9	61.7	97.4	Pioneer 25R49	43.0	61.7	74.5
Pioneer 26R31	44.6	61.2	81.9	Magnolia (AgriPro)	42.8	61.5	73.3
USG 3209 (Unisouth Genetics)	44.4	61.3	55.3	Wonder (AgriPro & Hyland)	42.7	61.2	69.5
W 111 (Wilkens)	44.3	61.1	87.5	Fl 302	42.6	60.0	85.8
Stine 902	44.2	60.7	90.1	McNair 1813	42.6	61.3	56.6
Nittany *	44.1	61.3	76.0	Rudy *	42.6		55.6
Dyna Gro 424	44.1	58.4	57.7	USG 3650 (Unisouth Genetics)	42.4	61.3	83.6
Mendon	44.1	59.8	67.3	Hopewell	42.4	60.8	55.6
Pioneer 26R38	44.1	61.6	79.4	Lowell	42.3	60.5	69.7
Annett	44.1	60.9	61.8	Delaware	42.3	59.3	63.5
Marilee	44.0	60.0	78.1	Avon	42.2	61.0	75.0

Average (n = 42): 44.2 g, 61.2 lb/bu, 71.

Extremely Fine Granulation Cultivars: Are Cultivars that Produce Extremely Fine Flour Valuable for Cake Baking?

Flour of fine particle size has been thought to be desirable for cake baking. Coarser-type cultivars may produce flour satisfactory for cake quality if pin milling can sufficiently reduce the particle size. Environmental conditions can induce coarser-type cultivars and softer cultivars to become softer than normal. However, conversely, environmental influences can cause a significant increase in flour particle size, as measured by mean volume diameter or break-flour yield, so that even softer cultivars produce coarser flour than would normally be expected. Cultivars that genetically possess extreme softness should produce fine flour granulation over diverse environments.

Caldwell, Coker 9184, Daisy, Patterson and Pioneer 2555 have very soft endosperm; and, if grown together and later milled would likely produce equal break-flour yield. However, break-flour yield analysis of three cultivars varying in break-flour yield demonstrated that the softer cultivars fluctuated more over diverse environments than did the coarser cultivars. Allis-Chalmers break-flour yield analyses were performed for three eastern grown cultivars, encompassing several years and numerous locations: Arthur (n = 47), Cardinal (n = 55) and Caldwell (n = 81).

Arthur was known to be a very coarse cultivar averaging 27.4% break-flour yield with 70% of the Arthur entries had break-flour yields that were within +/- 3 percentage points from the mean. Similarly Cardinal averaged 31.1% break flour for 55 entries and 73% of the Cardinals fell within +/- 3 percentage points of the mean. In contrast, 81 Caldwell samples averaged 35.7% break flour from the Allis-Chalmers Mill and 56% were within +/- 3 percentage points of the mean.

Presuming there were enough samples per cultivar to be statistically sound, it could be suggested that the softer cultivars were more susceptible to granularity fluctuations from environmental conditions. Extremely soft cultivars would also fluctuate in break-flour yield. Since they had greater softness, they likely would not be as prone to falling to too coarse a level. Therefore, extremely soft cultivars may nearly always produce very soft granulating flour over diverse environments. That characteristic would insure consistency in producing very fine granulating flour for superior cake baking.

The following table lists the cultivars identified as extremely soft with break flour yields at least 3 percentage points greater than Caldwell, Coker 9184, Daisy, Patterson and Pioneer 2555. Several extremely soft cultivars had break-flour yield 6 percentage points higher than the reference cultivars when grown under similar conditions. Many of the named cultivars are recently released. Gluten strength varied from medium weak to medium strong.

Table 8. Extremely soft cultivars.

Cultivar	Origin	Cultivar	Origin
Beck 102	Beck's Hybrids	Julie lV	IL Crop Improvement?
Citron	Michigan?	Mitchell	AgriPro
Coker 762	Syngenta Seeds	Monarch	Gries Seeds
Coker 9025 (?)	Syngenta Seeds	MPG 7921	Missouri Prem Genetics
DG 422 (?)	Dyna Grow	Pioneer 2568	Pioneer Hi-Bred Int'l
Excel 333		Raven	IL Crop Improvement?
FS 530	IL Imp Association	Roy	North Carolina St. Univ.
Genesis 9939	Genesis Brand	RW 1488	Classic-Nosco
GR 942	AGRA	Schultz 130	
GR 962 (?)	AGRA	SR 216	Terra
Hopewell (?)	Ohio State University	Terral 877	
HS 222R		Wisdom	Hyland Seeds, Canada
INW 0303	Purdue University	Wonder	Hyland Seeds, Canada

(?) indicates limited data

Table 9. Cultivars with Very Fine Granulation[(k)].

527 W	CM 577	FS 530	McLane	RS 919	Warrior
Abacus	Coffman	FS 539	McNair 1003	RS 987	Warwick
Absolut	Coker 68-19	G 3566	Merrel	RW 1488	Wellman 120
AG 2020	Coker 762	Garfield	Mitchell	RW 1517	Wellman 150
AGI 202	Coker 9024	Genesis 9511	Monarch	SG 1555	Wellman 9501
AGI 538	Coker 9025	Genesis 9939	MPG 7921	SR 211	Wellman 9830
Armor 4045	Coker 9184	Geneva	Navigator	SR 216	Wellman 9850
Beck 102	Coker 9375	Glacier	Packard	Stadler	Wellman 9920
Beck 103	Coker 9835	Goldberg	Patriot 210	Steyer 1809	Wilkens 111
Beck 107	Coker 9904	GR 942	Patterson	Stine 455	Wilson
Beck 122	Croplan 594W	GR 962	Pike	Stine 484	Wisdom
Becker	Cyrus	GR 983	Pioneer 2548	Stine 902	Wonder
Blazer	Daisy	Grandprize *	Pioneer 2553	Stoddard	
Boone	Dexter (AC)	Grant	Pioneer 2555	T 71	
Branson	Dyna Gro 422	Hickory	Pioneer 2568	Terral 101	
Brazen	Dyna Gro 424	Hoffman 14	Pioneer 25R18	Terral 877	
Caldwell	Dynasty	Hopewell	Pioneer 25R47	Timwin	
Casey	Excel	Houser	Pioneer 25R54	TS 3060	
Cayuga	Excel 300	HS 222R	Pioneer 25W41	TS 8040	
Cecil	Excel 333	HS 260R	Pioneer 2691	TW 91203	
Cedar	Excel 412	INW 0303	Purcell	USG 3650	
Charmany	Excell 400-1	Julie IV	Raven #1	Verne	
Clemens	FFR 525W	LG 1433	Richland	Voris 8044	
CM 539	FS 332	Magers	Roy		

*Historic Cultivar

Table 10. Cultivars with Very Coarse Granulation[l].

Ace	Dawson (AgriPro)	Harvard	Mammoth Red *	Rochester Red *	SW 350
AG 9346	Delta Queen	Harvest Queen *	Mediterranean *	Royal *	TS 4020
AGI 540	Diehl-Mediterranean *	Hoffman 57	Minturki *	Rudy *	Vermillion (bearded)
AGI 550	Dyna Gro 246	Hoffman 89	Morey	Russian Red *	Vermillion (unbearded)
American Banner *	Dyna Gro 426	Hoffman 95	Nabob *	RW 151	Vermont Winter Reeds *
Arise W33	Emily	HS 243R	Newcaster *	Sabbe	VPI 112 *
Arthur	Enigma	Illini Chief *	Nittany *	Savannah	Wilkens 101
AT 90W	Featherstone 520	INW 9853	Nured *	SC 1365	Wellman 109
Atlas 66	Flint *	Jones Fife *	NY 6432-10	Schultz 130	Wakeland
Baldrock *	Forward *	Joseph	OAC 104 *	Scotty	Walker *
Beck 109	Frisco *	Kavkaz	Penquite *	SG 1530	Wisconsin No. 2 *
Benjamin	Fulhio *	Kelo	Piening	SG 1545	Yorkwin *
Berkely Rock *	Fundulea	Key	Pioneer 9227	Sibley No. 81 *	Zimmerman *
Bounty	GA 1123	Kristy	Pioneer 9733	Silversheaf *	
Brandy	Gipsy *	Kruse *	Podach	Spencer	
Chieftan	GL 9240	L 15	Pontiac	SR 204	
Cobra	Gluten (B86) *	Leap Selection *	Pride of Genesee *	SR 49	
Coker 47-27 (NC origin)[m] *	Gold Drop *	Leapland *	Pryer	Stine 901	
Coker 9663	Greeson *	Lisbo	Red Indian *	Succession	
Compton	Hanover	Longberry No. 1 *	Red May *	SW 82	
Dawson *	Hardired (Nat'l Coll.)(n) *	Lucas	Reino		

*Historic Cultivar

Table 11. High Flour Protein Cultivars (Normalized, Since 1950)

