Milling and Baking Test Results for Hard Winter Wheat

Harvested in 2025

76th Report on Wheat Quality

Hard Winter Wheat Technical Board of the Wheat Quality Council

A coordinated effort by wheat breeders, producers, millers and bakers to improve wheat quality

This program was carried out in cooperation with the Wheat Quality Council, Lenexa, KS, The United States Department of Agriculture (USDA) - ARS, The Agricultural Experiment Stations of Colorado, Kansas, Montana, Nebraska, North Dakota, Oklahoma, South Dakota, and Texas, as well as private wheat breeding companies including Syngenta (AgriPro Wheat), Bayer (WestBred), Limagrain, and other collaborators from milling, baking, grain trade, other firms and academic organizations. This annual technical report was prepared by the USDA-ARS, Hard Winter Wheat Quality Laboratory in Manhattan, KS. The Wheat Quality Council (WQC) provides funds for the program with great effort and support from collaborators who run bake and other wheat end-use quality tests. Trade names, if used, are used to identify products only. No endorsement is intended, nor is criticism implied of similar products not mentioned.

Downloading or printing of this report is available through the Wheat Quality Council (http://www.wheatqualitycouncil.org), if you are member of WQC or a registered participant of the annual WQC meeting. Otherwise, please contact:

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2025

Milling and Baking Test Results for

Hard Winter Wheats

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The MISSION
of the WHEAT QUALITY COUNCIL:

ADVOCATE THE DEVELOPMENT OF NEW WHEAT VARIETIES THAT IMPROVE THE VALUE OF WHEAT TO ALL PARTIES IN THE UNITED STATES SUPPLY CHAIN.

The GOAL
of the WHEAT QUALITY COUNCIL:

IMPROVE THE VALUE OF ALL U. S. WHEAT CLASSES FOR PRODUCERS, MILLERS, AND PROCESSORS OF WHEAT.

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Description of the 2025 Testing Program

Founded in 1949, this is the **76th** year for the Hard Winter Wheat Milling and Baking Evaluation Program. This program is sponsored by the Wheat Quality Council and coordinated by the USDA-ARS Hard Winter Wheat Quality Laboratory (HWWQL) and Kansas State University Department of Grain and Food Science. Wheat experimental lines and check varieties (including common check and internal check) were submitted by public and private breeding programs in the Great Plains wheat growing region. This technical report includes GIPSA wheat market classification, physical grain testing, milling, analytical, rheological, and bread baking results.

Twenty-three composite entries this year were grown in two different Uniform Growout Systems (Northern and Southern) and Montana. The Northern has 8 composite entries including 1 check and 7 breeding lines from 4 breeding programs and the Southern has 13 composite entries including 1 check and 12 breeding lines from 7 breeding programs. The wheat samples were milled on the Miag Multomat mill in the Kansas State University Department of Grain and Food Science (Methods, Appendix A). The flour was distributed to 18 cooperators (16 for bread baking, 1 for tortilla, and 1 for noodle) for end-product quality evaluation. The wheat physical and chemical tests, flour quality analysis, and dough rheological tests (Mixograph, Farinograph, Alveograph, Extensigraph and GlutoPeak) were conducted by the HWWQL.

Also included in this report are alkaline noodle tests conducted by the HWWQL and protein analysis data generated by Dr. Michael Tilley in Manhattan, KS, as well as tortilla quality evaluated by Texas A&M University. Methods used to evaluate wheat lines are listed in Appendix A.

2025 WQC HWW Entries & Breeding Programs

Breeding Programs	Entry Number	Sample Identification
SOUTHERN	25-2401	CO19D087R_CO
	25-2402	CO200037R_CO
	25-2403	TX18DH287_TX
	25-2404	LCH22-7138_LM
	25-2405	LCH21-1343_LM
	25-2406	KS20HD134_KH
	25-2407	KS21H30_KH
	25-2408	SY Monument_CK
	25-2409	WB4650_WB
	25-2410	XH4002_WB
	25-2411	KS22U7907.13.RS002_UM
	25-2412	OK20738_OK
	25-2413	OK15Bx7-8-34-20-3_OK
NORTHERN	25-2414	23Nord-191_ND
	25-2415	SD20D009-9_SD
	25-2416	SD21B102-4_SD
	25-2417	SY Monument_CK
	25-2418	NE20620_NE
	25-2419	NEB 148-42_NE
	25-2420	X4027_WB
	25-2421	WB4650_WB
MONTANA	25-2422	Yellowstone_CK
	25-2423	SY Monument_CK
	25-2424	MT2270_MT
	25-2425	MTS2286_MT
	25-2426	MTAX22120_MT

CK=Check; CO=Colorado; OK=Oklahoma; LM=Limagrain; WB=Westbred (Bayer); TX=Texas; NE=Nebraska; KH= KSU-Hays; UM= USDA/ARS-Manhattan; MT=Montana; SD=South Dakota; ND=North Dakota.

2025 Wheat Classification Results from GIPSA

GIPSA Wheat Market Classification

ID	CL	DKG	TW	M	ODOR	HT	DKT	FM	SHBN	DEF	CCL	WOCL	GRADE
25-0002401	HRW	0.03	58.7	12.2	OK	0.0	0.3	0.0	0.8	1.1	0.0	0.0	U.S No. 2 HRW, DKG 0.0%
25-0002402	HRW	0.10	62.0	12.5	OK	0.0	0.0	0.0	0.3	0.3	0.0	0.0	U.S.No. 1 HRW, DKG 0.1%
25-0002403	HRW	0.05	60.6	12.9	OK	0.0	0.4	0.0	0.2	0.6	0.0	0.0	U.S. No. 1 HRW, DKG 0.1%
25-0002404	HRW	0.12	59.8	12.3	OK	0.0	0.2	0.0	0.3	0.5	0.0	0.0	U.S. No. 2 HRW, DKG 0.1%
25-0002405	HRW	0.03	60.2	12.1	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.3	U.S. No. 1 HRW, DKG 0.0%
25-0002406	HRW	0.01	60.1	12.1	OK	0.0	0.1	0.0	0.4	0.5	0.0	1.5	U.S. No. 1 HRW, DKG 0.0%
25-0002407	HRW	0.19	59.4	12.1	OK	0.0	0.1	0.0	0.4	0.5	0.0	0.0	U.S No. 2 HRW, DKG 0.2%
25-0002408	HRW	0.04	59.1	12.1	OK	0.0	0.1	0.0	0.4	0.5	0.0	0.0	U.S. No. 2 HRW, DKG 0.0%
25-0002409	HRW	0.02	58.1	12.2	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.0	U.S. No. 2 HRW, DKG 0.0%
25-0002410	HRW	0.05	60.1	12.2	OK	0.0	0.0	0.0	0.2	0.2	0.0	0.0	U.S No. 1 HRW, DKG 0.1%
25-0002411	HRW	0.01	60.5	12.0	OK	0.0	0.6	0.0	0.2	0.8	0.0	0.0	U.S No. 1 HRW, DKG 0.0%
25-0002412	HRW	0.08	62.0	12.4	OK	0.0	0.0	0.0	0.2	0.2	0.0	2.0	U.S.No. 1 HRW, DKG 0.1%
25-0002413	HRW	0.20	59.5	12.3	OK	0.0	0.5	0.0	0.1	0.6	0.0	0.0	U.S. No. 2 HRW, DKG 0.2%
25-0002414	HRW	0.02	60.2	12.6	OK	0.0	0.3	0.0	0.2	0.5	0.0	0.2	U.S No. 1 HRW, DKG 0.0%
25-0002415	HRW	0.01	60.7	12.4	OK	0.0	0.1	0.0	0.2	0.3	0.0	0.2	U.S. No. 1 HRW, DKG 0.0%
25-0002416	HRW	0.00	60.3	12.3	OK	0.0	0.2	0.0	0.2	0.4	0.0	0.0	U.S. No. 1 HRW, DKG 0.0%
25-0002417	HRW	0.04	60.4	12.3	OK	0.0	0.4	0.0	0.3	0.7	0.0	0.3	U.S No. 1 HRW, DKG 0.0%
25-0002418	HRW	0.00	62.7	12.5	OK	0.0	0.2	0.0	0.2	0.4	0.0	0.0	U.S No. 1 HRW, DKG 0.0%
25-0002419	HRW	0.06	62.3	12.5	OK	0.0	0.1	0.0	0.2	0.3	0.0	5.1	U.S No. 3 HRW, DKG 0.1%
25-0002420	HRW	0.02	61.7	12.4	OK	0.0	0.4	0.0	0.1	0.5	0.0	0.0	U.S. No. 1 HRW, DKG 0.0%
25-0002421	HRW	0.01	60.0	12.6	OK	0.0	0.4	0.0	0.2	0.6	0.0	0.2	U.S. No. 1 HRW, DKG 0.0%
25-0002422	HRW	0.03	62.1	11.1	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.0	U.S. No. 1 HRW, DKG 0.0%
25-0002423	HRW	0.01	62.0	10.8	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.0	U.S.No. 1 HRW, DKG 0.0%
25-0002424	HRW	0.01	61.8	10.7	OK	0.0	0.0	0.0	0.4	0.4	0.0	0.0	U.S.No. 1 HRW, DKG 0.0%
25-0002425	HRW	0.01	60.4	10.7	OK	0.0	0.0	0.0	0.9	0.9	0.0	0.0	U.S No. 1 HRW, DKG 0.0%
25-0002426	HRW	0.01	61.8	10.9	OK	0.0	0.0	0.0	0.6	0.6	0.0	0.0	U.S.No. 1 HRW, DKG 0.0%

Cl = Wheat class, DKG = Dockage (%), TW = Test weight (lb/bushels), DKT = Damaged kernels total (%), FM = Foreign materials (%), SHBN = Shrunken and broken kernels (%), DEF = Defects (%), CCL = Contrasting classes (%), WOCL = wheat of other classes. XWHT = mixed wheat

Wheat Breeder Plot and Entry Descriptions, Wheat and Flour Analytical, Physical Dough, and Bread Baking Data

SOUTHERN GROWOUT

25-2401	CO19D087R_CO
25-2402	CO200037R_CO
25-2403	TX18DH287_TX
25-2404	LCH22-7138_LM
25-2405	LCH21-1343_LM
25-2406	KS20HD134_KH
25-2407	KS21H30_KH
25-2408	SY Monument_CK
25-2409	WB4650_WB
25-2410	XH4002_WB
25-2411	KS22U7907.13.RS002_UM
25-2412	OK20738_OK
25-2413	OK15Bx7-8-34-20-3_OK

CK=Check; LM=Limagrain; WB=Westbred (Bayer); OK=Oklahoma; KH=KSU Hays; CO=Colorado; TX=Texas A&M; UM=USDA Manhattan.

