Proposal for Variety Release

OK03918C

Hard Red Winter Wheat

…for the Clearfield Production System

Submitted by OSU's
Wheat Improvement Team

OSU Division of AGRICULTURAL SCIENCES & NATURAL RESOURCES

Acknowledgments

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Oklahoma Agricultural Experiment Station
Oklahoma Wheat Commission
and the
Oklahoma Wheat Research Foundation.

The development and release of this cultivar embraces the mission of OSU's Division of Agricultural Sciences and Natural Resources to stimulate progress in Oklahoma's wheat industry.

The WIT also acknowledges the following individuals who supported the development and characterization of OK03918C:

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Experimental Designation

OK03918C, Hard Red Winter Wheat, *Triticum aestivum* L.(see Exhibit 1 for USDA-GIPSA classification)

Proposed Name

Centerfield, cleared for use by USDA, Marketing and Regulatory Programs, Seed Regulatory & Testing Branch on 16 February 2006

Origination and Breeding Procedure

OK03918C is an F_2-derived line currently in the F_8 generation (2005-2006 crop year). It was selected from the single cross, (TXGH12588-105*4/FS4)/2*2174. The experimental line TXGH12588-105 was eventually released as TAM 110 in 1996 by the Texas Agric. Exp. Stn. It served as the recurrent parent in a backcrossing program conducted by scientists at Texas A&M University to introgress the *AhasL-D1* gene from a mutant selection, FS4, of the French wheat cultivar, Fidel. This gene resides on the long arm of chromosome 6D and confers resistance to the imidazolinone herbicide, imazamox, that is absent in wild-type (non-mutated) wheat. Under a material-transfer agreement between Oklahoma State University and American Cyanamid Co., Dr. Tom Peeper acquired F_2 seedstock with the pedigree TXGH12588-105*4/FS4 in the fall of 1996. Single plants were selected in the greenhouse in the seedling stage for survival to a commercial rate (1x=4 oz/ac or 0.04 lb ai/ac) of imazamox. Several survivors were crossed with HBZ374C, a HRW wheat line eventually released by OSU in 1997 as 2174. The F_1 hybrid was backcrossed to 2174 in 1998 by Wayne Whitmore, Senior Agriculturalist for the Wheat Genetics research program conducted by Dr. Brett Carver. The BC_1F_1 seed were given the cross number of 98cx140.

The BC_1F_1 plant generation (about 10 plants) was grown in the greenhouse at Stillwater in 1999 and harvested in bulk from plot 99G1240. In 2000, the F_2 generation was advanced at Stillwater in field plot 001139005 and treated in March 2000 with a 2x commercial rate of imazamox. Single heads were harvested from surviving plants. OK03918C traces to a single $BC_1F_{2:3}$ head row selected at Stillwater in 2001 from plot 001156050-02 on the basis of tolerance to a 2x commercial rate of imazamox, plant and head type, maturity, and kernel size and uniformity. The $F_{2:4}$ head-row progeny was then evaluated in the 2002 Dual-Purpose Observation Nursery (DPON) using an augmented experimental design at Stillwater (dual-purpose management system) and Lahoma (grain-only system). This nursery, with exception of the replicated checks, was treated with imazamox (6 fluid oz./acre) on 15 March 2002. Compared with untreated neighboring plots of the check cultivar Ok101, OK03918C showed a 6 bu/ac yield advantage and a test weight advantage of 1 lb/bu, a hardness index of 69 units (+16 units), and a wheat protein content of 13.7% (+0.5 percentage units). This line showed a high proportion of spring-type plants, or plants with very low vernalization requirement (a feature all too common during the early stages of the OSU-CLEARFIELD breeding effort), that have since been removed in subsequent generations. What kept this line from being discarded in 2002 was its exceptional stay-green potential of the flag leaf and high yield potential of plants that were not winter-killed.

From 2002 to 2005, OK03918C was evaluated in the following replicated yield trials, representing 49 site-years in Oklahoma plus additional sites in neighboring states:

Replicated Yield Trials 1 (RYT1-IMI)	2002-2003
Oklahoma Elite Nursery 1 (OET1-IMI)	2003-2004
Oklahoma Elite Nursery 2 (OET2)	2004-2005
BASF Qualification Trials	2004-2005

It is currently being evaluated in the 2006 Wheat Variety Trials (WVT). End-use quality was externally examined by the USDA-ARS Hard Winter Wheat Quality Laboratory (HWWQL) in Manhattan, KS and was entered in the 2005 Hard Winter Wheat Milling and Baking Evaluation Program sponsored by the Wheat Quality Council. The BASF Qualification Trials were conducted according to CLEARFIELD Wheat Variety Qualification Protocol W-21. Two additional trials will be completed in 2006, but the results from four trials in 2005 affirm the required level of commercial tolerance to Beyond herbicide for commercialization of OK03918C.

Breeder-seed multiplication and off-type removal occurred in 2004 and 2005 at Goodwell, OK and Yuma, AZ, respectively. The 2005 increase produced approximately 100 bu breeder seed, from which about 6 bu of cleaned seed were planted for foundation seed production during the 2005-2006 crop year.

Description and Performance

Agronomic and quality assessment was based primarily on results from local breeder trials across Oklahoma. Comparisons in the breeder trials were directed at 2174, one of the parents of OK03918C, or Ok102, an improved descendent of 2174. Above and its sister selection, AP502CL, provided a comparison to relevant and adapted CLEARFIELD (hereafter abbreviated CL) cultivars. Above was tested only in 2003 and was replaced with AP502CL in years thereafter. We have not observed a substantive difference in their performance patterns, so comparisons to them were made interchangeably in this proposal. Wherever possible, Endurance served as a more contemporary comparison to assess the level of genetic improvement over a recent HRW release.

Grain yield performance

Across 22 site-years in breeder trials, OK03918C averaged 49 bu/ac, or about 2 to 3 bu/ac higher than current CL cultivars (Table 1). Only under severe drought stress in the spring of 2004 did the CL check exceed the yield of OK03918C. The following year (2005) was plagued with a severe stripe rust infection, which apparently favored OK03918C as it performed in a comparable yield range as non-CL cultivars. Strictly based on statewide yield performance, OK03918C offers a step up from Okfield and AP502CL or Above.

This advantage was accentuated when restricting comparisons to the central corridor sites extending from Ft. Cobb to Winfield, KS. Even with its poorer performance in the drought-stressed year of 2004, OK03918C held a distinct three-year

advantage **(**4 bu/ac or 9%) over AP502CL or Above (Table 2). Contrary to historical records, AP502CL actually performed better than most cultivars in north central OK in 2004, a year that catered to a TAM 110 or a TAM 110-related background. The only locale where OK03918C failed to consistently surpass AP502CL or Above was at Ft. Cobb, located in the southernmost area of the aforementioned sites; hence, further north, the average yield differential would have well exceeded 4 bu/ac.