Cultivar	%pts.	Cultivar	%pts.	Cultivar	%pts.	Cultivar	%pts.
Key	3.0	Abe	1.3	Holley	1.1	Hoffman 89	0.9
Atlas 66	2.8	Arthur	1.3	Knox	1.1	JMS 222	0.9
Kavkaz	2.5	Auburn	1.3	Knox 62	1.1	Podach	0.9
Taylor	2.5	Compton	1.3	McNair 1813	1.1	Scotty	0.9
Wakeland	2.2	Elkhart	1.3	McNair 701	1.1	Susquehanna	0.9
Tecumseh	2.1	FFR 566W	1.3	Morey	1.1	Twain	0.9
Hadden	2.0	Ionia	1.3	Omega 78	1.1	Arrow	0.8
Vigo	1.9	Lucas	1.3	Spencer	1.1	Blueboy ll	0.8
Reed	1.8	Oasis	1.3	Vermillion (beardless)	1.1	Downy	0.8
Seneca	1.8	Pennoll	1.3	Coker 9474	1.0	GA 100	0.8
Beau	1.7	Arthur 71	1.2	FL 301	1.0	GR 855	0.8
Callahan 115	1.7	Blazer	1.2	Fundulea	1.0	GR 915	0.8
Potomac	1.6	Coker 47-27	1.2	Hart	1.0	Logan	0.8
Royal	1.6	Laporte	1.2	Hunter	1.0	Pioneer 25W60	0.8
Coker 9227	1.5	Magnum	1.2	INW 9241	1.0	RS 927	0.8
Dancer	1.5	Monon	1.2	Jackson	1.0	Southern Belle	0.8
Pontiac	1.5	Riley	1.2	Kenosha	1.0	TS 4020	0.8
Redcoat	1.5	Sullivan	1.2	Lewis	1.0	Coker 9323	0.7
Benhur	1.4	Bayles	1.1	NY 6432-10	1.0	Coker 9543	0.7
Butler	1.4	Cayuga	1.1	Pioneer 2551	1.0	GA 1123	0.7
Chancellor	1.4	Coker 9803	1.1	Cartier	0.9		
Coker 68-15	1.4	Compact	1.1	Coker 747	0.9		
Doublecrop	1.4	Fredrick	1.1	Coker 9704	0.9		
FL 301H	1.4	Genesee	1.1	Harus	0.9		
Riley 67	1.4	GR 860	1.1	Hillsdale	0.9		

Table 12. Low Flour Protein Cultivars (Normalized, Since 1950).

Cultivar	%pts.
Mackinnon	-1.2
Kristy	-1.0
Pioneer 2548	-1.0
Sawyer	-1.0
SS 550	-1.0
Whitney	-1.0
Caldwell	-0.9
Charmany	-0.9
Coker 9835	-0.9
Freedom	-0.9
McNair 1003	-0.9
Pioneer 25R57	-0.9
Roane	-0.9
Tyler	-0.9
Pioneer 2580	-0.8
Argee	-0.7
Becker	-0.7
Coker 9663	-0.7
Pike	-0.7
Pioneer 26R46	-0.7

Sugar Snap Cookie Quality of Northern- vs. Southern-Grown Wheat

From 1987 through 1989 a collaborative study compared the cookie baking quality of several eastern soft wheats and several Pacific northwestern soft wheats. All fifteen cultivars were grown in Indiana, Michigan, Ohio and Washington (two locations). The Pacific northwest environment consistently produced cookies with smaller spread than those of the eastern locations.

The Southern-grown wheats may produce inferior cookie spreads compared with cookie quality of cultivars grown in northern states. Southern-grown cultivars of three to four decades ago were known to produce sugar-snap cookies of inferior quality. Is it possible that the cultivars widely grown in the South are, in fact, the source of the inferior cookie quality? Or, if it is true that Southern cookie quality is inferior, are the environmental conditions more adverse in the South than in the North?

The SWQL Allis-Chalmers database has quality information on 830 soft wheat cultivars introduced or released from about 1809 to 2006. A survey of the database identified thirty-eight cultivars that were significantly represented in the traditional eastern soft wheat region as well as in the traditional southern soft wheat region. Those thirty-eight wheats were: Arthur 71, Cardinal, Coker 833, Coker 916, Coker 9323, Coker 9543, Coker 9663, Coker 9704, Coker 9733, Coker 9803, Coker 9835, Dozier, FL 302, Hunter, Jackson, Keiser, Madison, Magnum, Mallard, Massey, McCormick, McNair 1003, Nelson, Oasis, Patton, Pioneer 2551, Pioneer 2555, Pioneer 2580, Pioneer 26R46, Roane, Saluda, Sawyer, Severn, Susquehanna, Tribute, Tyler, Wakefield and Wheeler.

Those thirty-eight cultivars were released between 1971 and 2002. Twenty-eight cultivars were southern produced while the remaining ten were eastern wheats. Those represented uniform eastern nursery, uniform southern nursery and individual sates. Data generated for the thirty-eight cultivars were from 180 different uniform nursery composites and 242 individual locations. The uniform southern nursery mostly represented southern-produced cultivars grown at numerous southern locations. The uniform eastern nursery would occasionally include a few southern-released cultivars and as many as eighteen locations with some of those being from southern states.

Sugar Snap Cookie Quality of the Same Cultivars Grown in the Northeast and Southeast (cont'd)

The eastern states that were included in the analyses for cultivars from a single location were: Illinois, Indiana, Michigan, New York, Ohio and Wisconsin.

The southern locations representing a single source were: Arkansas, Florida, Georgia, North Carolina, South Carolina and Virginia. Thus, the 242 samples from individual locations were from those twelve states.

The entire range in cookie quality represented was based on the mean cookie diameter for each of the thirty-eight cultivars from the two respective regions. That range was 17.1 cm to 18.6 cm for the thirty-eight eastern-grown samples and 17.0 cm to 18.5 cm for the thirty-eight southern-grown cultivars. The average of all thirty-eight cultivars grown in the eastern locations and the average of all thirty-eight cultivars that were southern-grown was the same value of 17.7 cm. That strongly suggested that the differing environmental conditions between the two regions were an insignificant variable based upon sugar-snap cookie quality as measured by cookie spread.

Is it possible that the diverse number of environments masked the variation that might have been observed for an individual location? Dr. Jerry Johnson, University of Georgia, and the USDA Soft Wheat Quality Laboratory will grow about 60 contemporary cultivars at those two locations. The first harvest of those mostly southern-produced cultivars will be in 2007. Cookie baking quality of those samples can be monitored over time and may contribute greatly to answering the question concerning the cookie baking potential between specific locations in the eastern and southern United States.

Manuscripts Associated with Soft Wheat Milling and Related Subjects

Guttieri, M. J., K. M. Peterson, and E. J. Souza. 2006. Milling and Baking Quality of Low Phytic Acid Wheat. Crop Sci. 46: 2403-2408.

Guttieri, M. J., K. M. Peterson, and E. J. Souza. 2006. Agronomic Performance of Low Phytic Acid Wheat. Crop Sci. 46: 2623-2629.

Guttieri, M. J., K. M. Peterson, and E. J. Souza. 2006. Mineral Distributions in Milling Fractions of Low Phytic Acid Wheat. Crop Sci. 46: 2692-2698.

Bowen, D., M.J. Guttieri, K. Peterson, K. Peterson, V. Raboy, E. Souza. Phosphorus Fractions in Developing Seeds of Four Low Phytate Barley (Hordeum vulgare L.) Genotypes. Crop Sci. 46: 2468-2473.

Delwiche, S., R.A. Graybosch, L.E. Hansen, E. Souza, and F.E. Dowell. Single kernel near-infrared analysis of tetraploid (durum) wheat for classification of the waxy condition. Cereal Chem. 83: 287-292.

Gaines, C.S., J. Fregeau Reid, C. Vander Kant, and C.F. Morris. 2006. Note: Comparison of methods for gluten strength assessment. Cereal Chem. 83: 284-286.

Guttieri, M.J., K. O'Brien, C. Becker, J.C. Stark, J.M. Windes, and E. Souza. 2006. Managing nitrogen fertility of irrigated soft white spring wheats for optimum quality. Can. J. Plant Sci. 86:459-464.

Nash, D. S.P. Lanning, P. Fox., J.M. Martin, N.K. Blake, E. Souza, R.A. Graybosch, M.J. Giroux, and L.E. Talbert. 2006. Relationship of dough extensibility to dough strength in a spring wheat cross. Cereal Chem. 83: 255-258.

Guttieri, M.J., C. Becker, and E. Souza. 2004. Application of wheat meal solvent retention capacity tests within soft wheat populations. Cereal Chem. 81: 261-266.

Souza, E.J., J.M. Martin, M.J. Guttieri, K. O'Brien, D.K. Habernicht, S.P. Lanning, G.R. Carlson, and L.E. Talbert. 2004. Influence of genotype, environment, and nitrogen management on spring wheat quality. Crop Sci. 44:425-432.

Guttieri, M.J., R. McLean, S.P. Lanning, L.E. Talbert, and E.J. Souza. 2002. Assessing environmental influences on solvent retention capacity of two soft white spring wheat cultivars. Cereal Chem. 79: 880-884.

Souza, E., R. Graybosch, and M.J. Guttieri. 2002. Breeding for improved milling and baking quality in wheat; a review. Journal of Crop Production 5:39-74.

Guttieri, M.J., D. Bowen, D. Gannon, K. O'Brien, and E. Souza. 2001. Solvent retention capacities of irrigated soft white spring wheat flours. Crop Sci. 41:1054-1061.

Experimental Milling of Soft Wheat Cultivars and Breeding Lines. Cereal Chemistry 59(1): 41-45

Small-Scale Milling to Estimate the Milling Quality of Soft Wheat Cultivars and Breeding Lines. Cereal Chemistry 59(4): 270-272

Distribution of Deoxynivalenol in Soft Wheat Mill Streams. Cereal Chemistry 62(6): 467-469

A Thirty-Minute Conditioning Method for Experimental Milling of Soft Wheat. Cereal Chemistry 63(1): 18-21

Revised Micro Testing for Soft Wheat Quality Evaluation. Cereal Chemistry 63(3): 177-182

Wheat Quality: A Quality Assessor's View. Cereal Foods World: April 1987

Milling Quality of Eastern Soft Wheat Cultivars Grown Between 1919 and 1984. Association of Operative Millers-Bulletin-March 1988

Predicting a Hardness Measurement Using the Single Kernel Characterization System. Cereal Chemistry 73(2): 278- 283

Milling and Baking Qualities of Some Wheats Developed for Eastern or Northwestern Regions of the United States and Grown at Both Locations. Cereal Chemistry 73(5): 521-525

Influence of Kernel Size and Shriveling on Soft Wheat Milling and Baking Quality. Cereal Chemistry 74(6): 700-704

Use of Aspiration and the Single Kernel Characterization System to Evaluate the Puffed and Shriveled Condition of Soft Wheat Grain. Cereal Chemistry 75(2): 207-211

Starch-Water Relationships in the Sugar-Snap Cookie Dough System. Cereal Chemistry 75(5): 660-664

Developing Agreement Between Very Short Flow and Longer Flow Mills. Cereal Chemistry 77(2): 187-192

Detection of Wheat Preharvest Sprouting Using a Pregelatinized Starch Substrate and Centrifugation. Cereal Chemistry 78(3): 282-285

Prediction of Test Weight from a Small Volume Specific Gravity Measurement. Cereal Chemistry 79(2): 227-229

Test Weight Characterization (Normalized)

Numerous cultivars have been characterized with respect to their genetically-related test weight differences. (In order to ascertain genetic traits, wheat is mechanically divided into three sizes and then each fraction is air-aspirated to produce an essentially shrivel-free sample).