Description of Test Plots and Breeder Entries

Southern Growout:

There are 13 composited entries including one check from 7 breeding programs (CO, OK, LM, KH, WB, UM, and TX). The Southern growout consisted of more than ten locations, but there were only six locations (OK, LM, KH, CO, UM and TX) submitting wheat samples for the composites used for end-use quality testing. Due to seed quality and quantity constraints only three (KH, UM, and TX) were used for the composite sample, all submitted locations were tested in the Micro-Quality portion.

BAYER (WESTBRED) by Adam Bray

Growing Location and Conditions

The 2025 Bayer Hard Winter Wheat Quality Council samples were grown in strips at Hale Center, TX under pivot irrigation. The field was planted 10/3/24 after cotton. Pre-plant fertilizer (60#N, 40#P, 30#K, 10#S) was incorporated. In season fertilizer consisted of one application of 14 gal of 32-0-0 through the center pivot, with a total season applied Nitrogen of 110 pounds. No diseases were observed. Plots received 7.13-inches rain from Oct- Dec 2024 and 4.4-inches rain from Jan-May 2025. Additionally, plots received 5.5-inches of irrigation. Plots were harvested on 6/04/2025 with a yield average of 73.8 bu/ac and test weight average of 58.5 lbs/bu. Entry 13 from OSU was not harvested due to loose smut on the heads, and entry 11 from USDA lost half of the plot to a combine issue at harvest.

XH4002

XH4002 is an experimental hard red winter wheat with medium maturity, good straw strength, and excellent yield potential. It has excellent resistance to Stripe Rust and is moderately resistant to FHB. It is resistant to Soilborne Mosaic Virus, with moderate resistance to both Tan Spot and Powdery Mildew. It has resistance to Hessian Fly and moderate acid soils tolerance. Internal quality testing indicates average protein and good test weight with above average functionality for hard red winter wheat class. XH4002 is being targeted for release in the eastern central plains.

WB4650

WB4650 is a medium maturity awnless hard red winter wheat with a strong virus package and excellent forage/grazing potential. It shows good resistance to both Wheat Streak Mosaic and Soilborne Mosaic viruses. It has good acid soils tolerance. It is moderately resistant to Stripe Rust and Leaf Rust. Internal quality testing indicates good protein, good test weight, and good end use functionality. WB4650 was released in 2025 targeting forage and dual-purpose growers in the northern and western central plains.

TEXAS A&M by Jackie C. Rudd and Shuyu Liu

Texas A&M AgriLife Research, Amarillo

The Texas southern growout of the Wheat Quality Council entries was at Bushland, TX (near Amarillo in the Texas Panhandle). Strips were planted adjacent to our intensively managed irrigated yield trials. We fertilized for a yield goal of 100 bu/a. The crop was irrigated with a linear at regular intervals from early March to early May. Crop development was normal for the Texas Panhandle.

TX18DH287

This hard red winter wheat line is a doubled haploid selection from an 8 parent cross [(TX1112-108/TAM 113)/(TAM 1112-20/Gallagher)]/[(TX12A001044/TAM114)/(Joe/TX12A001078)]. It is adapted throughout Texas and resistant to leaf rust, stripe rust, and stem rust. It is medium-early maturing and medium-tall height. It has an intermediate resistance to Hessian fly and bacterial leaf streak. It is Ppd-D1 sensitive. Heterozygote on Cmc4. It has Bx7oe and Dx5+10. It has Pinb-D1b and Sbm1.

OKLAHOMA STATE UNIVERSITY by Brett Carver

Description of Test Plots and Breeder Entries

The North Central Agronomy Research Station at Lahoma (12 miles west of Enid) remains the Oklahoma site for the southern uniform WQC growout. The WQC growout has occurred at this location for about 25 years, using a wheat-fallow rotation between the same two fields.

Grain yield in 2025 averaged 43 bu/ac across the entire field, including the growout. Yields were unprotected by fungicide and thus impacted by multiple leaf spotting diseases. Harvest occurred on June 12, 2025, or more than 10 days after harvest maturity. The delay was caused by multiple rainfall events that reduced test weight (mean of 58.2 lb/bu) but did not negatively impact pre-harvest sprouting (milled flour falling number mean, 405 sec). Wheat protein averaged 12.9%, the solvent retention capacity test with lactic acid averaged 135%, and mixograph mixing tolerance averaged 4.3 on 0 to 6 scale. We have used the quality data from this field to select for test weight retention and dough quality in a weathered environment. Unfortunately, the decision was made prior to the falling number test to exclude this site from the grain composite for the 2025 WQC evaluation.

OK15MASBx7 ARS 8-34-20HR-3 (=OK15Bx7-8-34-20-3)

OK15Bx7-8-34-20-3 is a re-selected full sibling to Paradox (Gallagher*3/ Snowmass), which was tested previously as OK15MASBx7 ARS 8-29 (WQC 21-2414). Their phenotypes are near-replicas, but with possibly stronger mixing tolerance and 5% higher grain yield statewide for OK15Bx7-8-34-20-3. The "Ox" functional ideotype has extremely strong dough characteristics with long hydration time and high farinograph water absorption (>62%), long dough development time exceeding 40 min, long stability times exceeding one hour, and low MTI (<15).

OK15Bx7-8-34-20-3 was the leading candidate to supplement or eventually replace acreage of Paradox and would be commercialized in a similar fashion as an ingredient flour source. However, a new Ox progeny of Paradox and Showdown was subsequently discovered in the next breeding cycle, which may cause pause on OK15Bx7-8-34-20-3.

OK20738

Following its first year of commercial seed production in 2018, Smith's Gold quickly rose to be a top-two planted variety across Oklahoma by 2020 and has since maintained similar status. It should be no surprise that the OSU wheat breeding program is stocked full of elite descendants from Smith's Gold.

We currently have eyes on three experimental lines for potential release, and one of those is OK20738 with the pedigree KS040477K-12/Smith's Gold. Its half-sibling, OK20708 (FDL Miranda/Smith's Gold), was tested in the 2024 WQC as entry 24-2408.

OK20738 was always considered our second choice, in the field, to OK20708. Poor WQC performance of OK20708 in 2024 turned our attention toward OK20738 in 2025. While OK20738 is the king of test weight among OSU elite lines, it did not handle the wheat streak mosaic infection in downstate Oklahoma in 2025 as well as OK20708. However, OK20738 shows all-season resistance to leaf rust and moderate adult-plant resistance to stripe rust.

Quality analysis of OK20708 subsequent to the 2025 Wheat Quality Council annual meeting indicated good dough strength and baking quality. It remains to be determined if the inconsistency may originate with adequate hydration. Moving forward, OK20708 is anticipated to garner more interest in release considerations, set to occur around March 2026. OK20708 would be positioned from the far eastern areas of the state to the far western panhandle. Its claim to fame is very high yield in high-yielding environments with excellent standability.

KANSAS-HAYS by Guorong Zhang

Description of Test Plots and Breeder Entries

The 12 lines and SY Monument (check) were planted on Sept. 27, 2024 in a dryland field at Hays experimental station with sandy-loam soil. The field was fertilized pre-planting with 60 lb/a N. The field had limited soil moisture at planting and the plots did not have very good stands.

However, plots grew well in the spring due to the abundant rainfall. There was moderate infection of a mixture of wheat streak mosaic virus and *Triticum* mosaic virus. Other diseases were not noticeable.

KS20HD134 (KS Flintlock)

KS20HD134 was released in August 2025 as KS Flinklock for central Kansas and surrounding regions. It is a hard red winter wheat with medium maturity and medium-short stature. KS20HD134 has high grain yield potential and very good yield records in central Kansas. KS20HD134 has a decent disease resistance package, including resistances to leaf rust, stem rust, and Soilborne mosaic virus; and intermediate resistances to stripe rust and *Triticum* mosaic virus. However, it is moderately susceptible to scab, acid soil, wheat streak mosaic virus, and Hessian fly. KS20HD134 has very good straw strength, very good winter hardiness, and moderate grain-shattering resistance. Its drought tolerance is about average. KS20HD134 has an average test weight and excellent baking quality.

KS21H30 (KS Tradition)

KS21H30 was released in August 2025 as KS Tradition for both dryland and irrigated fields in western Kansas and surrounding regions. It is a hard red winter wheat with late maturity and medium-tall stature. KS21H30 has high grain yield potential and good drought tolerance. It has a strong disease resistance package. It carries *Wsm2* and has the resistance to wheat streak mosaic virus at 21ºC. It also has resistances to stripe rust, leaf rust, stem rust, Soilborne mosaic virus, and acid soil; moderate resistance to Barley yellow dwarf virus; and intermediate resistance to *Triticum* mosaic virus. But it is moderately susceptible to scab and Hessian fly. KS21H30 has good straw strength, very good winter hardiness, and moderate grain-shattering resistance. Its test weight is about average and it has above average baking quality.