The BASF Uniform Qualification Trials were intended to provide direct comparisons of candidate-CL cultivars from various breeding programs in a common set of Great Plains environments in the presence (1x to 2x commercial rate) or absence of imazamox. Yield results were generated at one location each in Oklahoma, Colorado, Kansas, and Nebraska in 2005 (Table 3). As expected, neither the check cultivar, Above, nor OK03918C showed visible signs of herbicide injury. At three of the four sites, OK03918C easily surpassed the yield of Above, for a mean yield differential of almost 13 bu/ac. Part of this differential can be attributed to WSBMV and WSSMV resistance that was potentially expressed at Lahoma and Lincoln. Another contributing factor was stripe rust, present at all locations.

In summarizing the grain yield results, OK03918C offers excellent yield performance throughout central and western Oklahoma, independent of its resistance to imazamox. Insufficient evidence precludes a definitive description of adaptation to dual-purpose systems that emphasize grain production following grazing, though it is not perceived to outperform Okfield in that situation. OK03918C should complement Okfield by excelling in areas where Okfield does not. Those areas would extend throughout central Oklahoma particularly hindered by WSBMV/WSSMV.

Test weight

Test weight is a characteristic in critical need of improvement among all CL cultivars currently available in Oklahoma. Okfield is no exception. OK03918C provides significant improvement, as it resembles 2174 and Ok102 more than it resembles AP502CL, Above, or Okfield. Across 19 sites since 2003, it has exceeded the test weight of AP502CL and Above by 2.3 lb/bu (Table 4). We expect OK03918C to perform similar to current non-CL cultivars. The additional backcross to 2174 apparently enabled recovery of a market-preferred level of test weight.

Dual-purpose pasture profile

Although limited observations have been made on vegetative characteristics of OK03918C, we can cautiously summarize the data collected from the 2003-2004, 2004-2005, and 2005-2006 seasons. Based on opportunistic field readings of emergence under early-planted conditions, OK03918C shows strong high-temperature sensitivity similar to 2174, Ok102, Okfield, and Overley. On a scale of 1 (accelerated germination) to 5 (delayed germination), its score is about 4. Stand establishment will likely be delayed for OK03918C when planted extremely early or in hot soils compared with rapidly emerging cultivars such as Jagger, Ok101, and OK Bullet. Forage accumulation, or rate of canopy closure, has been observed to be above-average for OK03918C; hence it has good “catch-up” ability in a pasture management system.

Visual observations of forage accumulation during the vegetative period are

typically evaluated on a 1 (accelerated canopy closure) to 5 (highly retarded growth) scale. Multiple statewide ratings collected during the fall of 2004 averaged 2.0 for OK03918C and 3.4 for AP502CL; respective readings collected during the fall of 2005 were 2.3 and 2.7. Combined with a semi-erect growth habit (slightly more erect than Ok101 but less erect than 2174) and a coarse leaf texture (similar to Jagalene and Overley but more coarse than AP502CL), OK03918C possesses acceptable characteristics for wheat pasture utilization. In addition to observations in the field which indicate a desirable level of winter dormancy retention, OK03918C reached first-hollow-stem (FHS) stage in 2006 on 7 March, the same day as Okfield. AP502CL reached FHS stage six days earlier, whereas 2174 reached FHS stage three days later. Hence, OK02918C is considered moderately late for FHS stage – a desirable attribute when combined with timely heading and flowering.

Other agronomic attributes

OK03918C reaches the heading stage about the same time as non-CL cultivars with intermediate maturity. AP502CL is one of the earliest hard winter wheat cultivars. It reached heading 5 d earlier than OK03918C, which is still 2 d earlier than Okfield (Table 5). OK03918C maintains a functional and healthy flag leaf longer than most cultivars and substantially longer than AP502CL based on green-leaf retention scores (Table 5). In several environments, the flag leaf of AP502CL or Above was completely necrotic (score = 9) while the flag leaf of OK03918C was mostly green to partially chlorotic (score = 5-6). Foliar diseases, such as leaf or stripe rust, tend to force premature senescence of flag leaves of AP502CL noticeably sooner than OK03918C.

OK03918C is a moderately tall semidwarf wheat, or intermediate to AP502CL/Above (2 cm shorter) and Okfield (2 cm taller) (Table 6). With limited observations since 2004, it appears to have recovered the high straw strength and lodging resistance of 2174. It is far superior to current CL cultivars and it may offer slight improvement over Okfield. OK03918C is moderately tolerant to acidic soils. On a scale of 1 (tolerant) to 5 (highly susceptible) under critically low pH and high aluminum toxicity, OK03918C has scored 2.1, which places it in a category less tolerant than Endurance (score=1.3) but substantially more tolerant than AP502CL/Above (score=4.8) (Table 7). This level of tolerance allows OK03918C to be positioned in central areas of Oklahoma where current CL cultivars are not recommended.

Disease and insect reactions

One feature that distinguishes this candidate from previously released CL cultivars is its yielding ability in environments known to have wheat soilborne mosaic virus (WSBMV) and wheat spindle streak mosaic virus (WSSMV). Resistance to these diseases is a high priority for breeding all cultivars in our program; no less was that priority in selecting OK03918C, though its resistance rating is not as strong as Ok102 and 2174. The adaptation ranges for Okfield and OK03918C are very similar--as expected given their similar pedigrees--but OK03918C will fill a void left by Okfield, particularly in north central Oklahoma where these diseases persist. While considerble improvement in resistance to leaf and stripe rust was achieved in this candidate compared with current CL cultivars, further improvement will remain a priority in future

OSU-CL cultivar development. See Exhibit 2 for a detailed summary by Dr. R.M. Hunger for these and other disease reactions. Additional readings collected in breeder nurseries in 2005 (no symptoms observable in breeding nurseries in 2006) are summarized below for WSBMV/WSSMV, and leaf and stripe rusts. Our most recent observation on leaf rust reaction in south Texas (24 April 2006), where leaf rust pressure was moderately severe, was "resistant", with a score of 1 on a scale of 0 (immune) to 9 (highly susceptible).

Disease	**OK03918C**	**AP502CL**	**Scale**	**No. of sites**
WSBMV/WSSMV	2.0	3.0	1 to 4	2
Leaf rust	2.5	4.0	1 to 4	4
Stripe rust	1.3	2.7	0 to 4	7

The following ratings provide a compilation of Exhibit 2.