Cultivars that were grown together were compared to each other with respect to their test weight differences. A few hundred sets spanning three decades were evaluated and many newly analyzed sets have been added yearly. A number of contemporary cultivars that repeatedly demonstrated very similar test weights were identified as "reference" wheats. "Reference" cultivars were designated as zero (0) in an effort to normalize the remaining data. Thirteen categories, including the "reference" wheats, were developed by the Soft Wheat Quality Laboratory. Those categories ranged from –1.0 pound to +5.0 pounds in .5 pound-increments. The thirteen categories were new for the 2004 report and replaced the previously more condensed seven categories. Additionally, the single-digit normalized test weight designation was replaced with a value that was more recognizable. Sixty was added to each digit.

Test weight comparisons within a location were usually quite dependable, but could not be directly balanced with wheat from a different location, year or era[(c)]. The Soft Wheat Quality Laboratory traditionally reported the actual test weight of several hundred cultivars, but those values were relatively unreliable for direct comparisons. There were 654 cultivars (2006) from the SWQL database that have been analyzed for test weight versus normalized test weight. The number of determinations for each wheat ranged from 1 to 83. The correlation between actual test weight and normalized test weight was r = .53. Those cultivars having only one or two determinations had a correlation of r = 0.46 (n = 374), while those cultivars with three or more determinations had a correlation of r = 0.71 (n = 275).

The correlation between test weight and normalized test weight within a location and year should be very good. In 1994, Dr. Mark Sorrells, Cornell University, multiplied 134 named wheats for the SWQL. 98 of those cultivars were fully aspirated to remove shriveled kernels and test weight performed. Actual test weight was compared with the "historic" normalized test weight, and that correlation was r = 0.92.

Normalized Test Weight Characterization (cont'd)
"Weathering" is a significant factor in the reduction of test weight. Genetically softer cultivars appear to be detrimentally affected by the environment to a greater degree than are genetically coarser cultivars. Softer wheats exhibit a greater loss in test weight and density and a greater increase in softness than do harder-type wheats. Speculatively speaking, the softer cultivars are absorbing moisture from wet weather, humidity and dew more readily than coarser-type wheats. Thus, the softer cultivars are swelling and shrinking more frequently. Occasionally, though rarely, due to "ideal" growing conditions, the range in test weight among cultivars that normally express differences will either be compressed or non-existent.

Very old varieties have been included in the normalized test weight table, but, many of them mature later than most of the contemporary cultivars. Older varieties and contemporary cultivars have traditionally been grown together. They are harvested at the same time once the contemporary wheat has dried to a threshable level. Older varieties are somewhat higher in moisture content when harvested, which is indicative of their lateness.

To test if high moisture content at harvest may result in enhanced test weight, in 2005 the SWQL plots were harvested at around 20% to 22% moisture and the "border" cultivar was harvested at 30% moisture. Additional "border" was later harvested at 15% moisture. The 30%-moisture "border" cultivar was dried to about 11% moisture. Test weights of the dried 30% "border" and the 15% "border" were the same. That suggested that if wet weather were not a factor, harvesting at higher-than-normal moisture levels or varying moisture levels due to maturity differences, would not alter test weight relationships. Another conclusion might be that the older historic varieties could be compared with the newer varieties even if the maturity times were significantly different. Of course, comparisons can only be reliable in the absence of wet weather during harvest time. (All samples are placed in a dryer daily where the temperature will be about 95 to 100 °F.)

Normalized Test Weight Characterization (cont'd)
Cultivars are affected by precipitation, humidity and/or dew at some point in the maturation process. We speculate that grain above 30% moisture content is less likely to be negatively impacted by precipitation, humidity or heavy dew. Swelling and shrinkage may occur but with little effect. However, as the grain moisture falls below 30%, the probability of negative effect from precipitation, humidity and heavy dew increases. Density of the grain and the kernel surface "smoothness" likely will be altered. Contemporary, earlier-maturing cultivars are prone to more frequent periods of swelling and shrinking; the much later maturing-cultivars with higher moisture content are not. Almost without exception, the historic varieties in these plots are two to five pounds higher in test weight than the contemporary "reference" cultivars when harvested at the same time and when wet weather is a factor.

However, it was observed that cultivars maturing within a given time frame of a few days may respond similarly to environmental conditions; thus, the genetic traits which contributed to test weight differences were unaltered. Therefore the influence of the interacting variables associated with "weathering" was minimized. Our experience with grow-outs of 100 or more cultivars per year since 1987 and 200 cultivars annually since 2002 indicated that practically all of the contemporary varieties might be compared with each other in producing test weight differences that related to genetics.

The following graph represents normalized test weight of 661 varieties and cultivars from 1808 to 2003. Overall correlation between normalized test weight and year of origin was r = -0.25. The correlation from 1808 to 1979 (n = 137) was r = -0.49, however, the correlation from 1980 to 2003 (n = 524) was + 0.15.

Figure 7. Normalized Test Weight versus Crop Year.

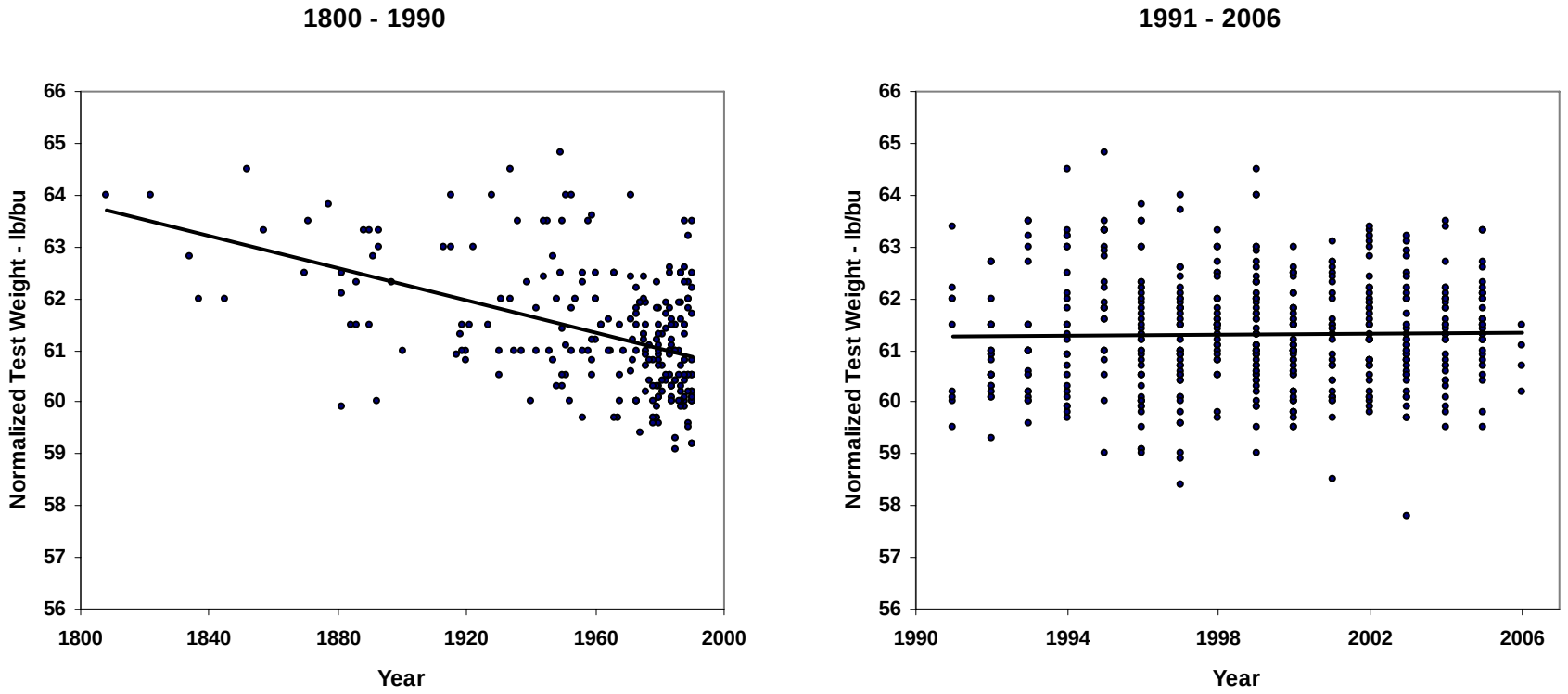
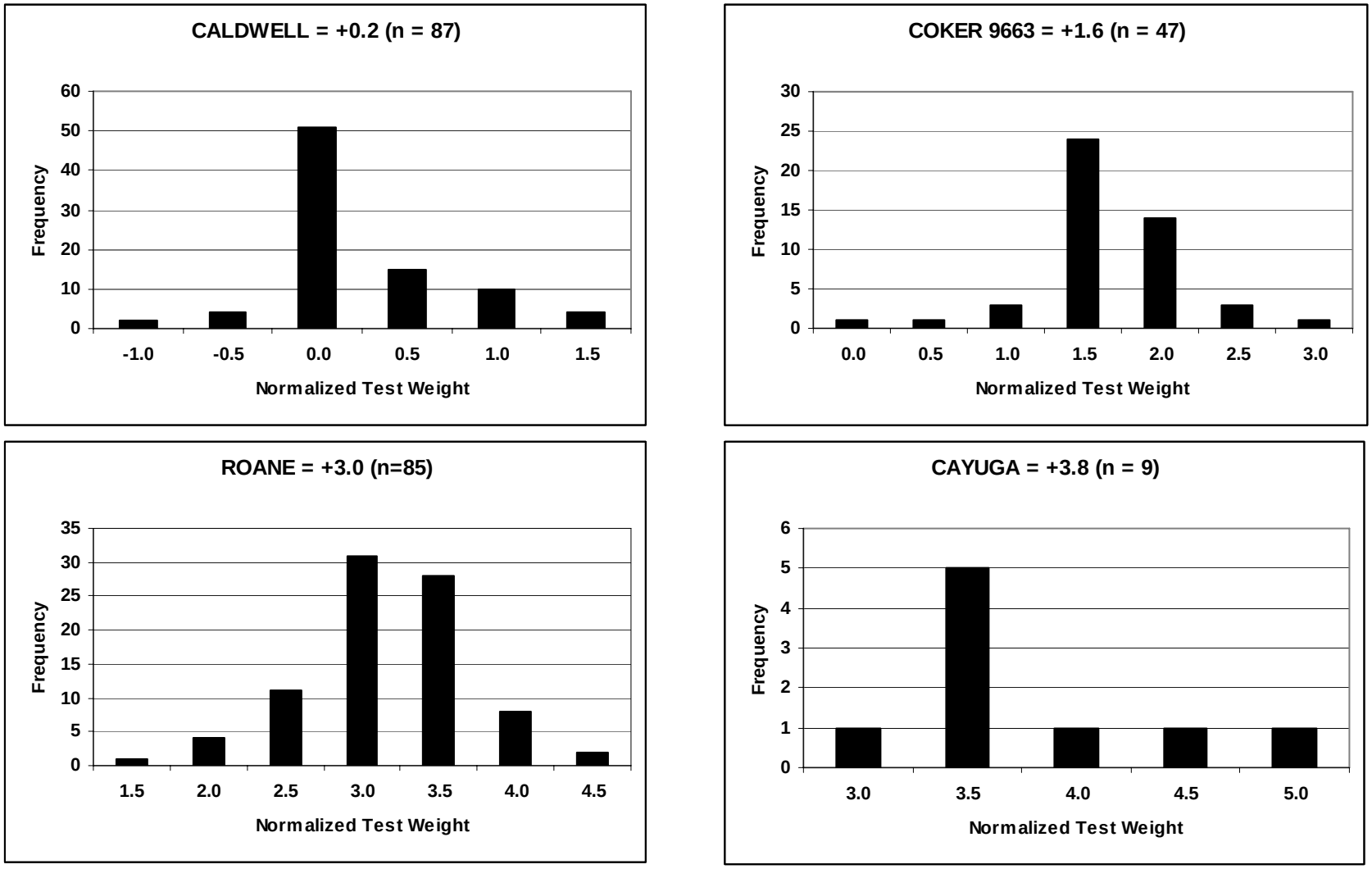