LIMAGRAIN by Marla Dale Barnett

Growing Location & Conditions

The 2025 southern hard winter Wheat Quality Council growout location provided by Limagrain Cereal Seeds was planted in Benton, KS on October 4, 2024. Soil moisture was moderate at planting. The field received no mechanical tillage prior to planting and the wheat crop followed corn. Emergence was good going into winter. The field received 100 lbs/acre actual nitrogen, 30 lbs/acre actual phosphate, and 10 lbs/acre of sulfur in March 2025 at Feekes growth stage 4. No fungicide was applied, as no fungal pathogens were prevalent. There was a substantial infection of wheat streak mosaic virus throughout the entire field. The mean grain test weight of the 13 entries was 46.5 lbs/bushel. Noting the poor test weight of the growout samples from the Benton, KS location, this location was not chosen to be included in the amalgamated 2025 flour sample. Micro milling analysis of the Benton, KS grain samples was recommended to be performed instead.

LCH22-7138

LCH22-7138 is an early maturing, medium short, hard red winter wheat adapted to both dryland and irrigated acres of the central plains that contains two genes of tolerance to CoAXium brand herbicide. LCH22-7138 is resistant to stripe rust, leaf rust, and stem rust. Tolerance to wheat streak mosaic virus (rated a 3 on a 0-9 scale) and soil-borne mosaic virus are also strengths of LCH22-7138 and important additions for the central plains CoAXium portfolio of wheat varieties. The line also contains moderate resistance to fusarium head blight. Straw strength and yield performance is excellent in both dryland and irrigated production.

Milling and baking quality data from LCS show desirable milling quality and acceptable baking quality. Small pup (100g) loaf volumes are noted as good, typically averaging 895 cc. Long mix times with excellent flour yields are noted for LCH22-7138. Flour protein has ranged from 10.2 to 12.9% depending on agronomic management and environmental variation.

LCH22-7138 will be released as LCS Troubadour AX.

LCH21-1343

LCH21-1343 is a medium maturing hard red winter wheat with good dual-purpose potential. The line has tolerance to acidic soils, soil-borne mosaic virus, and fusarium head blight. LCH21-1343 is resistant to stripe rust, leaf rust, and stem rust yet moderately susceptible to wheat streak mosaic virus (rated a 5 on a 0-9 scale). Straw strength and yield performance is excellent in both dryland and irrigated production.

Milling and baking quality data from LCS show acceptable milling and baking quality. Flour protein content is excellent averaging 12.1% across 7 location/years. Mixograph peak times typically exceed 4 minutes with small pup (100g) loaf volumes typically exceeding 940 cc.

LCH21-1343 will be released as LCS High Noon.

COLORADO by Esten Mason

Growing Location & Conditions

The Wheat Quality Council samples from Colorado originated from strip increases grown under irrigated conditions at the Agricultural Research, Development and Education Center. The field with the strip increases, including adjacent breeding and extension trials, was fertilized with a pre-plant application of 130 lbs N/acre (applied as 46-0-0) and 45 lbs S/acre. The planting date was September 20, 2024 and the harvest date was July 20, 2025. The trial was planted into moisture with good stands and good fall growth. No diseases noted. The winter and spring were average precipitation. Irrigation started in late April with ~6" total applied.

CO19D087R

Outlaw (Exp: CO19D087R) is a CSU release (2024), first entered into the Colorado Uniform Performance Trials in 2023. CO19D087R is a doubled-haploid line developed using the wheat x maize hybridization method from the cross CO12D1777/Langin. CO12D1777 is from the cross Denali/Antero//Byrd and is a sister line of the hard red winter wheat variety 'Canvas'. 'Langin' is a hard red winter wheat variety released by CSU in 2016. Outlaw has excellent yield potential and adaptation to Colorado and the southern plains. It is resistant to the wheat curl mite which vectors the mosaic virus complex. It has good resistance to stripe rust and stem rust, acid soil tolerance, and good milling and baking quality. Foundation seed was available in 2025.

CO200037R

Gabriel (Exp: CO200037R) is a CSU release (2024), first entered into the Colorado Uniform Performance Trials in 2023. CO200037R was derived from the cross Canvas//X170868/Canvas, designated X181735. It is an inbred line developed using a marker assisted backcross approach to introgress *Wsm3*, a new resistance gene for curl mite vectored viruses. Overall it has similar yield performance as Canvas. In addition to *Wsm3*, it is resistant to the wheat curl mite providing broad resistance against the mosaic virus complex. Moderate resistance to stripe rust and stem rust. Good milling and baking quality and acid soil tolerant. Foundation seed was available in 2025.

USDA-MANHATTAN by Mary Guttieri

The 2025 winter Wheat Quality samples from USDA-ARS (Manhattan, KS) originated from 150-ft strip increases grown at the USDA-ARS Meat Animal Research Center near Clay Center, NE located in south-central Nebraska (40.5369, -98.1495). The soil type is Hastings silt loam. The WQC strips were planted October 8th and 9th, 2024. The field was conventionally tilled with a field cultivator and there was a cover crop planted around the field area with the growout area being planted as soon after the previous crop was off. Based on the soil test results from samples collected in early 2025 a liquid fertilizer was applied on March 28th, 2025. The fertilizer applied was a 32-0-0 UAN mixture, 70 lbs/ac rate. Finesse and MCPA were also applied on March 27th, 2025. The Finesse was applied at a rate of .4 oz/ac and the MCPA was applied at a rate of 14.5 oz/ac. There was an application on May 1st, 2025 of Zidua and Nexicor. The Zidua was applied at a 3oz/ac rate and was put on to control any weeds that may be a problem before harvest. The Nexicor was put on at a rate of 13oz/ac and was put on to prevent any Fusarium Head Blight in the heads of the wheat. The field was irrigated and the irrigation was run based on the recommendation of the farm manager. The growout was harvested on July 8th, 2025, and average moisture was 12.49%. The average test weight in lb/bu was 59.34 and the mean yield was 107.96 bu/ac. Lastly the average protein was 11.52%.

KS22U7907.13.RS002

KS22U7907.13.RS002 has the pedigree WB Redhawk/KS11WGRC53-O. The distinguishing feature of this line is the resistance to leaf rust (*Lr57*) and the slow-rusting resistance to stripe rust (*Yr40*) conferred by a translocation from *Aegilops geniculata* on the short arm of chromosome 5D provided by the KS11WGRC53-O parent (pedigree WL711 [T5DL·5DS-5MgS(0.95)]/3*Overley. KS11WGRC53-O was released by the Kansas State University Wheat Genetics Resource Center. Both resistance genes are highly effective in Great Plains production and may be particularly useful in southern environments where fall infection with stripe rust is a concern. The presence of the translocation is easily monitored with a KASP assay. KS22U7907.13.RS002 is agronomically characterized by short stature, stiff straw, and early maturity.

The distinguishing quality characteristic of KS22U7907.13.RS002 is the unusually hard endosperm texture, which is a direct consequence of the translocation. The *Ae. geniculata* segment deletes both copies (*Pin-a* and *Pin-b*) of the puroindoline genes (https://doi.org/10.2135/cropsci2008.03.0143). It appears that the entire grain softness complex on 5DS is deleted. In contrast, current hard wheats either have a null allele (no protein produced) at *Pin-a,* or they have a variant in *Pin-b* that produces a less functional puroindoline protein. The consequences of this distinctive hardness characteristics on milling performance, beyond an X-mill, on water absorption, and on dough functionality are unknown. KS22U7907.13.RS002 was included in the 2025 WQC to generate evaluations of this unique quality characteristic and provide direction for breeding. ARS has not made a commercialization decision on KS22U7907.13.RS002. Seed is available for breeding under MTA.

Southern Growout: 2025 (Small-Scale) Samples

Test entry number	25-2401	25-2402	25-2403	25-2404
Sample identification	**CO19D087R_CO**	**CO200037R_CO**	**TX18DH287_TX**	**LCH22-7138_LM**
Wheat Data				
GIPSA classification	2 HRW	1 HRW	1 HRW	2 HRW
Test weight (lb/bu)	58.5	61.8	60.5	59.7
Hectoliter weight (kg/hl)	77.0	81.3	79.6	78.6
1000 kernel weight (gm)	30.83	31.38	36.2	32.66
Wheat kernel size (Rotap)				
Over 7 wire (%)	61.3	64.9	79.5	75.5
Over 9 wire (%)	38.1	35	20.3	24.3
Through 9 wire (%)	0.6	0.2	0.3	0.3
Single kernel (skcs)[a]				
Hardness (avg /s.d)	54.8/16.3	50.2/15.3	57.8/16.1	49.5/14.7
Weight (mg) (avg/s.d)	30.83/10.5	31.38/9.0	36.2/10.3	32.66/10.9
Diameter (mm)(avg/s.d)	2.53/40	2.52/0.35	2.76/0.44	2.61/0.44
Moisture (%) (avg/s.d)	12.18/0.43	12.0/0.39	12.1/0.39	12.0/0.44
SKCS distribution	09-21-35-35-01	12-30-31-27-03	07-16-32-45-01	16-26-29-29-03
Classification	Hard	Mixed	Hard	Mixed
Wheat protein (12% mb)	12.1	12.3	11.9	11.4
Wheat ash (12% mb)	1.43	1.38	1.44	1.50
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	76.1	77.6	76.3	77.1
Quadrumat Sr. Mill	71.1	73.1	69.5	72.3
Flour moisture (%)	12.7	14.6	13.0	13.4
Flour protein (14% mb)	10.8	11.1	10.7	10.2
Flour ash (14% mb)	0.48	0.47	0.51	0.49
Rapid Visco-Analyser				
Peak time (min)	6.0	6.1	6.2	6.1
Peak viscosity (RVU)	196.0	195.3	209.6	200.1
Breakdown (RVU)	70.7	60.7	80.0	72.1
Final viscosity at 13 min (RVU)	245.2	257.1	235.3	246.0
Minolta color meter				
L*	91.48	91.11	91.11	91.56
a*	-1.16	-2.08	-1.41	-1.23
b*	8.69	13.40	10.33	9.04
PPO	0.560	0.510	0.500	0.565
Falling number (sec)	371	392	404	350
Damaged Starch				
(AI%)	96.9	96.7	97.0	96.4
(AACC76-31)	9.0	8.8	9.1	8.4