Disease	**Reaction**
Leaf rust (adult-plant)	Moderately to highly resistant
Leaf rust (seedling)	Susceptible
Stripe rust (adult plant)	Moderately resistant
Stripe rust (seedling)	Moderately resistant
Stem rust (seedling)	Unknown
Wheat soilborne mosaic	Resistant
Wheat spindle streak mosaic virus	Resistant
Barley yellow dwarf virus	Mod. tolerant (slightly less tolerant than Okfield)
Septoria leaf blotch	Moderately susceptible
Tan spot	Susceptible
Powdery mildew (adult)	Intermediate

OK03918C is heterogeneous for reaction to biotype E greenbug. Our most recent survey indicates it segregates 46% resistant:54% susceptible (data provided by C. Baker, USDA-ARS, Stillwater). In seedling assays, OK03918C is susceptible to Biotypes 1 and 2 of Russian wheat aphid, but seedling reaction to Hessian fly is unknown. However, a significant spring infestation of Hessian fly infestation in 2005 produced an adult-plant rating for OK03918C of 1.5 (highly tolerant) on a scale of 1 (resistant) to 5 (highly susceptible), a reading similar to that observed for cultivars with known field resistance such as Ok102, 2174, and Chisholm.

Grain quality

Milling performance. Large and consistent kernel size is a desirable attribute to the milling industry, both for domestic and international markets. We evaluated kernel size by: i) determining large-kernel fraction as the weight of kernels retained on a No. 7 screen from a 200-g sample sifted with a RoTap machine for two minutes, and ii) kernel weight and kernel diameter measurements generated by the single-kernel characterization system (SKCS).

An obvious reflection of the severe stripe rust infection that occurred in 2005 can be found in the data for large-kernel fraction, kernel weight, and kernel diameter. Genotypes suffering the most damage also suffered the greatest decline in those parameters from previous years. OK03918C showed only modest declines in kernel size and weight in 2005 compared to previous years (Table 8). The CL checks suffered larger declines. Moreover, OK03918C had greater large-kernel fraction, TKW, and kernel diameter than the CL check in 2005 (a mean increase of 16%), whereas in previous years, those differences generally did not exist. Altogether, OK03918C possesses kernel size and shape characteristics consistent with high milling quality. On our experimental mill, however, we were unable to detect a significant difference in straight-grade flour yield between OK03918C and the CL check. Most CL varieties tend to have below-target levels of flour yield, including Okfield, but the values in Table 8 indicate the flour yield of OK03918C is headed in a desirable direction. This was substantiated by milling tests conducted by the USDA-ARS-HWWQL in Manhattan, KS (Exhibit 3) and ConAgra Foods, Inc. in Omaha NE (Exhibit 4), though OK03918C has lower flour yield than non-CL OSU cultivars (Exhibit 3).

Kernel texture, or hardness, can influence milling performance if too soft, or in some cases, if too hard. OK03918C has an optimal degree of kernel hardness, either based on resistance to crushing (SKCS, mean index of 71) or ground particle size estimated by NIR spectroscopy (mean index of 80) (Table 9). It also showed greater hardness than the CL check, with mean indices of 57 and 73, respectively. In summary, we would position the milling quality of OK03918C between AP502CL and non-CL cultivars with optimal milling performance such as Endurance.

Protein content. Wheat and flour protein content averaged 13.0% and 10.4% across 14 environments statewide, or about one percentage unit higher than AP502CL/Above (Table 10). Consistent with its lower flour yield, OK03918C was indistinguishable from the high-protein cultivars, 2174 and Ok102, in wheat protein, yet it tended to drop off in flour protein. Compared with 2174 and Ok102, OK03918C may have poorer separation of the higher protein bran layers, subsequently leading to loss of protein in the bran fraction and associated endosperm. Nevertheless, OK03918C has moderately high protein content and provides significant improvement over current CL cultivars, including Okfield (Exhibits 3 and 4).

Dough strength. Flour quality and dough strength were further evaluated based on three years of mixograph and two years of farinograph performance. Mixograph mixing time of OK03918C was optimal (4.2 min) and 1.0 minute longer than the CL check (Table 11). It also produces an acceptable mixogram that is wider at two minutes past peak dough development than the CL check. This may indicate greater strength in OK03918C, though not substantiated in the stability values that quantify the degree of mixogram curve ascent and descent. Larger values indicate greater ascent or descent and thus lower strength. We generally found no qualitative differences in mixograph performance among OK03918C, 2174, Ok102, and Endurance. The analysis provided by USDA-ARS at Manhattan (2005 crop only) indicated similar mixing tolerance between OK03918C and Endurance but weaker than other cultivars with historically high strength, such as Deliver and OK Bullet (Exhibit 3).

This dough strength pattern was mirrored in farinograph performance; however, the peak time results were generally too long and perhaps a function of low flour protein in these samples (Table 12). Low flour protein prohibits proper dough formation with

low energy input of the farinograph mixer. The absorption values are quite valid and indicate relatively good absorption for OK03918C. None of the five non-CL checks approached the absorption of OK03918C in 2005. The stability values (higher values indicate greater strength) were well above the targeted threshold of 10 min and thus did not discriminate among entries well.

The high farinograph absorption for OK03918C was further endorsed by high bake absorption (64.5%) in 2005 (Table 13). Strong performance in loaf volume and internal visual characteristics such as crumb grain and color placed OK03918C in the same bread baking quality class as the non-CL checks, and several points ahead of AP502CL. The crumb grain score produced in the USDA-ARS analysis was not as favorable, but their assessment of loaf volume was highly consistent (Exhibit 3). Based on these results and the quality profile provided by ConAgra (Exhibit 4), OK03918C should be acceptable for pan bread production.

Summary Justification

Cultivars featuring the imidazolinone-resistance trait at the single-gene dosage level are currently limited to AP502CL and Above, but several more are coming on board from neighboring state breeding programs. Those include Bond CL and Protection CL from Colorado, Infinity CL from Nebraska, and Okfield from Oklahoma. Except for Okfield's release in 2005, wheat producers in Oklahoma are virtually limited to AP502CL due to restricted seed availability or the lack of effective adaptation or disease resistance of other choices.

While the addition of Okfield adds a critical dimension to cultivar diversity in the CLEARFIELD pool, Oklahoma wheat producers will nevertheless need more choices with local adaptation and acceptable end-use quality should the CLEARFIELD management system gain wider acceptance. OK03918C offers a viable alternative to Okfield and either AP502CL or Above in central areas of Oklahoma, at a equivalent level of resistance to imazamox. OK03918C will likely complement Okfield rather than displace it, because Okfield still fills a critical need in western Oklahoma, particularly in areas that traditionally support winter grazing. OK03918C is expected to be highly suitable in commercial, large-scale baking operations.