Figure 8. Frequency Distribution of Normalized Test Weight for Four Cultivars.



Test Weight

GROUP A (59.0 lb/bu)
Dexter
Dyna Gro 424
Excel
G 3566 *
GA 100
GR 855
INW 0303 *
Kilen
L 409 *
McNair 3271 *
Packard
Roazon
Rosco
Stine 501 *
W 026 *

GROUP B (59.5 lb/bu)	
AGI 521	INW 0304
Alpine *	INW 0315
Autumn	INW 0411 *
Beck 105	Pioneer 25R47
Becker	Pioneer 25R56 *
Blueboy	Racine
Cherokee	Roy
Coker 916	SG 1540
Danny	Soissons *
Delaware	Steele
Delta Queen	Stine 455
Dyna Gro 422	Stine 481
Falcon *	Ticonderoga
FS 309 *	Timwin *
Hoppes	TN 101
Houser	Wellman 115
HS 260R *	

GROUP C (60.0 lb/bu)				
144 J *	Coker 9323	Gore	Patriot 160 *	SS 520
Abacus *	Coker 9375	GR 863 *	Pioneer 25R51	Stine 482
Adena	Coker 9835	GR 933	Pioneer 2545	Stoddard
AGI 525	Coker 9877	GR 942	Pioneer 2548	Terral 877 *
Anderson	Coker 9907 *	GR 962	Pioneer 2580	Titan
Arise W34 *	Croplan 514	Grant	Pioneer 25R26	TS 3060
Arrow (Historic)	Cyrus	Gregory	Pioneer 25R54	Tyler
Augusta	Daisy	H 101 *	Pioneer 25R75	Vicar *
Beck 103	Dawson Golden Chaff *	Hardired (NC)[n]	Pro Gold	Voris 8044
Beck 122	Diana	Hart	Quantum 706	Voris 8088
Big Red *	Dyna Gro 411	Honey	Quantum 9723 *	Wellman 9540
Boone	Ernie	INW 0301	Randal II *	Wellman 9920
Bradford	Excaliber *	INW 0316	Rebecca	Whitby
Branson	Excel 200 *	Keiser	Reo	Wilkens 101
Caldwell	Excel 300 *	Lincoln	RS 931	Willcross 795 *
Cardinal	FFR 38158	Madison	RS 987	Windsor *
Casey	FFR 510	Mallard	RW 1480	Yorkstar
Clark	FL 302	Marilee	RW 1505	
CM 577	FL 304	McNair 1587 *	Sawyer	
Coker 762 *	Freedom	Mendon	SG 1530	
Coker 9024 *	GL 9400 *	Morey	SR 205	
Coker 9152	Glacier	Panola	SR 219 *	

GROUP D (60.5 lb/bu)				
545 W *	Coker 9766	Golden *	Omega 78	SS 560
569 W *	Delta King 910	Gordon	Pacer	Stine 480
Adder	Douglas	GR 915	Patton	Stine 902
AG 2012 *	Downy	Harmil	Pennmore *	Strike 204 *
AGI 301 *	Dynasty	Hartzler 2400 *	Pioneer 2568	Susquehanna
Armon *	EH 9406 *	Hazen	Pioneer 2571	Terral LA 422
Armor 4045	Essex AC	Holley	Pioneer 25R57	Totem *
Ashley *	Excel 333 *	INW 0123 *	Pioneer 25W33	TS 6020
Atlas 66	Excel 388 *	INW 8852 *	Pioneer 26R15	Valor
Aurora	Excel 400	Jekyl	Pioneer 2737W	Verne
Bayles	Excel 500 *	JMS 222	Purcam *	Vigoro 9314W
Beck 112	Favor	John *	Ron AC	Vigoro 9510 *
Beck 125 *	FFR 511 *	Jolly	Rosen	Voris 8040
Beretta *	FFR 544 *	Kelley	Ross	W 036 *
Blazer	FFR 555W	Kent AC	RS 947	Wakefield
Bouillon	FL 301	Logan	RW 1430 *	Webster
Brand 350 *	GA 1123	Lowell	RW 1488	Wellman 131
Brazen	Galaxy 501*	Magnum	Sabbe	Wellman 9420
Campbell 9455	Genesis 9821 *	Massey	Samco *	Williams
Charmany	Genesis 9939 *	McLane II	SC 1337 *	Wisdom *
Citron	Genesis R035	McNair 1003 *	SC 1343	Wiser *
Coffman	Genesis R036	Mountain AC	Schultz 130 *	Wonderly
Coker 47-27 (NC)[m]	Genesis R046 *	MPG 7921	Scotty	Zavitz
Coker 9295	Glory	Navigator	SR 49	
Coker 9436	Goldberg	Nelson	SR 82	

GROUP E (61.0 lb/bu)					
527 W *	Coker 797	Genesis R022 *	McNair 701	Raven # 1 *	Valprize *
AG 9346	Coker 9025	Genesis R045	McNair 2203 *	Raven # 2	USG 3342
AGI 203 *	Coker 9134	Goldfield	Merrimac *	Redcoat *	Venture
AGI 538	Coker 9312	Grandprize *	Mitchell	Roberts	Vigo *
Annett	Cornell 595 *	Hancock	Monon	Roland	Vigoro 9222
Anthony	D 8006	Hartzler 2300 *	Morrall	RS 901	Vigoro 9304W *
Argee	Excel 352tw *	Hickory	Nomad *	RS 917 *	Vigoro 9512
Armor 3235	Excel 399 *	Hillsdale	OAC 104 *	Savage *	Voris 7070 *
Ashland *	Excel 450 *	Hoffman 37 *	OH 708	SC 1317 *	W2-912
Avon *	Feck	Honor *	OH 776	SC 1330 *	Wakeland
Batavia	Feland	Hopewell	Patriot 210 *	Shelby	Weaver
Beck 161	FFR 38247	HS 222R	Patterson	Smoke *	Wellman 150
Beck 168	FFR 38358 *	HS 243R	Pioneer 2540	Southern Belle	Wellman 9501 *
Benton	FFR 518W	HS 250R *	Pioneer 2551 *	SR 203 *	Wellman 9710
Blueboy ll	FFR 523W	HTW 215 *	Pioneer 2555 *	SR 211	Wellman 9950 *
Brave	FFR 566W	INW 0102 *	Pioneer 2691	SR 216 *	Wheeler
Brody *	FFR 588 *	INW 9811	Pioneer 26R22 *	SR 87 *	Whitney
Caledonia	FL 303	INW 9824	Pioneer 26R31	SS 550	Wilkens 111
Callahan 115	Forward	Ionia	Pioneer 26R58	SS MPV 57	Willcross 738 *
Campbell 9202 *	Foster	Jacob	Pioneer S-76	Stacy	Wilson
Cecil	Frisco *	Jentes	Pioneer S-78 *	Stine 454	Wise *
Cedar	FS 200 *	Julie lV *	Pontiac	Strike 480 *	Wonder
Chancellor	FS 321 *	Karena	Potomac	Sullivan	Y98-912
Chelsea	FS 527 *	Lewis	PRO 100 *	Superior	Yorkwin *
Choptank	FS 569 *	LG 1388	PRO 104 *	Terral 817	
CM 527W	Genesee	MacKinnon AC	PS 1359 *	Thorne	
CM 544	Genesis 9822 *	Mason	Purcell	Todd *	
Coker 65-20 *	Genesis 9953	McLane	Quantum 708	VA 97W-375	