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Southern Growout: 2025 (Small-Scale) Samples (continued)

Test entry number	25-2405	25-2406	25-2407	25-2408
Sample identification	**LCH21-1343_LM**	**KS20HD134_KH**	**KS21H30_KH**	**SY Monument_CK**
Wheat Data				
GIPSA classification	1 HRW	1 HRW	2 HRW	2 HRW
Test weight (lb/bu)	60.1	59.8	59.2	58.9
Hectoliter weight (kg/hl)	79.0	78.6	77.9	77.6
1000 kernel weight (gm)	35.0	34.6	32.1	34.2
Wheat kernel size (Rotap)				
Over 7 wire (%)	79.6	69.9	72.8	79.3
Over 9 wire (%)	20.3	29.9	26.8	20.4
Through 9 wire (%)	0.2	0.3	0.4	0.4
Single kernel (skcs)[a]				
Hardness (avg /s.d)	53.3/15.3	65.9/15.3	59.9/15.8	62.6/17.4
Weight (mg) (avg/s.d)	35.0/10.0	34.6/10.2	32.1/9.6	34.2/11.6
Diameter (mm)(avg/s.d)	2.76/0.39	2.71/0.41	2.68/0.37	2.71/0.45
Moisture (%) (avg/s.d)	11.9/0.5	12.2/0.4	12.4/0.5	12.5/0.4
SKCS distribution	10-20-34-36-01	02-07-24-67-01	04-15-33-48-01	05-14-21-60-01
Classification	Hard	Hard	Hard	Hard
Wheat protein (12% mb)	12.8	12.4	12.7	12.6
Wheat ash (12% mb)	1.58	1.46	1.54	1.53
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	76.0	76.2	75.7	77.5
Quadrumat Sr. Mill	70.1	69.1	68.0	70.1
Flour moisture (%)	13.3	13.0	13.7	13.5
Flour protein (14% mb)	11.5	11.1	11.2	11.4
Flour ash (14% mb)	0.48	0.51	0.50	0.54
Rapid Visco-Analyser				
Peak time (min)	6.1	6.2	6.2	6.1
Peak viscosity (RVU)	188.5	231.8	175.4	183.3
Breakdown (RVU)	67.7	102	57.3	61.9
Final viscosity at 13 min (RVU)	229.9	228.2	219.8	235.3
Minolta color meter				
L*	91.44	91.07	90.74	90.54
a*	-1.15	-0.66	-0.97	-0.85
b*	8.70	8.78	9.16	8.98
PPO	0.456	0.484	0.546	0.292
Falling number (sec)	361	355	352	412
Damaged Starch				
(AI%)	96.6	97.0	96.9	97.3
(AACC76-31)	8.5	9.0	9.0	9.4

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Southern Growout: 2025 (Small-Scale) Samples (continued)

Test entry number	25-2409	25-2410	25-2411
Sample identification	**WB4650_WB**	**XH4002_WB**	**KS22U7907.13.RS002_UM**
Wheat Data			
GIPSA classification	2 HRW	1 HRW	1 HRW
Test weight (lb/bu)	57.9	59.8	60.1
Hectoliter weight (kg/hl)	76.3	78.6	79.1
1000 kernel weight (gm)	30.6	33.7	31.7
Wheat kernel size (Rotap)			
Over 7 wire (%)	80.3	74.5	75.2
Over 9 wire (%)	19.6	25.4	24.6
Through 9 wire (%)	0.2	0.1	0.2
Single kernel (skcs)[a]			
Hardness (avg /s.d)	54.5/15.1	49.6/14.5	80.2/18.2
Weight (mg) (avg/s.d)	30.6/9.3	33.7/10.3	31.7/9.0
Diameter (mm)(avg/s.d)	2.71/0.41	2.68/0.39	2.83/0.38
Moisture (%) (avg/s.d)	12.5/0.5	12.2/0.5	11.7/0.52
SKCS distribution	09-18-36-37-01	13-23-39-25-03	01-04-08-87-01
Classification	Hard	Mixed	Hard
Wheat protein (12% mb)	12.5	12.7	14.2
Wheat ash (12% mb)	1.58	1.48	1.57
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	75.5	75.7	67.8
Quadrumat Sr. Mill	69.2	68.8	64.4
Flour moisture (%)	13.0	13.8	12.7
Flour protein (14% mb)	11.0	11.1	12.8
Flour ash (14% mb)	0.53	0.50	0.61
Rapid Visco-Analyser			
Peak time (min)	6.1	6.2	6.2
Peak viscosity (RVU)	216.8	220.4	163.5
Breakdown (RVU)	82.3	75.2	56.9
Final viscosity at 13 min (RVU)	251.4	268.3	200.6
Minolta color meter			
L*	91.12	91.45	89.89
a*	-1.07	-1.15	-0.86
b*	8.93	8.53	9.76
PPO	0.586	0.513	0.184
Falling number (sec)	387	370	343
Damaged Starch			
(AI%)	96.6	96.3	97.9
(AACC76-31)	8.6	8.2	10.2

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Southern Growout: 2025 (Small-Scale) Samples (continued)

Test entry number	25-2412	25-2413
Sample identification	**OK20738_OK**	**OK15Bx7-8-34-20-3_OK**
Wheat Data		
GIPSA classification	1 HRW	2 HRW
Test weight (lb/bu)	61.7	59.0
Hectoliter weight (kg/hl)	81.1	77.6
1000 kernel weight (gm)	37.3	37.7
Wheat kernel size (Rotap)		
Over 7 wire (%)	80.8	82.8
Over 9 wire (%)	19.1	17.1
Through 9 wire (%)	0.2	0.2
Single kernel (skcs)[a]		
Hardness (avg /s.d)	71.7/16.0	71.2/15.9
Weight (mg) (avg/s.d)	37.3/9.9	37.7/11.0
Diameter (mm)(avg/s.d)	2.82/0.39	2.89/0.43
Moisture (%) (avg/s.d)	12.2/0.4	12.2/0.4
SKCS distribution	01-06-15-78-01	02-05-14-79-01
Classification	Hard	Hard
Wheat protein (12% mb)	13.0	12.6
Wheat ash (12% mb)	1.51	1.61
Milling and Flour Quality Data		
Flour yield (%, str. grade)		
Miag Multomat Mill	76.4	71.4
Quadrumat Sr. Mill	67.6	64.5
Flour moisture (%)	13.4	13.2
Flour protein (14% mb)	11.4	11.4
Flour ash (14% mb)	0.54	0.55
Rapid Visco-Analyser		
Peak time (min)	6.2	6.3
Peak viscosity (RVU)	168.7	192.8
Breakdown (RVU)	61.5	60.5
Final viscosity at 13 min (RVU)	204.6	248.7
Minolta color meter		
L*	90.68	90.54
a*	-0.96	-1.10
b*	9.21	9.56
PPO	0.495	0.204
Falling number (sec)	341	361
Damaged Starch		
(AI%)	97.2	97.3
(AACC76-31)	9.4	9.5

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Southern Growout: Physical Dough Tests and Gluten Analysis
2025 (Small-Scale) Samples

Test Entry Number	**25-2401**	**25-2402**	**25-2403**	**25-2404**
Sample Identification	**CO19D087R_CO**	**CO200037R_CO**	**TX18DH287_TX**	**LCH22-7138_LM**
MIXOGRAPH				
Flour Abs (% as-is)	64.8	64.3	65.7	61.5
Flour Abs (14% mb)	63.2	65.2	64.7	61.3
Mix Time (min)	6.8	6.5	4.3	6.9
Mix tolerance (0-6)	6	5	4	6
FARINOGRAPH				
Flour Abs (% as-is)	58.5	62.3	64.4	58.9
Flour Abs (14% mb)	56.9	63.2	63.4	58.7
Peak time (min)	6.1	4.8	5.3	5.0
Mix stability (min)	25.7	13.1	13.3	13.1
Mix Tolerance Index (FU)	17	14	15	22
Breakdown time (min)	25.0	13.3	14.5	13.5
ALVEOGRAPH				
P(mm): Tenacity	90	122	137	102
L(mm): Extensibility	59	68	67	48
G(mm): Swelling index	17.1	18.3	18.2	15.4
W(10^{-4} J): strength (curve area)	216	306	336	201
P/L: curve configuration ratio	1.53	1.79	2.04	2.13
Ie(P_{200}/P): elasticity index	60.5	54.9	54.6	54.6
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	580/900/904	391/673/695	457/626/646	388/591/715
Extensibility (mm at 45/90/135 min)	142.7/134.5/115.6	131/114.3/104.6	136.6/124.1/134.2	129.4/104.5/98.1
Energy (cm^2 at 45/90/135 min)	154.2/207.6/165.3	85.9/115.8/98.4	107.1/125.8/143.6	83.9/87.3/89.8
Resist $_{max}$ (BU at 45/90/135min)	870.7/1270.7/1207.5	520/861/787	618/827/858	520/695/785
Ratio (at 45/90/135 min)	4.06/6.69/7.82	2.99/5.89/6.65	3.34/5.04/4.81	3/5.66/7.29
PROTEIN ANALYSIS				
HMW-GS Composition	2*, 7+9, 5+10	1, 7+8, 5+10	2*, 7+8, 5+10	null, 7+8, 5+10
TPP/TMP	0.96	0.86	1.03	0.81
SEDIMENTATION TEST				
Volume (ml)	57.1	46.4	48.5	46.9