Probable Area of Adaptation and Limitations

OK03918C is widely adapted to Oklahoma and combines into one cultivar the primary adaptation zones ascribed to AP502CL (western Oklahoma) and 2174 (central Oklahoma). It will be primarily positioned for the north central and central portions of the state prone to acquire wheat soilborne mosaic and spindle streak mosaic virus and low–pH areas prone to aluminum toxicity.

OK03918C, like Okfield, will not only appeal to grain-only producers but also to dual-purpose producers who place greater emphasis on winter grazing potential and grain production. Forage accumulation in the early fall is above-average, but we do not recommend extremely early seeding of OK03918C due to its heat sensitivity during germination (similar to 2174).

Varietal Replacement

Cultivar	Superior attribute of OK03918C justifying replacement
Above/AP502CL	Adaptation range readily extends into central Oklahoma Green-leaf retention Tolerance to leaf rust and stripe rust Large kernel size at a substantially higher test weight Later FHS and longer winter grazing potential Recovery from grazing and grain yield in dual-purpose system
Okfield	Tolerance to WSBMV and WSSMV Acid-soil tolerance Leaf rust resistance Test weight Slight improvement in forage accumulation (visual assessment only)
2174	Imidazolinone resistance Broader adaptation range into western Oklahoma

Seed Increase Status

About 5 ac of OK03918C was planted for foundation seed production by OKFSS Inc. in Stillwater in the fall of 2005, with the anticipation of producing approximately 150 bu foundation seed for distribution in the summer of 2006. Foundation seed production was scaled back after dismal interest shown in Okfield and all CL cultivars in 2005 in Oklahoma. About 5 bu breeder seed will be re-generated at Goodwell during the 2005-2006 crop year.

Pedigreed Classes

Recommended classes of seed production are Breeder, Foundation, Registered, and Certified.

Proposed Method of Release

A restricted release consistent with terms agreed upon by BASF and the Oklahoma Agric. Exp. Stn. is anticipated, and application for plant variety protection will be filed in early 2007.

Cooperating Scientists

Identification of OK03918C as a candidate cultivar was accomplished through OSU's Wheat Improvement Team, which includes Brett Carver (lead scientist), Bob

Hunger, Art Klatt, Dave Porter, Jeanmarie Vercot-Lubicz, Patricia Rayas-Duarte, Bjorn Martin, Kris Giles, and Tom Royer. Special assistance was provided by Tom Peeper in securing and validating the herbicide resistance trait. Also cooperating in the testing of OK03918C were breeders throughout the Great Plains associated with the Hard Winter Wheat Performance Nursery Program. They represent state Agricultural Experiment Stations, the USDA-ARS, and private companies. Without their cooperation, this release would not have been possible.

Table 1. Mean grain yield recorded in breeder trials, 2003 to 2005 (*n* sites per year).

Entry	2003 RYT1 (*5*)	2004 OET1 (*6*)	2005 OET2 (*11*)	Weighted yield superiority of OK03918C[†]
	---------- bu/ac ----------			
OK03918C	**58.1**	**56.2**	**41.4**	**—**
Okfield	—	—	38.4	+3.0[‡]
AP502CL/Above	57.0	57.0	37.5	+2.0[‡]
2174	58.9	—	—	-0.8
Endurance	—	—	43.7	-2.3
Ok102	56.5	55.4	35.1	+3.7
Nursery mean	55.8	52.6	41.7	+1.4
LSD (0.05)	7.0	6.5	4.2	—

† $\frac{\sum f_i(\overline{X}_{OK03918C} - \overline{X}_C)_i}{\sum f_i}$, where f_i = no. of sites in year *i*, and $\overline{X}_{OK03918C}$ and $\overline{X}_C$ are means for OK03918C and comparison check cultivar, respectively, in year *i* which both were evaluated

‡Indicates the yield of OK03918C exceeded the yield of Okfield by 3.0 bu/ac and the yield of AP502CL/Above by 2.0 bu/ac

Table 2. Mean grain yield recorded in breeder trials conducted in central-corridor locations (Ft. Cobb to Winfield, KS), 2003-2005 (*n* sites per year).

Entry	2003 RYT1 (*2*)	2004 OET1 (*3*)	2005 OET2 (*6*)	Across years[†] (*11*)[‡]
	---------- bu/ac ----------			
OK03918C	**52.1**	**53.6**	**40.8**	**46.3**
AP502CL/Above	39.0	60.6	34.5	42.4
Nursery mean	46.4	54.2	40.0	45.0
LSD (0.05)	7.6	5.5	5.1	—

[†] Weighted mean based on number of sites per year

[‡] Locations include, from south to north, Ft. Cobb, El Reno (DP), Marshall (GO, DP), Lahoma, and Winfield

Table 3. Regional grain yield comparisons from the 2005 BASF Qualification Trials (15 entries) at variable rates of Beyond herbicide.

Entry	Rate	Lahoma, OK	Haven, KS	Lincoln, NE	Ft. Collins, CO	Across location
		---------- bu/ac ----------				
OK03918C	Control	45.6	NA	82.3	69.2	
	1X	44.6		73.2	64.1	
	2X	50.5		81.2	76.5	
OK03918C	**Overall**	**46.9**	**58.4**	**78.9**	**69.9**	**63.5**
Above	Control	35.6	NA	69.7	35.4	
	1X	32.0		73.7	30.8	
	2X	33.3		71.3	40.3	
Above	**Overall**	**33.6**	**62.9**	**71.6**	**35.5**	**50.9**
Nursery mean[†]		35.1	61.5	76.2	58.6	57.9
LSD (0.05)[‡]		2.9	4.7	6.8	8.8	—

[†] Contains 13 other experimental lines from breeding programs in Oklahoma, Colorado, Kansas, Nebraska, and at WestBred (Kansas).

[‡] For comparison of overall means for OK03918C vs. Above.

Table 4. Mean test weight recorded in breeder trials, 2003 to 2005 (*n* sites per year).

Entry	2003 RYT1 (*4*)	2004 OET1 (*4*)	2005 OET2 (*11*)	Weighted differential of OK03918C[†]
	---------- lb/bu ----------			
OK03918C	**59.3**	**58.4**	**58.3**	**58.5**
Okfield	—	—	57.1	+1.4[‡]
AP502CL/Above	57.9	56.8	55.4	+2.3
Ok102	59.9	59.0	57.9	0.0
2174	59.7	—	—	-0.4
Endurance	—	—	57.8	+0.5
Nursery mean	58.7	58.1	58.2	+0.2
LSD (0.05)	1.0	0.7	0.8	—

† $\frac{\sum f_i(\overline{X}_{OK03918C} - \overline{X}_C)_i}{\sum f_i}$, where f_i = no. of sites in year *i*, and $\overline{X}_{OK03918C}$ and $\overline{X}_C$ are means for OK03918C and comparison check cultivar, respectively, in year *i* which both were evaluated.