GROUP F (61.5 lb/bu)					
547 W	Coker 9663	FS 332 *	McNair 4823 *	Ramrod	Tiller *
Abe	Compton	FS 530 *	Merrell	Randal *	Truman
AGI 101	Conquest *	Genesis 9959 *	Neuleib *	Red Indian *	Twain
AGI 204	Crawford *	Genesis R047	Nittany *	Redhart (NC) *	USG 3209
AGI 535	Dancer	Gibson *	OH 751 *	RS 909	USG 3650 *
AGI 550	Dawson (AgriPro) *	Goldcoin	P 92145A2-4-6-2-8 *	RW 1487	VA 97W-469
Andy	Diehl-Mediterranean *	Golden Cross *	Parker *	Seneca *	Vigoro 9211 *
Arthur	Discovery *	GR 860	Patriot	Severn	W1-018
Arthur 71	Dominion	GR 876 *	PH 46 *	Shiloh	W3-077
Bailey 4287 *	Doublecrop	GR 9956 *	Pike	Sisson	Warrior *
Bascom	Dyna Gro 403 *	GSR 2500 *	Pioneer 2550	Skyline *	Warwick
Beck 102 *	Dyna Gro 419	Hartman	Pioneer 2553	SS 8302 *	Wellman 121
Beck 108	E1007W	Harus	Pioneer 25R35	Stadler *	Wellman 9940
Bernard	Ebberts 518 *	Hoffman 14	Pioneer 25R49	Steyer 1809	White Wonder *
Besecker	Emmit	INW 0302	Pioneer 25R63	Stine 488	Wilkens 126 *
Bravo	Ena	INW 9812 *	Pioneer 25W41	Stine 901	
Cartier	Featherstone 176	Knox 62	Pioneer 2643	Strike 205	
Clemens	FFR 36803 *	Kristy	Pioneer 26R24	Sunsation *	
Clemson 201	FFR 502W *	LA 711	Pioneer 26R38	SW 350 *	
CM 568	FFR 525	Laser *	Pioneer 26R46	SW 873 *	
CM 569W	FFR 568	MacMillian	PRO 202 *	SW 89 *	
Coker 747	FFR 558W	Magnolia *	Pryer	Talbot *	
Coker 833	FL 301H	McNair 1813	Quantum 7203	Terral 1011 *	

Test Weight

GROUP G (62.0 lb/bu)				
556 W *	Coker 9105 *	Garfield	Pat	Saluda
Absolut *	Coker 9227	Gasta *	Pearl	SC 1325
AG 9112	Coker 9543	Gator *	Pioneer 2510	SC 1347 *
AGI 202 *	Coker 9553	Hoffman 95	Pioneer 2552	SC 1352
Akos 2234 (RCAT) *	Coker 9733	Howell	Pioneer 25R18 *	Stine 479
Alma	Coker 9803	HTW 9850	Pioneer 25R23	Stine 484
American Banner	Cooper	Huron	Pioneer 25R44	SW 403
AR 839	D 6234	Husky	Pioneer 25R78	Tayland *
Armor 3035 *	DF 102R *	INW 8841 *	Pioneer 25W60	Tecumseh *
Atlas 50 *	Dominator *	INW 9531	Pioneer 2628 *	TS 4040
Auburn	Dozier	Jack *	Pioneer 2684	Vigoro 9212
Bavaria	Ebberts 501 *	Jackson	Pocahontas	Vigoro 9412
Beau	Elkhart	Jaypee	Purdue No. 1 *	Wellman 111
Beck 117	Excel 392 *	Kancom	Quantum 7123	Wellman 120
Bess	Excel 412tw *	Kaskaskia	Reino	Wellman 141
Cassady *	Fairfield *	Kenosha	Renwood 3260	Wellman 9350
Century ll	FFR 38250 *	Knox	Renwood 3706	Wellman 9910
Chesapeake	Fillmore	L 25 *	Richland	Wiley
China *	Fleming	Marion *	Rowland *	Wilkens 132 *
CM 529	Frankenmuth	Mediterranean *	RS 919	Willcross 723 *
CM 539	FS 539 *	Monarch	RS 949	
CM 558	Fuzz *	Natchez *	RS 953	
Coker 61-19 *	GA931233-E17	Oasis	Ruler	

GROUP H (62.5 lb/bu)		
AGS 2000	Dawson (historic) *	Magic
AGS 2031 *	Declaration	Nured
AGS 2060	DF 101R	NY 6432-10
AGS 2485 *	EH 9410 *	Pioneer 25R37
Andnox *	Featherstone 520	RW 1498 *
Arbor *	FFR 522W	RW 1517
Ariss	Fredrick	SG 1555
Arrow (new)	FS 322 *	SG 1560 *
Aubrey	FS 329 *	SR 215
Beck 107	Fulcaster	SS 8404 *
Beck 110	Fultz *	SS 864 *
Benhur *	GA 93124E16	Strategy *
Blackhawk *	Genesis 7388 *	Stuckey
Bledsoe	Geneva	SW 82 *
Bowerman *	Greeson *	Taylor 49
Bradley	Hoffman 28	Traveler
Coastal *	Hoffman 45	TS 5020
Coker 9474	Hunter	TS 8040
Coker 9511	INW 0101	USG 3408
Coker 9704	INW 9853 *	USG 3592
Coker 983	Joseph	Voris 9250 *
Coker 9904	Kelo *	Voris 9550 *
Columbia	Key	Wellman 9830
Coyote*	Magers	

GROUP I (63.0 lb/bu)	
AG 2020	Imperial Amber *
AGI 201 *	Kruse *
Arise W33 *	LG 1433
Atlantis	Lisbo
ATW 270	McCormick
Cobra	Neuse NC
Coker 9184	Nudel
Emily *	Pioneer 2566 *
Excel 354tw *	Pioneer 25R42
FFR 535W *	Pioneer 26R12
G/F 92485E15	Pioneer 26R61
Genesee Giant *	Roane
GL 9240 *	Rochester Red
Gold Drop	RS 927
GR 983	SG 1550
Harold *	SR 204
Harvard	SR 218 *
Hondo*	Succession *
HS 257R *	Terral 101 *
Illini Chief *	

Test Weight

GROUP J (63.5 lb/bu)	
Agra Tech 91W	Podach
Beck 109	Pride of Genesee *
Brandy	Rachel
Canawa *	Russian Red *
Carlisle	RW 151
Coker 47-27 (Nat'l Collection)[m]	Savannah
Dyna Gro 426	Seabreeze *
Enigma *	Spencer
Fundulea	SS 8308 *
Hoffman 89	Tribute
INW 0412 *	TS 4020
Kay *	Vermillion (bearded) *
L 15	Walker *
Lucas	Wellman 130
Mammoth Red	Wellman 9140
Patriot 180 *	Wellman 9850
Penquite	

GROUP K (64.0 lb/bu)
AGI 540
Agra Tech 90W *
Benjamin
Cayuga
Coker 68-15 *
Gipsy
Goens *
Nabob *
Pennoll *
Purplestraw *
SC 1365
Taylor
VPI 131 *
Wisconsin No. 2 *

GROUP L (64.5 lb/bu)
Chieftan
Clarkan
Flint *
SG 1545
Wellman 109 *

GROUP M (65.0 lb/bu)
Dyna Gro 246
Kan Queen

Myth of Some Relationships among HRW, SRW, and HRS

Environmental factors induce a range of responses among cultivars in test weight and kernel density. The soft wheat cultivars Cayuga, Roane, Tribute and Pioneer 25R37 will for the most part be 3-4 pounds higher in test weight in contrast to soft wheat cultivars such as Caldwell, Honey, Mountain AC and Pioneer 25R26 when grown together. There will also be density differences and a variation in granularity. (Softness Equivalence (SE) calculated from Quadrumat milling will be substituted for granularity.) Milling quality would not be affected and will reflect the cultivars historic milling performance.

Soft wheat was said to be lower in test weight and density because it was softer than hard wheat. The density and test weight differences between hard and soft wheat has been due to environmental circumstances as cultivars respond in varying degrees to wet weather, humidity and/or due. Harder type cultivars may experience less frequent and/or less drastic periods of swelling and shrinkage during wet weather, humidity and/or the effects from due. Softer cultivars likely respond more easily to swelling and shrinkage due to their ability to absorb and release moisture with ease. In addition, glume characteristics likely are involved as a barrier to moisture penetration. However, there have been naturally occurring “ideal” weather conditions where there seems to have been little, if any, affect upon the test weight and density of the various cultivars, but the SE’s of the samples varied true to their genetic relationship. Some portions of the traditional softness/hardness theory appeared to be questionable.