Southern Growout: Physical Dough Tests and Gluten Analysis 2025 (Small-Scale) Samples (continued)

Test Entry Number	**25-2405**	**25-2406**	**25-2407**	**25-2408**
Sample Identification	**LCH21-1343_LM**	**KS20HD134_KH**	**KS21H30_KH**	**SY Monument_CK**
MIXOGRAPH				
Flour Abs (% as-is)	64.7	67.3	65.1	66.9
Flour Abs (14% mb)	63.7	66.3	64.2	63.3
Mix Time (min)	3.5	6.3	5	10
Mix tolerance (0-6)	3	6	4	6
FARINOGRAPH				
Flour Abs (% as-is)	62.8	66.0	65.0	67.3
Flour Abs (14% mb)	61.8	65.0	64.8	66.9
Peak time (min)	6.0	6.7	5.2	5.9
Mix stability (min)	10.8	15.8	12.1	12.3
Mix Tolerance Index (FU)	23	13	19	21
Breakdown time (min)	13.1	16.9	12.4	12.1
ALVEOGRAPH				
P(mm): Tenacity	100	149	152	174
L(mm): Extensibility	86	44	36	38
G(mm): Swelling index	20.6	14.7	13.3	13.7
W(10^{-4} J): strength (curve area)	276	278	229	297
P/L: curve configuration ratio	1.16	3.39	4.19	4.56
Ie(P_{200}/P): elasticity index	52.4	57.9	0	0
EXTENSIGRAPH				
Resist (BU at 45/90/135 min)	342/421/443	546/620/696	482/620/670	661/898/995
Extensibility (mm at 45/90/135 min)	138.8/136.2/137.9	129.6/120.6/124	129.8/124.9/122.8	133.1/116.6/117.8
Energy (cm^2 at 45/90/135 min)	81.7/101/105.2	120.1/121.4/137.6	102.4/124/125.9	148.2/159.6/182.2
Resist $_{max}$ (BU at 45/90/135min)	439/573/581	743/816/924	622/822/853	891/1132/1310
Ratio (at 45/90/135 min)	2.46/3.09/3.21	4.21/5.14/5.61	3.71/4.96/5.46	4.97/7.7/8.45
PROTEIN ANALYSIS				
HMW-GS Composition	2*, 7+8, 5+10	2*, 7+8, 5+10	2*, 7+9, 5+10	2*,7+9,5+10
TPP/TMP	0.84	0.82	0.78	0.90
SEDIMENTATION TEST				
Volume (ml)	51.0	54.4	52.9	60.8

Southern Growout: Physical Dough Tests and Gluten Analysis 2025 (Small-Scale) Samples (continued)

Test Entry Number	25-2409	25-2410	25-2411
Sample Identification	WB4650_WB	XH4002_WB	KS22U7907.13.RS002_UM
MIXOGRAPH			
Flour Abs (% as-is)	65.1	63.4	73.3
Flour Abs (14% mb)	64.1	63.3	72.1
Mix Time (min)	4.3	3.6	3.5
Mix tolerance (0-6)	4	3	3
FARINOGRAPH			
Flour Abs (% as-is)	63.3	62.9	77.9
Flour Abs (14% mb)	62.4	62.9	76.6
Peak time (min)	6.8	7.3	5.2
Mix stability (min)	13.8	12.8	8.4
Mix Tolerance Index (FU)	11	26	31
Breakdown time (min)	15.4	14.0	10.1
ALVEOGRAPH			
P(mm): Tenacity	109	105	205
L(mm): Extensibility	60	55	39
G(mm): Swelling index	17.2	16.5	13.9
W(10^{-4} J): strength (curve area)	245	214	323
P/L: curve configuration ratio	1.82	1.91	5.26
Ie(P_{200}/P): elasticity index	53.5	49.4	0
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	406/654/756	346/524/579	329/308/218
Extensibility (mm at 45/90/135 min)	140.3/121.8/110.7	133.6/131.7/120.1	139.2/148.1/163.3
Energy (cm^2 at 45/90/135 min)	98.7/128.4/123.2	77.4/117/107.4	76/79.5/70.1
Resist $_{max}$ (BU at 45/90/135min)	541/846/905	440/713/748	407/404/323
Ratio (at 45/90/135 min)	2.89/5.37/6.83	2.59/3.98/4.82	2.36/2.08/1.34
PROTEIN ANALYSIS			
HMW-GS Composition	1, 17+18, 5+10	2*, 7+9, 5+10	1, 17+18, 5+10
TPP/TMP	0.91	0.91	0.87
SEDIMENTATION TEST			
Volume (ml)	50.5	59.0	52.3

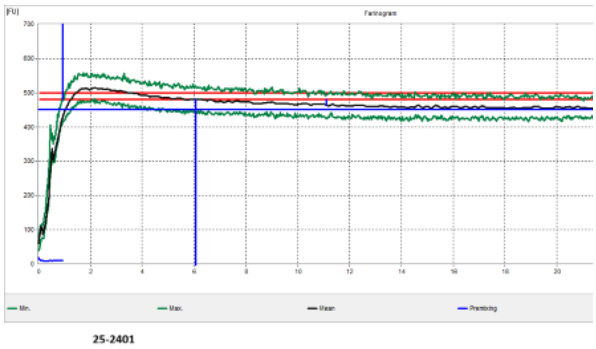
Southern Growout: Physical Dough Tests and Gluten Analysis 2025 (Small-Scale) Samples (continued)

Test Entry Number	**25-2412**	**25-2413**
Sample Identification	**OK20738_OK**	**OK15Bx7-8-34-20-3_OK**
MIXOGRAPH		
Flour Abs (% as-is)	70.9	71.8
Flour Abs (14% mb)	70.0	70.9
Mix Time (min)	4.6	16
Mix tolerance (0-6)	4	6
FARINOGRAPH		
Flour Abs (% as-is)	70.3	73.3
Flour Abs (14% mb)	69.4	72.4
Peak time (min)	5.1	51.8
Mix stability (min)	10.6	58.8
Mix Tolerance Index (FU)	24	4
Breakdown time (min)	12.1	60.0
ALVEOGRAPH		
P(mm): Tenacity	181	
L(mm): Extensibility	36	
G(mm): Swelling index	13.3	
W(10^{-4} J): strength (curve area)	276	
P/L: curve configuration ratio	5.03	
Ie(P_{200}/P): elasticity index	0	
EXTENSIGRAPH		
Resist (BU at 45/90/135 min)	437/514/539	1138/1638/1638
Extensibility (mm at 45/90/135 min)	129.1/128.3/126.1	119.8/79.4/79.4
Energy (cm^2 at 45/90/135 min)	91.9/108.4/108.8	214.6/155.9/155.9
Resist $_{max}$ (BU at 45/90/135min)	554/680/683	1532/1638/1638
Ratio (at 45/90/135 min)	3.38/4.01/4.27	9.5/20.63/20.63
PROTEIN ANALYSIS		
HMW-GS Composition	1, 7+8, 5+10	2*, 7^{OE}+8, 5+10
TPP/TMP	0.91	0.93
SEDIMENTATION TEST		
Volume (ml)	49.6	64.4

Physical Dough Tests – Farino and Mixo

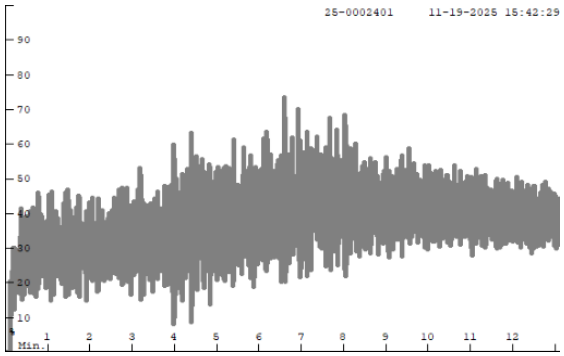
2025 (Small Scale) Samples – Southern Growout

Farinograms



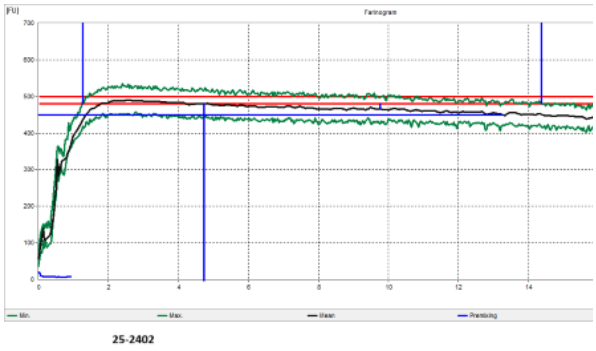
Water abs = 56.9%, Peak time = 6.1 min,
Mix stab = 25.7 min, MTI = 17 FU