‡ Positive differentials indicate OK03918C had higher test wt. by the amount indicated.

Table 5. Deviation from the nursery mean for heading date (expressed as days after 31 March; *n* sites per year), estimated heading date, and stay-green ratings from breeder trials, 2003-2005.

Entry	Heading date: 2004 OET1 (*3*)	Heading date: 2005 OET2 (*4*)	Heading date: Est. heading date[†]	Green-leaf retention score: AL05	FC05	ER05	ST03-1	LA05	FC04	LA04	ST03-2
	---------- d ----------			---------- 3-9 ----------							
OK03918C	**+3.2**	**+1.9**	**28 Apr**	**4.5**	**5.5**	**4.5**	**5.0**	**5.0**	**5.0**	**6.0**	**6.0**
Okfield	—	+3.4	30 Apr	4.0	4.5	3.5	—	6.5	—	—	—
AP502CL	-1.5	-2.9	23 Apr	9.0	7.0	7.0	6.0	9.0	9.0	9.0	9.0
Ok102	+1.2	+1.9	27 Apr	4.0	8.5	8.0	6.0	8.0	6.0	6.5	7.0
2174	—	—	—	—	—	—	5.0	—	—	—	6.0
Endurance	—	+1.6	27 Apr	4.5	5.5	7.0	—	8.0	—	—	—
Nursery mean (d after Mar 31)	23.8	26.4	25 Apr	5.4	5.5	5.7	5.9	6.2	6.8	7.0	7.7
LSD (0.05)	—	—	—	1.3	1.0	1.2	—	1.1	0.8	0.9	—

[†]Estimated as the weighted mean deviation from the overall nursery mean (25 April); cultivars with fewer readings yield estimates with lower confidence. Readings taken primarily from Lahoma and Goodwell.

[‡]Potential scale of 1-9, but actual scale of 3-9, where lower values indicate better green-leaf retention (stay-green). Environments arranged left to right for decreasing overall stay-green, and abbreviated as Altus (AL), Ft. Cobb (FC), El Reno (ER), Stillwater (ST), first reading (ST-1) and second reading (ST-2); and Lahoma (LA) for years 2003 (03) to 2005 (05).

Table 6. Deviation from the nursery mean for plant height (*n* sites per year), estimated plant height, and lodging resistance scores from breeder trials, 2004-2005.

	Plant height			Lodging score[‡]			
	2004	2005		2004	2005		
Entry	OET1 (*2*)	OET2 (*5*)	Estimated height[†]	Goodwell irrig	Altus	Lahoma	Goodwell irrig.
	cm			1-5			
OK03918C	**-4**	**+1**	**82**	**2.5**	**1.0**	**1.0**	**1.0**
Okfield	—	+2	84	—	1.0	3.5	1.0
AP502CL	-2	-3	80	2.5	4.5	2.5	2.5
Ok102	-7	-7	75	1.5	1.5	1.5	1.0
Endurance	—	-3	79	—	1.5	2.0	1.5
Nursery mean	85	82	82	2.4	1.8	1.7	1.7
LSD (0.05)	—	—	—	1.2	1.0	0.7	0.9

[†]Estimated as the weighted mean deviation from the nursery mean (82 cm); cultivars with fewer measurements yield estimates with lower confidence. Readings taken from locations throughout Oklahoma.

[‡]No lodging (1) to severe lodging (5).

Table 7. Acid-soil tolerance ratings from breeder trials and Wheat Variety Trials (WVT), 2003 to 2006 (*n* measurements per site).

Entry	2003 RYT1 (*3*)	2005 OET2 (*1*)	2006 OET1 (*1*)	2006 OET2 (*3*)	2006 WVT (*1*)	Overall mean
	---------- 1-5[†] ----------					
OK03918C	**2.0**	**2.0**	**2.0**	**2.3**	**2.0**	**2.1**
Okfield	—	1.0	3.0	—	3.0	2.3
AP502CL/Above	5.0	5.0	5.0	5.0	4.0	4.8
Ok102	3.3	3.0	—	—	—	3.2
2174	2.7	—	—	—	2.0	2.4
Endurance	—	1.0	1.0	2.0	1.0	1.3
Nursery mean	3.0	2.5	2.3	3.0	3.0	2.8

[†] Highly tolerant (1) to very susceptible (5).

Table 8. Kernel size and flour yield based on Rotap-separation and single-kernel characterization system (SKCS) profiles, from breeder trials (*n* sites per year), 2003-2005. Data provided by C.E. Shelton, OSU Wheat Quality Laboratory.

	Large-kernel fraction		SKCS								
			1000-kernel wt.			Kernel diam			Flour yield		
Entry	2004 (*4*)	2005 (*6*)	2003 (*4*)	2004 (*4*)	2005 (*6*)	2003 (*4*)	2004 (*4*)	2005 (*6*)	2003 (*4*)	2004 (*4*)	2005 (*6*)
	------ % ------		---------- g ----------			---------- mm ----------			---------- % ----------		
OK03918C	**75.8**	**65.2**	**32.9**	**30.6**	**29.6**	**2.54**	**2.40**	**2.37**	**60.7**	**57.7**	**58.5**
AP502CL/Above	77.1	57.5	32.9	32.5	26.9	2.40	2.40	2.11	60.2	56.6	58.2
2174	—	—	32.3	—	—	2.54	—	—	62.9		—
Ok102	69.1	—	—	30.4	—	—	2.39	—	—	61.6	—
Endurance	—	57.8	—	—	27.9	—	—	2.14	—	—	62.7
Selections & checks	73.0	60.6	32.5	31.0	29.4	2.48	2.41	2.29	62.3	59.3	62.1
LSD (0.05)	5.5	7.4	1.7	2.0	1.7	0.08	0.11	0.08	2.1	1.9	1.5
C.V. (%)	6.0	12.7	4.4	5.4	6.0	2.7	3.6	3.7	2.8	2.6	2.6
Target Value	**>65.0**		**>30.0**			**>2.20**			**>60.0**		

Cultivars shaded in blue had significantly higher values than OK03918C; those in red had significantly lower values.

Table 9. Kernel hardness based on single-kernel characterization system (SKCS) profiles and NIR analysis from breeder trials (*n* sites per year), 2003-2005. Data provided by C.E. Shelton, OSU Wheat Quality Laboratory.