The validation datasets are limited, but there are four different groups of samples represented by: 1998 California grown HRS recombinant set, 2002 Canadian grown HRW and SRW, 2001 Ohio grown HRW and 1985 Ohio grown SRW. Additional cultivars within two of the sets and a fifth identified set remain to be analyzed. The average test weight of the three classes of wheat was: HRW (65.8#), HRS (66.2#) and SRW (65.9#). The average grain density for the three classes was: HRW (1.39186), HRS (1.39454) and SRW (1.39493). However, the SE values were not identical as might be assumed, but varied significantly. The range in SE among the HRW samples was 31% to 37%, HRS was 21% to 48% and SRW was 47% to 51%. The range in SE across classes from 21% to 51% represented nearly 70% of the entire range between hard and soft wheat. That variation in SE between hard and soft wheat where test weight and density are essentially identical, defies the traditional thinking. Obviously, the endosperm compaction must be the same for the three classes of wheat, but the affinity of the cellular structures to “release” its contents during milling or grinding differ tremendously.

SWQL Growouts

Resistant Cultivars in an Extreme Environment (2003 Wooster)

The Soft Wheat Quality Laboratory harvested 270 historic and contemporary cultivars in 2003. Release or introduction date ranged between 1881 and 2003. Heading date encompassed 15 days. There was an extended period of wet, cool weather that resulted in significantly greater incidence of plant diseases. Larry Herald, of the Ohio State University wheat breeding program, determined that Powdery Mildew, Septoria Leaf & Glume Blotch, and Fussarium Head Blight were present at moderate levels. A low incidence of Wheat Spindle Streak Mosaic Virus showed early but diminished as the growing season progressed. 43 cultivars were eliminated from the set due to marginal fall germination or low levels of sprout at harvest. Sprouting was confined to some of the white cultivars.

Of the 227 remaining cultivars test weight varied from 42.2 # to 60.5 #. The average of the 227 test weights was 52.8 #. Under close scrutiny, it was evident that the higher test weight cultivars had grain that appeared to have normal seed coat color, generally, those cultivars above 55 # test weight. However, the lower test weight cultivars had a glaring "bleached" appearance. The SWQL has referred to that circumstance as being "weathered" [j]. Dr. Carl Griffey, Virginia Polytechnic Institute and State University indicated that differences in heading date would have the greatest effect on test weight in years when wet weather delays harvest, but the relationship between heading date and test weight were largely over-ridden by differences in disease resistance among cultivars. Correlation between release date and "as is" test weight was r = .02 and between heading date and "as is" test weight r = .19. Correlation between the cultivars historic 1000 kernel weight and "as is" test weight was r = .07.

Sixty-seven cultivars were chosen to be aspirated to remove all shriveled grain. Only those cultivars that visually had normal seed coat color were utilized. The sixty-seven varieties represented the entire range of normalized test weight data (-1.5# to 4.8#). Normally, the test weights of shriveled-free samples in practically every set would relate extremely well with their historic normalized test weight. However, the correlation between normalized test weight and shriveled-free test weight was only r = .49. Apparently, weathering and disease overrode the genetic differences. Normalized test weight versus heading date was r = .12.

In spite of the severe environmental conditions, there were 31 cultivars that achieved "as is" test weights that were at least 57.0 #. On the following page is a list of those cultivars and their respective test weight.

Table 13. Test weight of resistant cultivars in an extreme environment (Wooster, OH. 2003 crop).

Cultivar	Origin	Class	Test Weight (as is)
Pioneer 25R42	Pioneer Hi-Bred Int'l	SRW	60.5
Pioneer 2684	Pioneer Hi-Bred Int'l	SRW	59.7
Hondo	Agripro	HRW	59.6
Kan Queen	Private (1949)	SRW	59.4
Pioneer 25R37	Pioneer Hi-Bred Int'l	SRW	59.4
Pioneer 25R18	Pioneer Hi-Bred Int'l	SRW	59.0
Tribute	Virginia Polytechnic	SRW	59.0
Coker 9733	Syngenta	SRW	58.6
W 130	Wellman	SRW	58.4
Podach	Steyer Seeds	SRW	58.3
Pioneer 2643	Pioneer Hi-Bred Int'l	SRW	58.3
Coker 983	Syngenta	SRW	58.1
ARLA 85411	Univ. of Arkansas	SRW	58.0
Sullivan	Purdue University	SRW	58.0
Harvest Queen	Private (1897)	SRW	58.0
Beau	Purdue University	SRW	57.9
W 036	Westbred	SRW	57.9
Spencer	Hybritech	SRW	57.7
Lisbo	AGRA	SRW ?	57.6
Beck 110	Beck Seeds	SRW	57.6
W 711	Westbred	SRW	57.6
Southern Belle	Agripro	SRW	57.3
Weaver	Steyer Seeds	SRW	57.3
Severn	Maryland Ag. Exp. Station	SRW	57.2
SG 1560	Shur Grow	SRW	57.0

Resistant Cultivars in an Extreme Environment (2004 Wooster)

Heading dates for all samples were within an eight-day period (143-150) and there was no wet weather during that time. Immediately after heading there was a rainy period that persisted four consecutive days. Nine days of rain ensued during the second and third week of June. There was a dry period between June 18th and July 10th where there was only one day of light rain. On June 21st grain moistures were determined for ten cultivars that ranged in heading date. Moisture varied from 41% for Clark and Caldwell to 47% for Pioneer 25R26 and Hopewell. By June 29th the grain moisture ranged from 25% for Clark and Caldwell to 37% for Pioneer 25R26 and Hopewell. Samples were harvested July 1st to July 5th. Larry Herald, Ohio State University, indicated that disease pressure was similar to 2003; Powdery Mildew, Septoria Leaf and Glume Blotch and Fusarium Head Blight.

All cultivars were free of sprout damage. Each sample was inspected for grain condition and 144 of the 270 were selected for additional analysis. Test weight was determined on the "as is" sample. Several important samples were aspirated to remove shriveled kernels and then milled. Milling and baking data paralleled the historic information thereby confirming the soundness of the grain.

The highest 31 contemporary cultivars' test weights are listed on the following page. There were 15 historic varieties dating to the 1800's that were in the original top 25 for test weight, but they were excluded since their late heading date may have resulted in high test weight, and it does not necessarily indicate their robust resistance to disease. For comparative purposes, Kan Queen was 4th in 2003 and Harvest Queen was 15th. In 2004 Kan Queen was 1st with a test weight of 62.0 lbs. while Harvest Queen was 5th with a test weight of 60.0 lbs.

Table 14. Test weight of resistant cultivars in an extreme environment (Wooster, OH. 2004 crop).

Cultivar	Origin	Class	Test Weight (as is)
Roane	Virginia Polytechnic	SRW	61.0
Tribute	Virginia Polytechnic	SRW	59.7
W 9850	Wellman	SRW	59.5
Tecumseh	Michigan State	SWW	59.3
W 130	Wellman	SRW	59.0
Spencer	Hybritech	SRW	59.0
Wheeler	Virginia Polytechnic	SRW	58.7
Pioneer 26R12	Pioneer Hi-Bred Int'l	SRW	58.6
Neuse NC	North Carolina State	SRW	58.6
McCormick	Virginia Polytechnic	SRW	58.6
W 9940	Wellman	SRW	58.3
Pontiac	Agripro	SRW	58.3
Renwood 3706	Virginia Polytechnic	SRW	58.1
Fredrick	Canada	SWW	58.1
V 9211	Vigoro	SRW	58.0
Sullivan	Purdue University	SRW	58.0
Monarch	Gries Seed	SRW	57.9
INW 0101	Purdue University	SRW	57.9
Richland	Cornell University	SWW	57.8
Magers	Steyer Seeds	SRW	57.7
Atlas 66	North Carolina State	SRW	57.6
W 9350	Wellman	SRW	57.5
SG 1560	Shur Grow	SRW	57.5
Hart	University of Missouri	SRW	57.5
Pioneer 25R35	Pioneer Hi-Bred Int'l	SRW	57.4

Highest Test Weight Cultivars in 2005 Wooster

The SWQL harvested 217 cultivars between July 3rd and July 7th. Growing conditions were excellent as evidenced by the greatest field yield since 1989 when the SWQL began growing significant numbers of cultivars. Light rain occurred six days from May 15th to May 31st for a total of .45 inches. There were fourteen days of very light rain in June totaling 1.02 inches. Harvested samples were dried at approximately 100 °F. to a moisture level of around 11.2%.

All entries were cleaned on a modified Carter-Day dockage tester to remove "field trash". No grain was discarded or removed. Test weight was determined on the "as is" samples. Cultivars possessing test weights of 59 pounds and lower were not correlated with the degree of shriveled grain. Those lower test weights were associated with the cultivars' extremely fine flour granulation. Cultivars that are coarse in flour granularity tend to have higher test weight. Test weights of the top 31 contemporary cultivars are presented on the following two pages.

Two hard red winter cultivars and two semi-hard cultivars intended for production in the Eastern United States are not included in the data. Hondo, Magic, Jack and Carlisle had test weights of 62.9, 62.1, 63.2 and 61.5, respectively. A non-contemporary cultivar, Coker 47-27, had a test weight of 62.2 pounds. Coker 47-27 was omitted from the data.

Table 15. Test weight of the top 31 cultivars (Wooster, OH. 2005 crop).