Mixograms

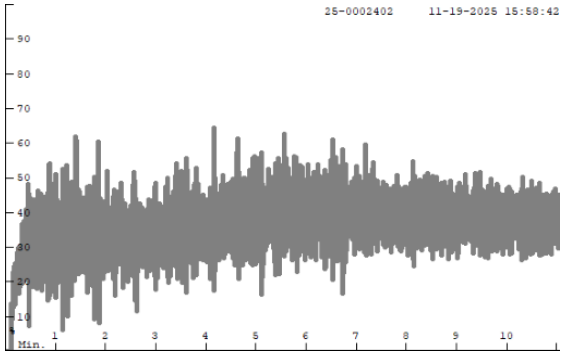


Water abs = 63.2%
Mix time = 6.8 min

25-2401, CO19D087R_CO



Water abs = 63.2%, Peak time = 4.8 min,
Mix stab = 13.1 min, MTI = 14 FU



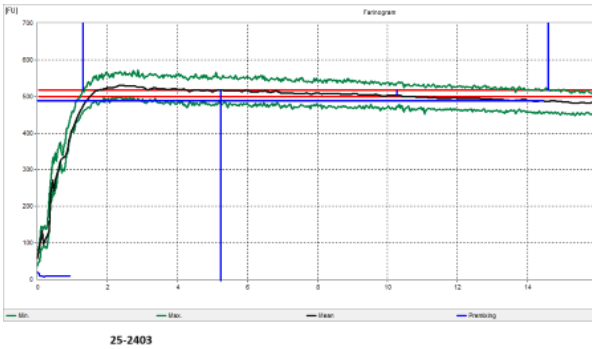
Water abs = 65.2%
Mix time = 6.5 min

25-2402, CO200037R_CO

Physical Dough Tests – Farino and Mixo

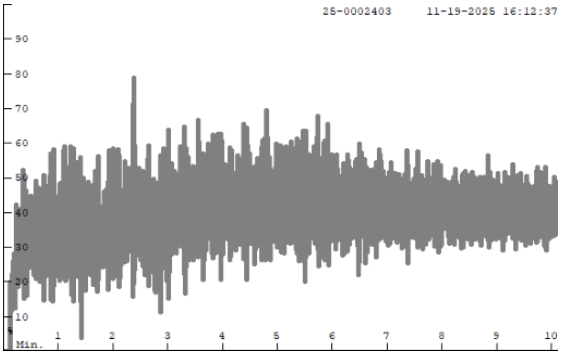
2025 (Small Scale) Samples – Southern Growout (Continued)

Farinograms



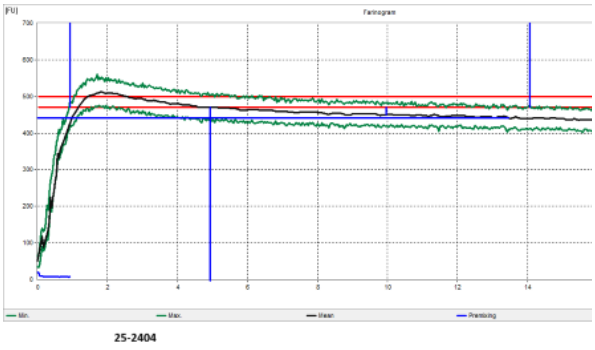
Water abs = 63.4%, Peak time = 5.3 min,
Mix stab = 13.3 min, MTI = 15 FU

Mixograms

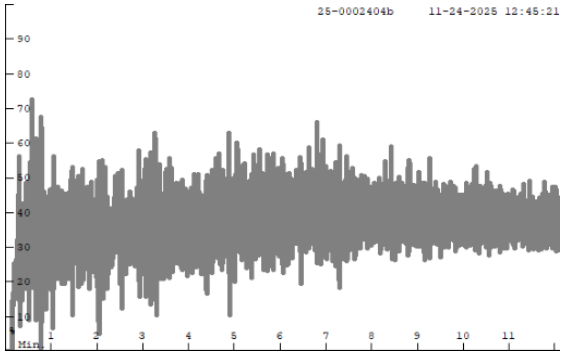


Water abs = 64.7%
Mix time = 4.3 min

25-2403, TX18DH287_TX



Water abs = 58.7%, Peak time = 5.0 min,
Mix stab = 13.1 min, MTI = 22 FU



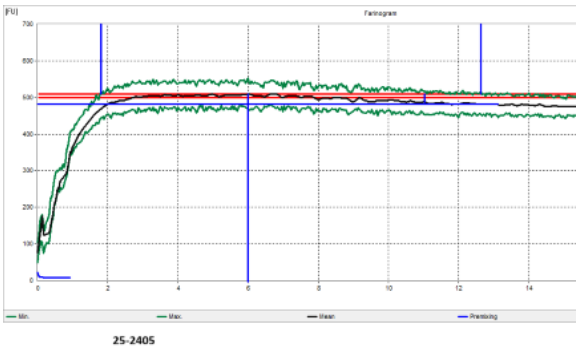
Water abs = 61.3%
Mix time = 6.9 min

25-2404, LCH22-7138_LM

Physical Dough Tests – Farino and Mixo

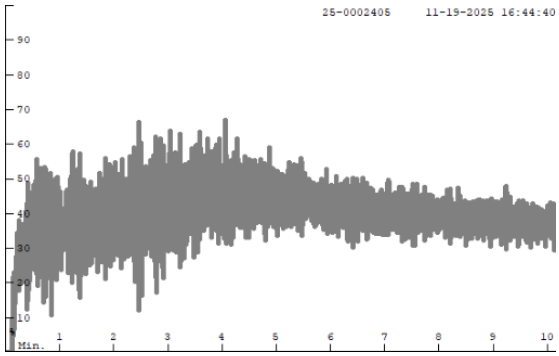
2025 (Small Scale) Samples – Southern Growout (Continued)

Farinograms



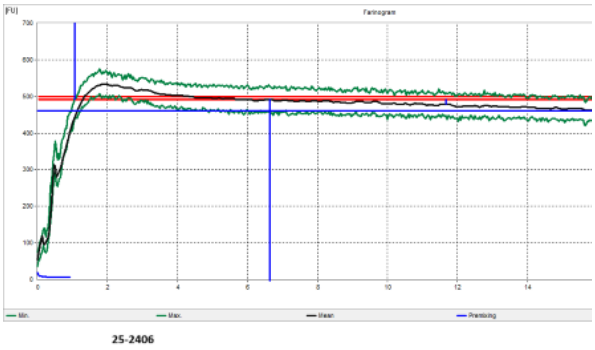
Water abs = 61.8%, Peak time = 6.0 min,
Mix stab = 10.8 min, MTI = 23 FU

Mixograms

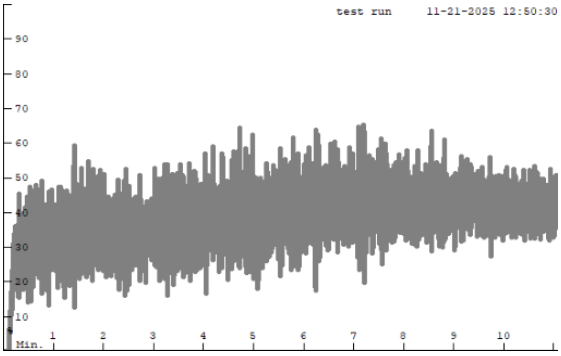


Water abs = 63.7%
Mix time = 3.5 min

25-2405, LCH21-1343_LM



Water abs = 65.0 %, Peak time = 6.7 min,
Mix stab = 15.8 min, MTI = 13 FU



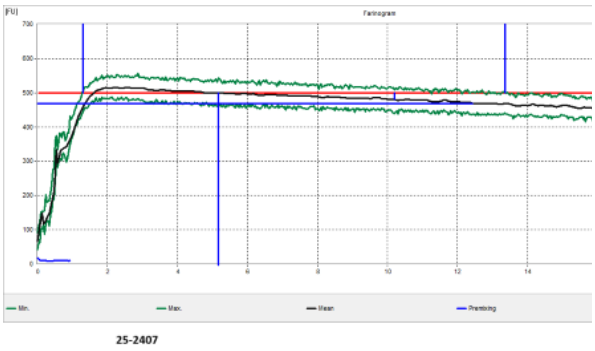
Water abs = 66.3%
Mix time = 6.3 min

25-2406, KS20HD134_KH

Physical Dough Tests – Farino and Mixo

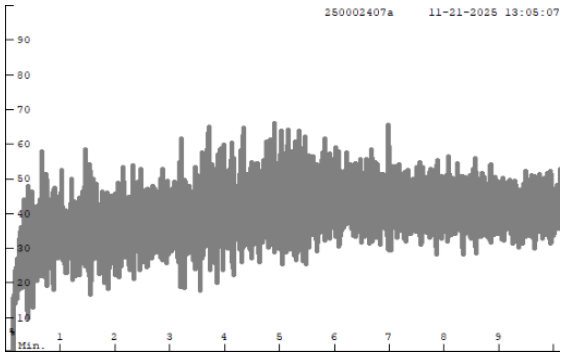
2025 (Small Scale) Samples – Southern Growout (Continued)

Farinograms



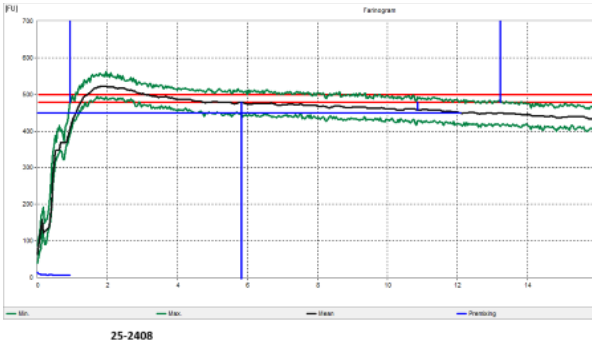
Water abs = 64.8%, Peak time = 5.2 min,
Mix stab = 12.1 min, MTI = 19 FU