	Hardness index					
	SKCS			NIR		
Entry	2003 (*4*)	2004 (*4*)	2005 (*6*)	2003 (*4*)	2004 (*4*)	2005 (*6*)
OK03918C	**68**	**72**	**72**	**80**	**78**	**81**
AP502CL/Above	54	59	58	75	75	71
2174	63	—	—	76	—	—
Ok102	—	71	—	—	70	—
Endurance	—	—	59	—	—	70
Selections & checks	60	66	65	73	74	76
LSD (0.05)	3	4	4	4	7	3
C.V. (%)	5	5	6	5	8	4
Target value	**>60**			**>65**		

Cultivars shaded in blue had significantly higher values than OK03918C; those in red had significantly lower values.

Table 10. Wheat and flour protein content summarized across 14 environments from breeder trials (*n* sites per year), 2003-2005. Data provided by C.E. Shelton, OSU Wheat Quality Laboratory.

	Wheat[†]			Flour[†]		
Entry	2003 (*4*)	2004 (*4*)	2005 (*6*)	2003 (*4*)	2004 (*4*)	2005 (*6*)
	%					
OK03918C	**13.4**	**13.1**	**12.6**	**10.7**	**10.5**	**10.1**
AP502CL/Above	12.1	12.2	11.2	9.7	9.5	8.7
2174	13.5	—	—	11.4	—	—
Ok102	—	13.2	—	—	11.0	—
Endurance	—	—	11.9	—	—	9.6
Selections & checks	13.1	12.9	12.4	10.7	10.4	10.1
LSD (0.05)	0.4	0.5	0.5	0.5	0.5	0.6
C.V. (%)	2.8	3.4	4.6	3.6	4.1	6.1

[†] 12% m.b. for wheat and 14% m.b. for flour

Cultivars shaded in blue had significantly higher values than OK03918C; those in red had significantly lower values.

Table 11. Mixograph characteristics summarized across 14 environments from breeder trials (*n* sites per year), 2003-2005. Data provided by C.E. Shelton, OSU Wheat Quality Laboratory.

Entry	Mixing time			Mixing tolerance rating			Mixing tolerance-curve width			Mixing tolerance-stability		
	2003 (4)	2004 (4)	2005 (6)	2003 (4)	2004 (4)	2005 (6)	2003 (4)	2004 (4)	2005 (6)	2003 (4)	2004 (4)	2005 (6)
	--------- min. ---------			(1-10)	(1-10)	(0-6)	---------- mm ---------					
OK03918C	**4.9**	**3.8**	**3.9**	**4.5**	**4.5**	**2.5**	**14.5**	**14.8**	**12.9**	**6.8**	**8.5**	**8.4**
AP502CL/Above	4.0	3.0	2.7	4.0	5.0	3.0	9.7	10.6	12.3	6.1	6.3	6.0
2174	6.2	—	—	4.5	—	—	13.1	—	—	8.4	—	—
Ok102	—	5.4	—	—	5.0	—	—	15.5	—	—	7.9	—
Endurance	—	—	4.3	—	—	2.1	—	—	11.4	—	—	6.6
Selections and checks	6.0	4.0	5.3	4.4	4.7	2.7	12.6	13.9	14.3	7.2	7.4	5.7
LSD (0.05)	1.4	0.5	1.0	1.2	1.1	0.7	2.8	2.7	2.3	2.2	2.2	2.5
C.V. (%)	19.3	9.4	20.2	23.6	18.9	29.2	18.8	15.8	16.6	26.2	24.7	45.6
Target value		**3-7**		**>3.0**	**>3.0**	**>2.0**		**>10.0**			**<10.0**	

† Mixing time adjusted for flour protein, and mixogram curve width measured at 2 min. past peak.

Cultivars shaded in blue had significantly higher values than OK03918C, except for stability in which case cultivars shaded in blue had more desirable (lower) values. Large C.V.'s indicate high magnitude of GxE interactions (error term).

Table 12. Farinograph characteristics of composite grain samples collected statewide from breeder trials in 2004 and 2005. Data provided by C.E. Shelton, OSU Wheat Quality Laboratory.

Entry	Absorption		Peak time		Stability	
	2004[†]	2005[‡]	2004	2005	2004	2005
	-------- % --------		---------- min ----------			
OK03918C	**59.6**	**59.8**	**12.5**	**20.7**	**16.9**	**12.3**
AP502CL	60.0	58.4	16.5	2.3	28.1	12.5
Ok102	58.4	—	18.5	—	26.7	—
Ok101	—	55.0	—	12.2	—	19.8
Deliver	—	56.0	—	16.9	—	22.1
Endurance	—	54.3	—	2.3	—	17.5
Jagalene	—	56.5	—	14.3	—	22.4
Overley	—	56.5	—	16.0	—	26.1
Selections & checks	59.5	57.0	14.8	12.2	20.5	17.1

[†] Composite sample from Marshall (grazed), Lahoma, Altus, Goodwell (irrigated).

[‡] Composite sample from Stillwater, Marshall (grain-only and dual-purpose), Lahoma, Ft. Cobb, Altus, Sweetwater, Goodwell (dryland and irrigated).

Table 13. Bread-baking characteristics of composite grain samples collected statewide from breeder trials in 2004 and 2005. Data provided by C.E. Shelton, OSU Wheat Quality Laboratory.

	Bake absorption		Loaf volume		External score		Internal score		Total score	
Entry	2004[†]	2005[‡]	2004	2005	2004	2005	2004	2005	2004	2005
	-------- % --------		-------- cc --------		---- (1-35) ----		---- (1-30) ----		---- (1-65) ----	
OK03918C	**64.0**	**64.5**	**760**	**870**	**31.5**	**29.5**	**28.5**	**25.0**	**60.0**	**54.5**
AP502CL	63.5	64.0	750	805	31.0	29.0	28.0	22.0	59.0	51.0
Ok102	64.0	—	820	—	31.5	—	28.0	—	59.5	—
Ok101	—	63.0	—	810	—	30.0	—	26.5	—	56.5
Deliver	—	65.0	—	823	—	30.5	—	24.5	—	55.0
Endurance	—	62.0	—	808	—	28.5	—	25.0	—	53.5
Jagalene	—	63.0	—	808	—	30.0	—	24.5	—	54.5
Overley	—	63.0	—	853	—	31.0	—	24.0	—	55.0
Selection & checks	63.9	64.2	789	791	31.3	30.0	27.9	24.3	59.2	54.0

[†] Composite sample from Marshall (grazed), Lahoma, Altus, Goodwell (irrigated).

[‡] Composite sample from Stillwater, Marshall (grain-only and dual-purpose), Lahoma, Ft. Cobb, Altus, Sweetwater, Goodwell (dryland and irrigated).