	Cultivar	Origin	Class	Test Weight (as is)
1	Coker 68-15	Coker/Syngenta	SRW	63.7
2	Neuse NC	North Carolina State	SRW	63.1
3	Tribute	Virginia Polytechnic	SRW	62.5
4	Coker 9184	Syngenta	SRW	62.5
5	Spencer	Hybritech	SRW	62.4
6	Coyote	JGL	SRW	62.3
7	INW 0101	Purdue University	SRW	62.3
8	AGS 2485	AGSouth Genetics	SRW	62.3
9	SC 1352	Seed Consultants	SRW	62.2
10	Pat	University of Arkansas	SRW	62.1

Test Weight of the Top 31 Cultivars for 2005 Wooster, Ohio (cont'd)

	Cultivar	Origin	Class	Test Weight (as is)
11	DG 246	Dyna Grow	SRW	62.1
12	USG 3592	Unisouth Genetics	SRW	62.0
13	Renwood 3260	Virginia Polytechnic	SRW	62.0
14	Pioneer 25W41	Pioneer Hi-Bred Int'l	SWW	61.9
15	Coker 9312	Syngenta	SRW	61.9
16	Monarch	Gries Seeds	SRW	61.8
17	Pioneer 2550	Pioneer Hi-Bred Int'l	SRW	61.8
18	AGI 101	Advanced Genetics	SRW	61.8
19	Morey	University of Georgia	SRW	61.8
20	AGI 201	Advanced Genetics	SRW	61.7
21	Wiley	Steyer Seeds	SRW	61.7
22	INW 0302	Purdue University	SRW	61.6
23	Pioneer 26R61	Pioneer Hi-Bred Int'l	SRW	61.6
24	Cooper	AgriPro	SRW	61.5
25	Pioneer 2552	Pioneer Hi-Bred Int'l	SRW	61.5
26	FS 530	Illinois Improvement Assoc.	SRW	61.5
27	Gator	Sunbeam Extract	SRW	61.5
28	Vigoro 9412	Royster-Clark	SRW	61.4
29	Elkhart	AgriPro	SRW	61.4
30	Strike 205	Butch Seed Co.	SRW	61.3
31	Roane	Virginia Polytechnic	SRW	61.2

Highest Test Weight Cultivars in 2006 Wooster

There were 119 double-planted cultivars harvested from the SWQL plots on July 6 and July 7. From May 10 through May 19, when most of the cultivars were heading, rain occurred daily for a total of 3.47". There were periods of rain until June 5. Total precipitation between June 5 and June 20 was only .35". From June 21 to July 5, there were five days with precipitation amounts varying between .29" to 1.37". One hundred one cultivars had a small percentage of scab. Fifteen other cultivars were found to have increased levels of scab. Three cultivars were nearly scab-free. Those were: AGI 301, Campbell 9455 and Coker 9436.

On June 29 grain moistures were determined for several cultivars. Patterson was the lowest with a grain moisture of 35% followed by Blazer with 38% while Pioneer S-76 and Hopewell were 41% and 42%, respectively. By July 2 Blazer was 21% and Patterson was 24% while Hopewell was 35%. Immediately after harvest, the samples were dried at about 105 °F. to a moisture level around 8.5%.

The 119 cultivars were cleaned to remove "field trash" and test weights were determined. Nine reference cultivars are included for comparison. Twenty-one cultivars possessing the highest test weights are listed on the succeeding page.

Table 16. Highest test weight cultivars (Wooster, OH. 2006 crop).

Reference Cultivars	Origin	Class	Test Weight (as is)
Foster	AgriPro	SRW	59.8
Patterson	Purdue University	SRW	59.6
Coker 9803	Coker/Syngenta	SRW	59.3
Hopewell	Ohio State University	SRW	59.1
Caldwell	Purdue University	SRW	58.5
Pioneer 25R26	Pioneer Hi-Bred Int'l	SRW	58.3
Patton	AgriPro	SRW	58.1
Coker 983	Coker/Syngenta	SRW	57.7
Pioneer 2580	Pioneer Hi-Bred Int'l	SRW	56.7

Cultivars with the Best Test Weight in Wooster, Ohio, in 2006 (cont'd)

Cultivar	Origin	Class	TW (as is)
INW 0412	Purdue University	SRW	61.9
Strategy	Virginia Polytechnic Inst.	SRW	61.8
Beck 117	Beck's Hybrids	SRW	61.7
TS 4040	Thompson Seeds	SRW	61.5
Roane	Virginia Polytechnic Inst.	SRW	61.1
Wellman 111	Wellman Seeds	SRW	61.1
Jaypee	University of Arkansas	SRW	61.0
AGI 204	Advanced Genetics	SRW	60.8
Monarch	Gries Seed	SRW	60.8
Coker 9134	Syngenta Seeds	SRW	60.7
SC 1325	Seed Consultants	SRW	60.7
FFR 544W		SRW	60.7
Cassady	Buckeye	SRW	60.5
Coker 9474	Syngenta Seeds	SRW	60.5
Coker 9227	Syngenta Seeds	SRW	60.4
Oasis	Purdue University	SRW	60.4
Pioneer 2643	Pioneer Hi-Bred International	SRW	60.4
Feck	Steyer Seeds	SRW	60.3
Pat	University of Arkansas	SRW	60.3
SS 8302	Southern States	SRW	60.1
Benton	AgriPro	SRW	60.0

Gluten Strength (Lactic Acid SRC)

Lactic Acid Solvent Retention Capacity (SRC) Test

The lactic acid SRC values displayed in this report were from Allis-Chalmers milled sprout-free flours and were adjusted to 9% flour protein. Lactic acid SRC relates to the glutenins and is predictive of gluten strength for soft wheat. Limited data suggests that lactic acid SRC values may be fairly consistent within a soft wheat cultivar when regressed to a constant 9% protein level. Research in journal publications consistently finds significant location and genotype effects for lactic acid SRC, yet typically very minor contributions of genotype by environment interactions. Some of the environmental effects may be due to variation in total protein concentration. However the quality of protein in a sample can be influenced by the environment, as has been repeatedly demonstrated in the hard wheat literature. In soft wheat, we have observed that samples from Michigan have produced lactic acid SRC values three consecutive years (2000, 2001 and 2002) that are about ten percentage points lower than the same varieties from other locations. Allis-Chalmers lactic acid SRCs from about 112% to 133% are thought to represent stronger gluten soft wheat cultivars. Values that are about 60% to 75% are thought to be indicative of weak gluten varieties.

The lactic acid SRC test is influenced by flour ash (milling method), sprouting, milling moisture, shriveled grain, flour protein content and adverse environmental conditions. Low ash flours will produce elevated levels of lactic acid SRC in contrast to higher levels of ash, even though the flour protein difference between the low ash and higher ash flours is very small. Between 0.32% and 0.47% ash, limited data revealed a 0.53% change in lactic acid SRC per .01% point change in ash after adjustment for flour protein. Very low levels of visibly undetectable sprout can greatly elevate lactic acid SRCs. Grain that possesses a high level of visible sprout will display moderately elevated lactic acid SRCs. Grain that has early beginnings of internal sprout (low alpha-amylase activity) will display greatly elevated levels of lactic acid SRCs. Shriveled grain will reduce the lactic acid SRC values, therefore masking the true potential of the strength of the gluten.

Lactic Acid SRC, Cont'd.
The moisture content of milled grain is extremely important, especially if a very simple mill such as the Quadrumat Junior is utilized. As the moisture content of the grain approaches 10%, the flour lactic acid SRCs are compressed so that there is almost no difference between a strong-gluten and a weak-gluten cultivar. At 15% grain moisture level, there will be nearly 40 percentage points difference in flour lactic acid SRCs between the strong- and weak-gluten cultivars. The SWQL Quadrumat Junior milled flour from Pioneer 25R26 and Reed (AC) would be examples of the 40 percentage points range in lactic acid SRC. The lactic acid SRCs from the milled flours of the weak-gluten cultivars (between 10% and 15% grain moisture) are unaffected by moisture level regardless of the quantity of bran in the flour. However, as the bran contamination in the flour increases due to lower grain moisture, the flour lactic acid SRCs of the strong-gluten wheats are severely reduced.

Lactic acid SRCs of a given cultivar increase as flour protein increases. There is a nearly 7 percentage point change in lactic acid SRC per 1 percentage point change in flour protein.

Adverse environmental conditions will also influence the degree to which the lactic acid SRC test predicts gluten strength. For instance, we have observed that as scab damage increases in grain, lactic acid SRCs of their flours decrease. Robert Bequette reported that severe leaf disease infection greatly reduced the mixing time on a mixograph. Bequette also referenced a paper presented by John Bernardin of the US Regional Research Center at Albany, CA, which stated that synthesis of the glutenin fraction of the gluten ceases at high climatic temperatures.

Karl Finney showed in 1987 that mixing requirement is primarily controlled by glutenin quality. Thus, it could be deduced that some diseases and heat damage likely will reduce the lactic acid SRCs. However, Wooster, Ohio experienced heavy leaf diseases in 2003 and again in 2004, but Pioneer 25R26 lactic acid SRC paralleled the mixogram from 2002 when ideal weather conditions prevailed. The flour proteins were the same.

Lactic Acid SRC, Cont'd.
Two lactic acid SRC databases have been in the developmental process since 2000. That data was generated on the Allis-Chalmers mill and the laboratory-built Quadrumat Sr. mill. A third database was recently established for small samples milled on the Quadrumat Jr.mill. Databases may help ascertain the degree of consistency for lactic acid SRC within cultivars grown in many diverse environments and free from weather damage. The Allis-Chalmers lactic acid SRC data suggest a high degree of uniformity across environments. Only weather-damaged-free cultivars are milled on the Allis-Chalmers milling system. All breeder-submitted samples are milled on the Quadrumat mill, including weather-damaged wheat. Therefore, the range in lactic acid SRCs within a cultivar is expanded.

In Wooster, Ohio, 2003, it rained eleven days between June 30 and July 17, which delayed harvest until the middle of July. About the first week in July would have been the normal time to harvest. Although there was no visible sprout, subsequent milling analysis indicated the cultivars were damaged for milling. In a limited study, a few cultivars were analyzed for lactic acid SRC and falling number. The lactic acid SRC for each cultivar was compared to the Allis-Chalmers database to determine the normal value. The increase in lactic acid SRC of the 2003-grown cultivars varied between 9.8% and 34.2%. A superior milling cultivar, Foster, had the smallest increase while the highest protein cultivar, Beau, increased the most.