Mixograms

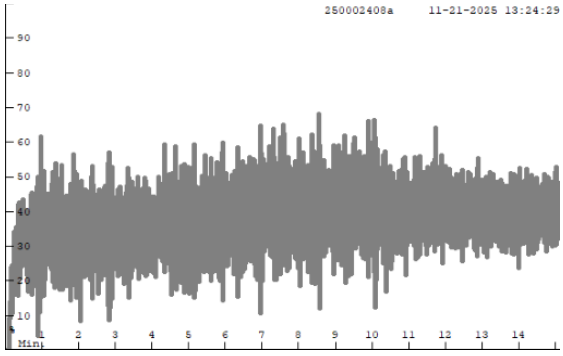


Water abs = 64.2%
Mix time = 5.0 min

25-2407, KS21H30_KH



Water abs = 66.9%, Peak time = 5.9 min,
Mix stab = 12.3 min, MTI = 21 FU

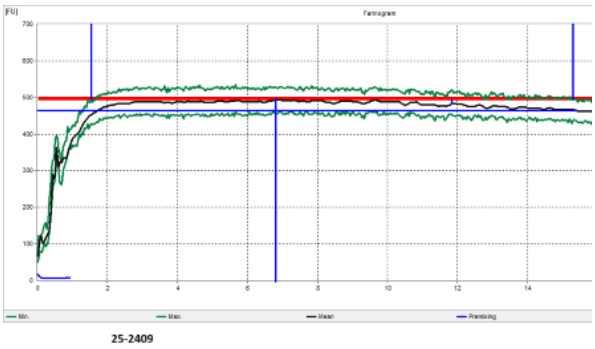


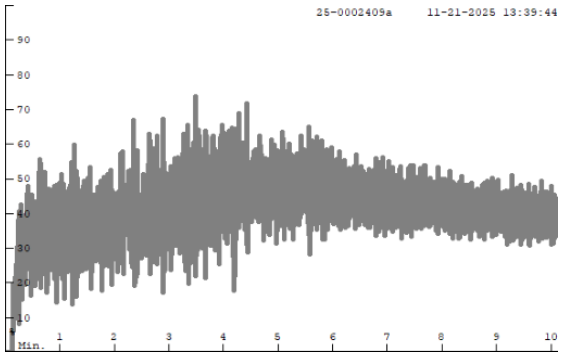
Water abs = 63.3%
Mix time = 10 min

25-2408, SY Monument_CK

Physical Dough Tests – Farino and Mixo

2025 (Small Scale) Samples – Southern Growout (Continued)

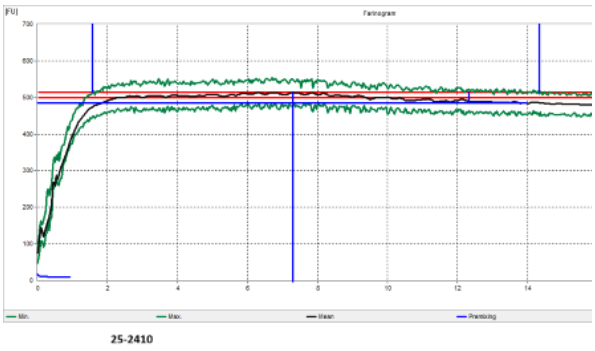


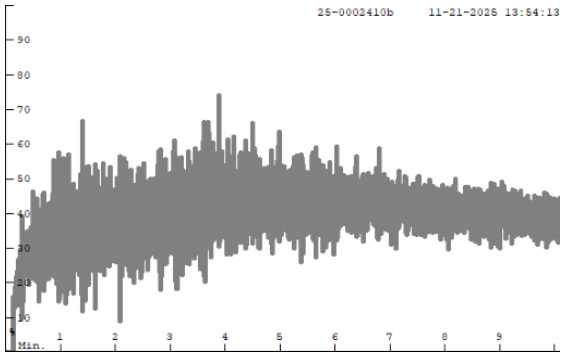


Water abs = 62.4%, Peak time = 6.8 min,
Mix stab = 13.8 min, MTI = 11 FU

Water abs = 64.1%
Mix time = 4.3 min

25-2409, WB4650_WB





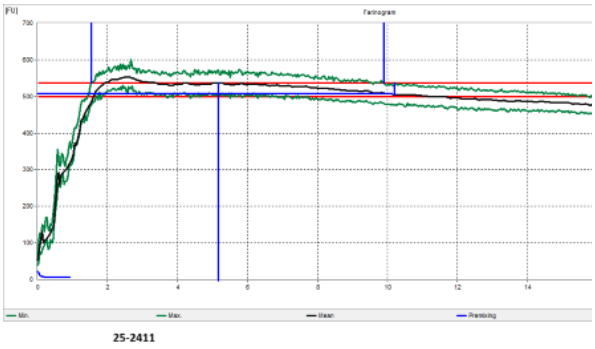
Water abs = 62.9%, Peak time = 7.3 min,
Mix stab = 12.8 min, MTI = 26 FU

Water abs = 63.3%
Mix time = 3.6 min

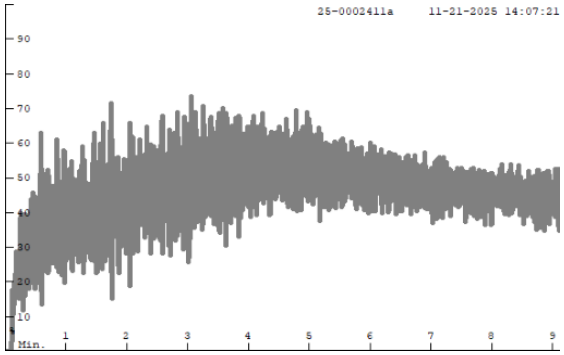
25-2410, XH4002_WB

Physical Dough Tests – Farino and Mixo

2025 (Small Scale) Samples – Southern Growout (Continued)

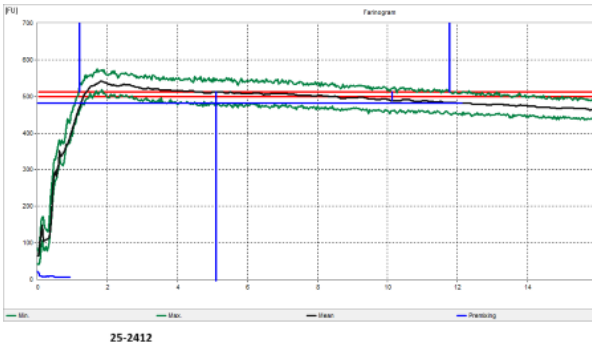


Water abs = 76.6%, Peak time = 5.2 min,
Mix stab = 8.4 min, MTI = 31 FU

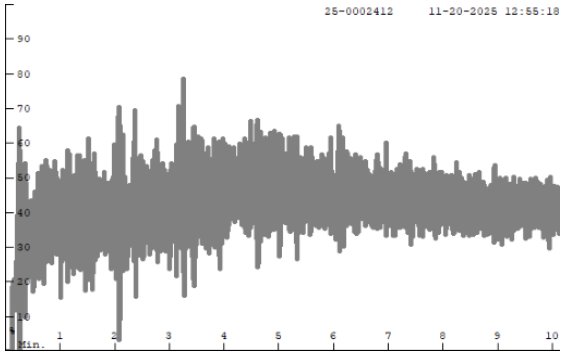


Water abs = 72.1%
Mix time = 3.5 min

25-2411, KS22U7907.13.RS002_UM



Water abs = 69.4%, Peak time = 5.1 min,
Mix stab = 10.6 min, MTI = 24 FU

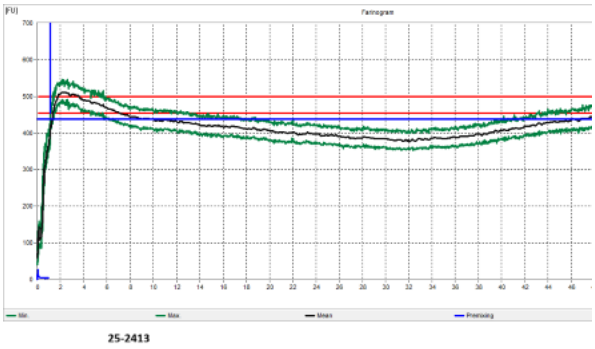


Water abs = 70.0%
Mix time = 4.6 min

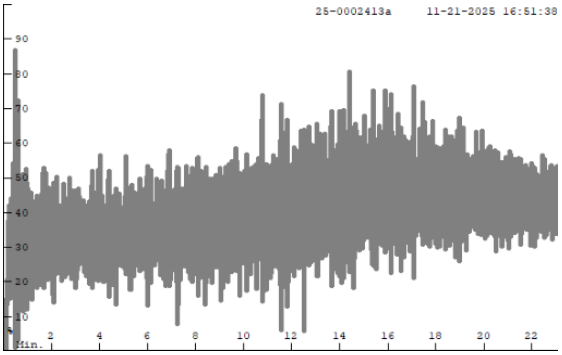
25-2412, OK20738_OK

Physical Dough Tests – Farino and Mixo

2025 (Small Scale) Samples – Southern Growout (Continued)