Exhibit 1
USDA-GIPSA-FGIS Grain Classification
Stillwater, OK
2004-2005 crop year
1 page

Proposal for Release of Plant Materials

Hard Red Winter Wheat Cultivar

OK03918C

USDA United States Department of Agriculture

Grain Inspection Packers and Stockyards Administration

Technical Services Division
Board of Appeals and Review
10383 N. Ambassador Drive
Kansas City, MO 64153
(816) 891-0457

January 23, 2006

Brett F. Carver - Wheat Breeder
Oklahoma State University
368 Agricultural Hall
Stillwater, OK 74078-6028

Re: OK03918C

Thank you for submitting a type sample of OK03918C which is intended to be released as Hard Red Winter Wheat . We evaluated the variety using the criteria listed below to determine how well suited it is for the current visual wheat classification system. Based on this review, we would classify the subject variety Hard Red Winter Wheat .1

Weight of sample submitted 500 grams . To ensure this variety is properly classed throughout the national inspection system, please submit a minimum of 4000 grams so we can distribute type samples to the various inspection laboratories.

EVALUATION CRITERIA (based on intended class):

	ACCEPTABLE	UNACCEPTABLE
Kernel Morphology	✓	
Hardness Index	✓	

COMMENTS:

Hardness Score 89.
Good HRW.
Pedgree: 2174*2/(TXGH12588-105*4/FS4)

Sincerely,

Michael Eustrom, Chief
Board of Appeals and Review

cc: MASB

1 The above decision applies to the quantity of wheat submitted for our review and does not apply to any other identified lots. The effect of environment on morphological characteristics may be significant and necessitate reevaluation.

Exhibit 2
Disease reaction summary
Compiled by Dr. Bob Hunger and Dr. Jeanmarie Verchot
3 pages

Proposal for Release of Plant Materials

Hard Red Winter Wheat Cultivar

OK03918C

22 June 2006

Dr. Brett Carver
Department of Plant & Soil Sciences
Oklahoma State University
Stillwater, OK 74078

Dear Dr. Carver:

Below is a summary describing the reactions of **OK03918C** to various wheat diseases, including wheat soilborne mosaic virus (WSBMV)/wheat spindle streak mosaic virus (WSSMV), leaf rust (*Puccinia triticina*), stripe rust (*P. striiformis*), powdery mildew (*Blumeria graminis* f. sp. *tritici*), septoria leaf blotch (*Septoria tritici*), and tan spot (*Pyrenophora tritici-repentis*). No data were available in my files for reaction to stem rust (*P. graminis* f. sp. *tritici*) or to Hessian fly (*Mayetiola destructor*). A summary of the observations used to determine these reactions are presented on the page attached to this letter. Reactions to the WSBMV/WSSMV complex, leaf rust, and stripe rust are based on multiple ratings over several years. Reactions to the other diseases are based on more limited observations, which for some of the diseases are exclusively greenhouse trials.

OK03918C is **resistant to WSBMV / WSSMV** and should exhibit insignificant losses to these virus diseases.

OK03918C appears to express **moderate to high adult plant resistance to wheat leaf rust caused by races of *P. triticina* present in Oklahoma and Texas during the three seasons from 2004-2006**. Several greenhouse tests have all indicated susceptibility in the seedling stage to races of *P. triticina* collected from Oklahoma and south Texas. However, field ratings in Oklahoma have indicated moderate (20S) to high resistance (25R) in Oklahoma, and moderate resistance (20S, 40S) in south Texas.

OK03918C appears to be at least **moderately resistant to stripe rust**, with only one reading in Kansas (Winfield, 2005) indicating moderate susceptibility.

Based on greenhouse testing, OK03918C is **susceptible to tan spot and septoria leaf blotch, but appears to be moderately susceptible to powdery mildew**.

Please contact me if clarification or additional information is needed.

Sincerely,

Robert M. Hunger
Professor

Jeanmarie Verchot-Lubciz
Associate Professor

DISEASE REACTIONS OF OK03918C

Wheat Soilborne Mosaic Virus / Wheat Spindle Streak Mosaic Virus

Year/location	Symptoms (1-4)	ELISA WSBMV	ELISA WSSMV
2006/Stw (PLP; BFC NID 92 #18)	1 1 2	0.220 0.247 0.119	0.216 0.246 0.130
2006/Stw (PLP; BFC NID 90 #10)	1 1 1	0.123 0.133 0.141	0.252 0.074 0.091
2006/Stw (PLP; BFC NID 80 #34)	1	0.123	0.207
2005/Stw (PLP; BFC NID 92 #14)	'2' '2'		
2005/Stw (PLP – AK readings)	MR-MS		
2005/Win (Sid Perry; scale 1-5) (probably primarily WSSMV)	1 1 1 (range of '1's – '5's)		
2004/Stw (PLP; BFC NID 90 #6)	'2' (02-Mar) & '2' (10-Mar)		
2003/Stw (PLP; BFC NID 79 #18)	'2' (24 Mar)		

Rusts

Year/location	Leaf rust Sdlng	Leaf rust Field	Stripe rust
2006/Stw (Grnhse; BFC NID 92 #18)	3 3 3	2 2 2 (Lah)	
2006/Stw (Grnhse; BFC NID 80 #34)	3+		
2006/(BFC NID 90 #10)	3+ 3+ 3-	4 6 3 (Lah)	
2005/Stw (Grnhse; BFC NID 92 #14)	3+ 3+ 3+		
2005/Lah (27-Apr)			R ('R' to 'S')
2005/Alt (7-Apr)			0 ('0' to '++')
2005/Mar (27-Apr)		25R ('5R' to '65S')	MR ('S' to 'R')
2005/Ftc (7-Apr)			0 + 0 (scale of '0' to '+++' w/ many '0's & 5 '+++'s)
2005/So TX (AK)		TR (accuracy not known; incomplete vernalization)	
2005/Win, KS			4 (1-5 scale)
2005/PLP; (AK)		20S	
2004/Stw (Grnhse; BFC NID 90 #6)	3 3 3		
2004/So TX (AK)		5R/40S (line was mixed or segregating)	
2003/So TX (AK)		40S (accuracy not known; incomplete vernalization)	

Other Diseases

Powdery mildew:

- Intermediate (3- 3- 3-): 2006 BFC 92#18; grnhse @ Stw.
- Intermediate (3- 3- 3-): 2006 BFC 90#10; grnhse @ Stw.
- Resistant (;):2004 BFC NID 90#6; grnhse @ Stw.

Tan spot:

- Susceptible (3 3 3): 2006 BFC 92#18; grnhse @ Stw.
- Susceptible (3 3 3): 2006 BFC 90#10; grnhse @ Stw.
- Moderately susceptible: 2005 BFC NID 92 #14; grnhse @ Stw.
- Susceptible: 2004 BFC NID 90#6; grnhse @ Stw.