The possibility arose that the lactic acid SRC assay was predicting alpha-amylase activity. However, falling number determinations on the flour yielded average values across cultivars of 442 seconds. That data paralleled the falling number values across cultivars for the 2000 crop in Wooster when adverse weather damaged the wheat for milling. Those falling numbers averaged 433 seconds. (The values for both years were considered to be normal for sound wheat. SWQL studies have indicated that the falling number test is extremely sensitive and can detect very low levels of alpha-amylase activity.)

It is not known why lactic acid SRCs become elevated when excessive wet weather occurs at or near harvest time. The SWQL evaluation program attempts to identify breeder entries that display higher than normal lactic acid percentages with respect to known standards. That information is given to those involved with the breeding program. Standard cultivars that were grown under the same circumstances as the test lines should always be included.

The following tables will identify stronger-gluten strength cultivars and weaker-gluten strength cultivars. The cultivars listed are thought to be free from weather damage.

Table 17. Relationship between lactic acid SRC and SWQL mixograph score.

Allis-Chalmers Lactic Acid SRC (%) (Adjusted to 9% Protein)	Mixograph score	Allis-Chalmers Lactic Acid SRC (%) (Adjusted to 9% Protein)	Mixograph score
126 -	8	85 – 94	4
115 – 125	7	78 – 84	3
104 – 114	6	67 – 77	2
95 – 103	5	< 67	1

Table 18. Weak gluten cultivars.

Cultivar	Lactic acid SRC (%)	Cultivar	Lactic acid SRC (%)
Rural New Yorker No. 57 *	57	H 101	73
Dawson Golden Chaff *	60	Winter King *	73
Genesee	62	AG 2020 (Ag Alumni Seed)	74
Redwave *	64	INW 0316	74
Reed (AC)	65	Wheeler	74
Potomac	66	Kent (AC)	75
Goldberg	66	RW 1480 (Andersons)	75
FFR 558	66	Stine 480 (hybrid?)	75
INW 0304	67	MacKinnon (AC)	75
Bowie *	67	Gordon	75
Pettit (soft white spring)	68	Newcaster *	75
SC 1330 (Seed Consult.)	69	RS 931 (Rupp Seeds)	76
USG 3342 (Unisouth Genetics)	69	W 109 (Wellman)	76
Benton (AgriPro)	70	Red Indian *	76
Honey (AGRA)	70	Patton (AgriPro)	77
Autumn (MCIA)	70	Sabbe	77
W 101 (Wilkens)	71	W 9920 (Wellman)	78
Emmit	71	Pioneer 25W60	78
AGI 525 (Advanced Genetics)	72	OAC 104 *	78
W 115 (Wellman)	72	Leapland *	78
Adder	72	Pryer (Steyer Seeds)	78
INW 9824	72	Clark	78

*Lactic acid SRC adjusted to 9% flour protein basis.

Table 19. Strong gluten cultivars.

Cultivar	Lactic acid SRC (%)	Cultivar	Lactic acid SRC (%)
Arise W34	133	Gator (Sunbeam Extract)	112
FFR 36803	124	Stine 902	111
Vigoro 9222 (Royster-Clark)	124	Coker 9803	111
AGS 2060	123	Pike	111
Pioneer 25R26	121	Wilson	111
Warrior (Arone PS)	121	VA 97W-469	110
Key	120	Hardired (Coker)(Nat'l Collec)[n]	110
Feck (Steyer Seeds)	119	Pioneer 25W33	110
AGI 301 (Advanced Genetics)	119	Coker 9474	110
Renwood 3260 (VPI)	118	Gibson (AgriPro)	110
Navigator	118	Jackson	110
Pioneer 26R15	116	Renwood 3706 (VPI)	110
Pioneer 25R44	116	FS 539 (IL Imp Assoc)	109
Carlisle (C&M Seeds)	115	SR 219 (Terra)	109
Jacob (Steyer Seeds)	115	Vigoro 9510 (Royster-Clark)	109
Rachel	115	AG 2012 (Ag Alumini Seed)	109
Warwick (Hyland)	114	Pioneer 2553	109
Venture (Genesis Brand)	114	Vigoro 9412	108
Campbell 9455 (Campbell Seed)	114	INW 0102	108
Raven #2 (Ebberts)	113	Wisdom (Hyland)	108
Elkhart	112	Beretta (AgriPro)	107
Pioneer 2643	112	Tribute	107

*Lactic acid SRC adjusted to 9% flour protein basis.

Notes

a) Pooled standard deviation was generated from 15 cultivars where the number of observations per cultivar ranged from 8 to 21. There were several years and locations represented within each cultivar. However, the mill score standard deviation will be about 1.43 when evaluating cultivars and test lines that have been grown and harvested together.

b) The “No. for Avg.” represents the number of different samples that have been milled to date. The “No. for Avg.” may not parallel the actual number of determinations for individual quality traits. In the case of gluten strength, lactic acid solvent retention capacity evaluation has been a recently employed test. Friability, a milling parameter, cannot be directly calculated for millings prior to 1984. Some samples have been eliminated for milling quality if there were a question concerning marginal grain condition due to shriveling or weather damage.

c) The normalized test weight tables will indicate those cultivars where there was a degree of uncertainty.

d) 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%.

e) Endosperm Separation Index (ESI). The quantity 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. Therefore, the lower the E.S.I. value is the better the wheat is for milling; thus, less energy is consumed in producing straight-grade flour.

f) 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 will fall into this category. Those cultivars displaying friabilities below 27% usually reflect very poor reduction of middling stock on the smooth rolls.

A cultivar with a friability of 25% would exhibit about a 15% increase in the amount of stock which enters the corrugated and smooth rolls of the SWQL Allis-Chalmers mill if contrasted with another cultivar with a friability of 30%. If we could project 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 a cultivar with a friability of 25% and 156,000 # of stock for a cultivar with a friability of 30%. The cultivar with a friability of 25% would also yield about 3.5% less flour.

Cultivars possessing low milling quality produce middling stocks which after being crushed on the smooth rolls do not release flour well. That results 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.

g) Cookie spread determined within a location is a reliable indicator of 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. However, it has been determined that the average cookie spread for three different examples of a cultivar will be representative of that wheat. In previous years, + average, average, and – average were assigned to cultivars for cookie spread evaluation. Those values were designated based on the particular cultivars comparison to known standards within the particular location. Cultivars with larger cookie spreads tend to release moisture efficiently during the baking process due to lower Alkaline Water Retention Capacity (AWRC) while cultivars yielding smaller diameter cookies tend to be higher in AWRC and hold the moisture longer during baking. The historic correlation between cookie diameter and AWRC within soft wheat historically has been about .4. However, the inclusion of older "historic" varieties that are low in AWRC but exhibiting very small cookie spreads has reduced the statistical relationship to about .23 correlation. (The older varieties can be two to three percentage points higher in protein content which can greatly contribute to reduced cookie spread. AWRC is unaffected by protein level.)

   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. A poor milling cultivar that would be coarse in granulation rarely have acceptable cookie baking quality.

h) Flour protein differences among cultivars can be a reliable indicator of genetic variation provided the varieties are grown together. Flour protein can vary from year to year at any given location. Based on the Soft Wheat Quality Laboratory grow-outs, protein can vary as much 1.5 percentage points for a cultivar grown at various locations in the same ½ acre field. Flour protein that was very low (6%) would permit greater expansion in sugar-snap cookie baking. Flour protein that was 8% to 9% would be representative of wheat geneticist's submitted samples and SWQL grow-out cultivars. As flour protein increases, the expansive capability of the cookie during the baking process will be inhibited. Flour protein from a single non-composite sample may not be representative.

i) Protein quality is an evaluation of "elasticity" or strength of the gluten. It is not protein quantity. A cultivar could possess a low quantity of protein and exhibit strong gluten strength. It is thought that gluten strength is desirable for cracker production. Measurement of that strength has been on a scale of 1-8. A value of 8 would be very strong whereas a value of 1 would be extremely weak. Soft wheat flours that are about 8.5% protein and lower can be challenging in trying to evaluate gluten strength on the mixograph.

j) 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.

Note: Wet weather at harvest time will lower test weights, lower grain density, can greatly increase the softness of the kernel and the flour usually will produce larger cookie spread, yet not affect milling-yield potential. Throughput at the 1st-break rolls is diminished with weathered wheat. However, since the wheat is softer there would be an increase in break-flour yield and less middling stock 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 test weights in excess of 60# / bushel while weathered, unsprouted, non-shriveled wheat can display 57# / bushel test weight after aspiration to remove shriveled grain. Wheat can possess alpha-amylase activity while displaying no visual indication of sprouting. There has been evidence that moderate infection of leaf diseases do not affect milling properties once damaged (shriveled) kernels have been removed. However, baking quality of sugar snap cookies may be affected. Cultivars known to have reduced milling quality due to weathering are not included in the data.

k) Cultivars equal to or softer than Batavia, Caldwell, Cayuga, Coker 9835, Hopewell, and Pioneer 25R57 when grown under similar conditions.

l) Cultivars that are at least 9 percentage points below Caldwell break-flour yield (Allis-Chalmers Mill). Arthur, Beck 109, Coker 9663, Pioneer 25W60, Podach and Tribute are cultivars that would belong in that category.

m) Coker 47-27 was acquired from North Carolina in 1991 and appeared to be different from the Coker 47-27 acquired from the National Small Grains Collection.

n) Hardired was acquired from North Carolina in 1991 and has produced quality data greatly different from the Hardired acquired from the National Small Grains Collection. Both examples appear to be visually identical, appearance-wise, in the field.

o) Rex is a soft white winter wheat from Oregon released in 1933. Literature of the era indicated that Rex had poor milling properties. A sample of Rex was acquired from the National Small Grains Collection and was grown in Wooster, Ohio, where it produced good quality grain. Our intent in acquiring Rex was to determine the accuracy of a 1930’s evaluation. A SWQL Allis-Chalmers milling of Rex indicated it to be extremely poor in milling quality.