Septoria:

- Susceptible (8 9 9 8 9 9 9 8 8 9 9 8): 2006 BFC 92#18; grnhse @ Stw
- Intermediate (MS, MS, MS, MS, MR, MS, MS, MS, MS): 2005 BFC NID92 #14 @ Stw.

Exhibit 3
USDA-ARS-HWWQL Quality Report
2004-2005 crop year
Grain composite from 9 Oklahoma environments
Compiled by Dr. Brad Seabourn, Manhattan, KS
1 page

Proposal for Release of Plant Materials

Hard Red Winter Wheat Cultivar

OK03918C

Trait	Unit	OK03918C	Okfield	OK Bullet	Deliver	Endurance	Sample mean (*n* =16)
Test wt.	**lb/bu**	59.4	58.1	60.8	60.1	59.0	60.0
SKCS-TKW	**g**	27.5	28.0	28.2	28.4	27.7	28.1
SKCS-TKW SD	**g**	7.3	8.3	8.5	7.6	7.9	8.0
SKCS-Diam	**mm**	2.21	2.24	2.29	2.16	2.12	2.19
SKCS-Diam SD	**mm**	0.45	0.52	0.60	0.43	0.48	0.50
SKCS-Hardness		73	73	75	60	59	65
SKCS-Hardness SD		18.2	19.1	17.2	18.4	17.8	17.8
SKCS-Classification		HARD	HARD	HARD	HARD	HARD	
Flour yield	**%**	62.8	61.5	65.7	66.6	64.6	65.6
Flour ash (14% mb)	**%**	0.34	0.39	0.32	0.33	0.31	0.32
Wheat protein (14% mb)	**%**	13.1	12.3	14.0	12.9	11.5	12.8
Flour protein (14% mb)	**%**	11.6	10.9	12.5	11.6	10.2	11.4
Mixograph mix time	**min**	3.34	2.27	4.38	4.74	3.30	3.87
Mixograph mixing tolerance	**0-6**	2	2	3	5	2	3.3
Mixograph absorption	**%**	64.3	63.1	65.7	64.2	61.9	63.9
Farinograph absorption	**%**						
Farinograph time	**min**						
Farinograph stability	**min**						
Bake mix time	**min**	3.81	3.34	5.63	6.70	3.98	4.90
Bake absorption	**%**	61.9	60.5	64.0	62.8	60.9	62.6
Loaf volume	**cc**	908	888	903	860	810	858
Specific loaf volume	**cc/g**	6.3	6.1	6.1	5.9	5.6	5.9
Loaf volume regression		70.5	74.3	63.9	65.3	70.2	67.0
Crumb grain	**0-6**	2.3	2.4	3.5	4.3	3.5	3.8
Crumb color		creamy	slight yellow	creamy	creamy	creamy	

Exhibit 4
ConAgra Foods, Inc. (Enterprise Services) Quality Report
2004-2005 crop year
Grain composite from 9 Oklahoma environments
Compiled by Mary Sorensen, Omaha, NE
1 page

Proposal for Release of Plant Materials

Hard Red Winter Wheat Cultivar

OK03918C

Quality Trait	03974-2006-00838 HWW **OK02518W**	03974-2006-00839 HWW **OK02522W**	03974-2006-00837 HWW **GUYMON**	03974-2006-00849 HRW **ENDURANCE**	03974-2006-00850 HRW **OK BULLET**
WHEAT ASH 12%	1.496	1.464	1.506	1.439	1.444
WHEAT PRO 12%	14.57	15.12	14.33	12.27	14.4
WHEAT FN 12%	453	510	188	351	416
WHEAT PPO	959.7	1002	932.9	792	740.1
WHEAT TW (lb / bu)	59.3	59.5	60.1	59.1	60.8
SKCS HARD	73	70	66	63	74
SKCS TKW (g)	28.9	29.4	26.5	28	30.9
SKCS DIAMETER (mm)	2.33	2.36	2.15	2.19	2.37
SKCS +7W (%)	44.3	46.7	26	33.3	47.7
SKCS +9W (%)	53.7	52.5	72.3	62.4	50
SKCS PAN (%)	2	0.7	1.7	4.3	2.3
MILLING EXTRACTION (%)	73.3	74.2	73.2	73.5	74.7
FLOUR ASH 14%	0.459	0.471	0.431	0.472	0.502
FLOUR PROTEIN 14%	12.92	13.3	13.37	10.48	12.99
FARINOGRAPH ABS 14%	62.5	62.1	60.6	57	61.1
FARINOGRAPH MTI	30	30	65	60	30
FARINOGRAPH PEAK (min)	6	6.5	5	5	5
FARINOGRAPH STABILITY (min)	11	10.5	7.5	8.5	10.5
BAKE RESULTS					
ABSORPTION (%)	63.5	62.5	61.0	59.5	61.0
MIX TIME (min)	23	20	18	8	18
VOLUME (cc's)	2650	2700	2625	2650	2650
VOLUME COMMENTS	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE	ACCEPTABLE
DOUGH HANDLING					
SPONGE - POINTS	4	4	4	4	4
SPONGE - COMMENTS	BOLD	SL DRY/BOLD	SL STICKY	BOLD	BOLD
AT MIX - POINTS	18	18	18	17	18
AT MIX - COMMENTS	GOOD	GOOD	GOOD	SL STICKY	GOOD
AT CUT - POINTS	18	14	18	18	18
AT CUT - COMMENTS	GOOD	GASSY/GOOD+	GOOD	GOOD	GOOD
DOUGH HANDLING TOTAL SCORE (45 pts)	40	36	40	39	40
INTERNALS					
COLOR - POINTS	9	8	9	10	9
COLOR - COMMENTS	CREAMY(UNBL)	BRIGHT/CREAMY(UNBL)	CREAMY (UNBL)	BRIGHT	BRIGHT BUT SL CREAMY
BODY - POINTS	9	9	9	9	9
BODY - COMMENTS	GOOD	GOOD	GOOD	GOOD	GOOD
GRAIN - POINTS	11	12	12	12	12
GRAIN - COMMENTS	SL OPEN	SL IRREGULAR	SL ROUND	SL IRREGULAR	SL IRREGLUAR
TEXTURE - POINTS	9	9	8	9	9
TEXTURE - COMMENTS	GOOD	GOOD	SL HARSH	GOOD	GOOD
INTERNAL TOTAL SCORE (45 pts)	38	38	38	40	39
EXTERNALS					
EXTERNAL TOTAL (10 pts)	9	10	9	9	8
EXTERNAL COMMENTS	SL INSUFFICIENT	GOOD	SL INSUFFICIENT	SL RAGGED	RAGGED
TOTAL SCORE (100 pts)	87	84	87	88	87
ADDITIONAL COMMENTS				SL LOW MIX REQUIREMENT	