Water abs = 72.4%, Peak time = 51.8 min,
Mix stab = 58.8 min, MTI = 4 FU

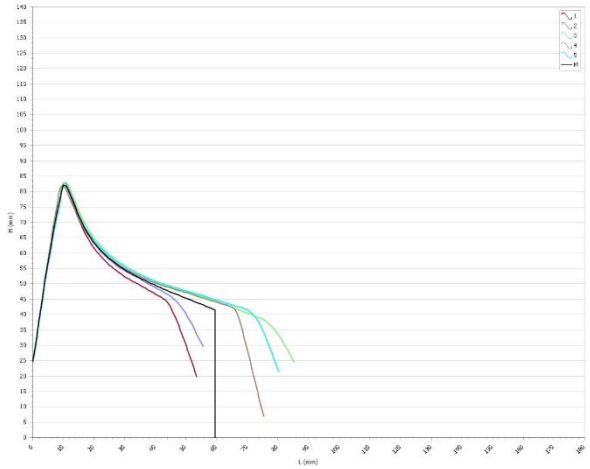


Water abs = 70.9%
Mix time = 16 min

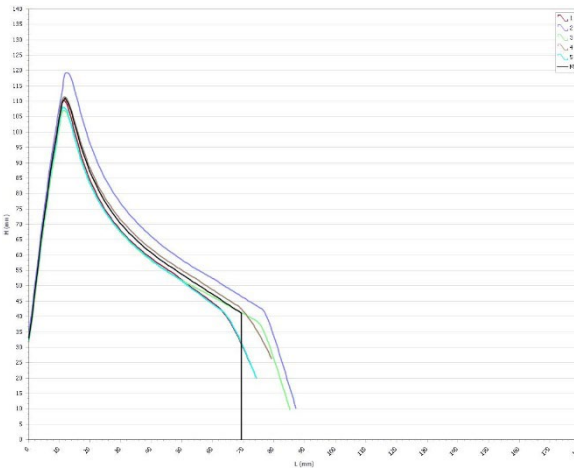
25-2413, OK15Bx7-8-34-20-3_OK

Physical Dough Tests - Alveograms

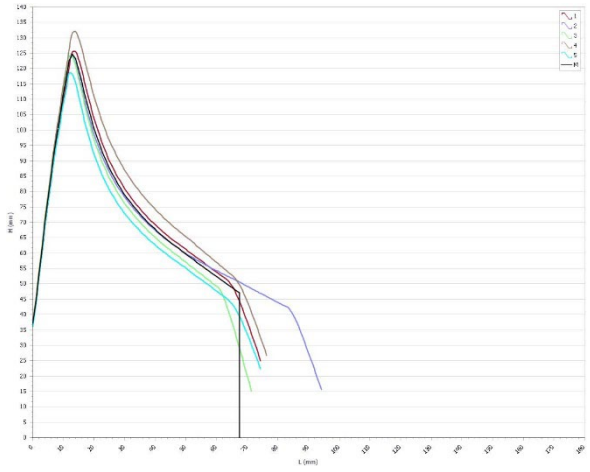
2025 (Small Scale) Samples – Southern Growout



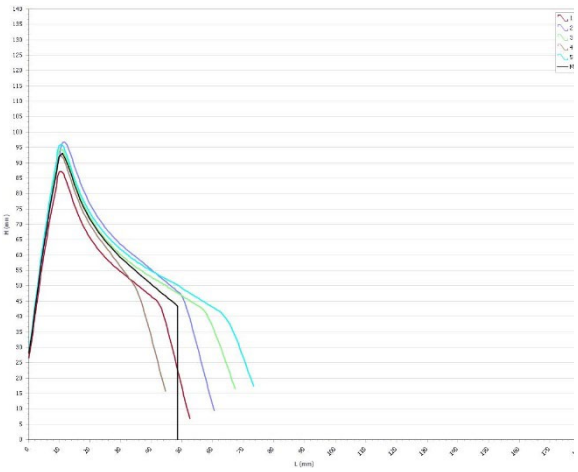
25-2401, CO19D087R_CO
P(mm H_20) =90, L(mm) = 59, W($10E^{-4}$ J) = 216



25-2402, CO200037R_CO
P(mm H_20) =122, L(mm) = 68, W($10E^{-4}$ J) = 306



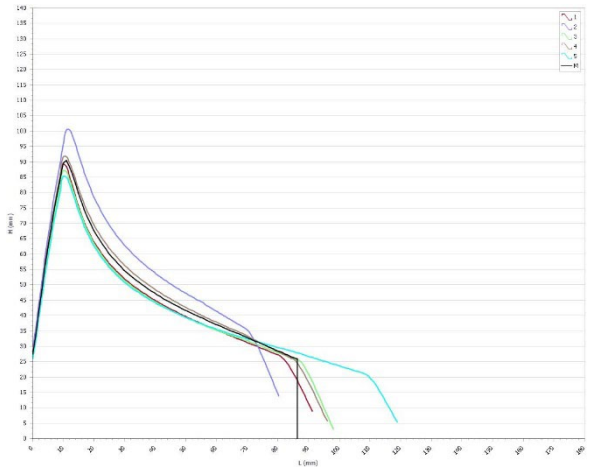
25-2403, TX18DH287_TX
P(mm H_20) = 137, L(mm) = 67, W($10E^{-4}$ J) = 306



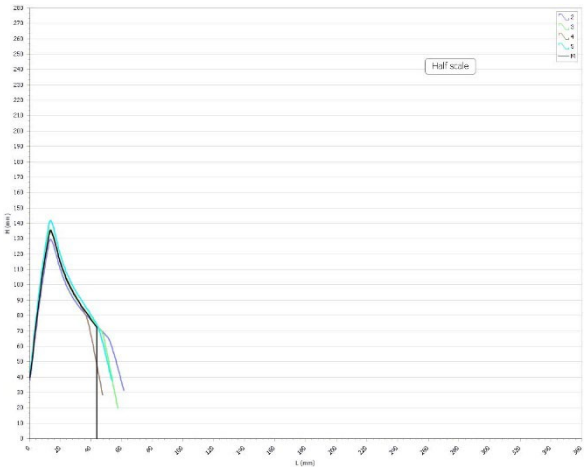
25-2404, LCH22-7138_LM
P(mm H_20) =102, L(mm) = 48, W($10E^{-4}$ J) = 201

Physical Dough Tests - Alveograms

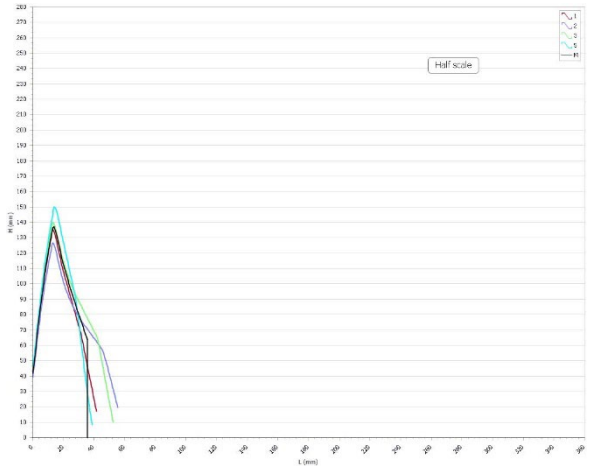
2025 (Small Scale) Samples – Southern Growout (Continued)



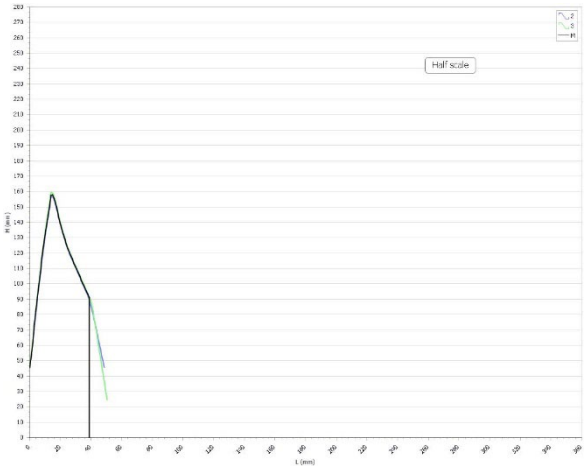
25-2405, LCH21-1343_LM
P(mm H_20) = 100, L(mm) = 86, W($10E^{-4}$ J) = 276



25-2406, KS20HD134_KH
P(mm H_20) = 149, L(mm) = 44, W($10E^{-4}$ J) = 278



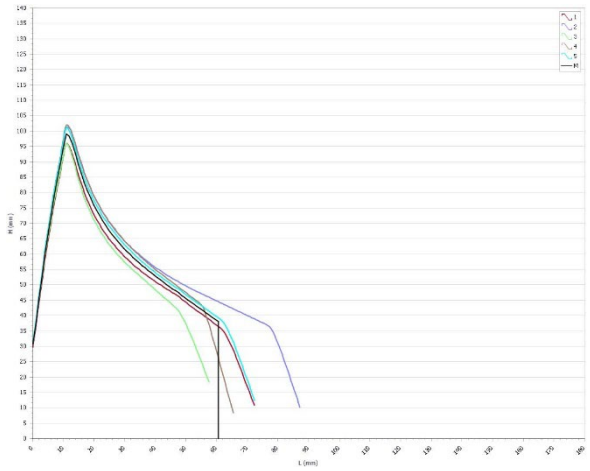
25-2407, KS21H30_KH
P(mm H_20) = 152, L(mm) = 36, W($10E^{-4}$ J) = 229



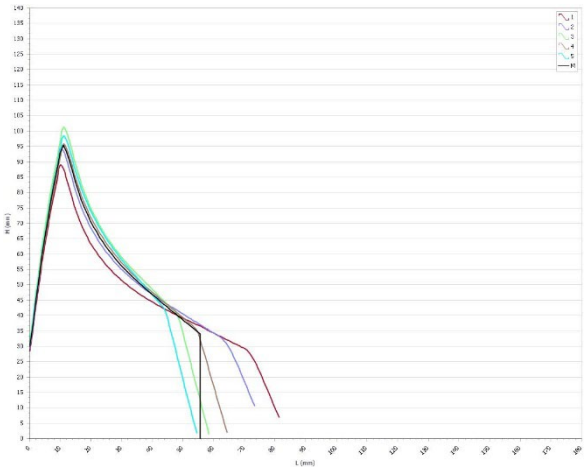
25-2408, SY Monument_CK
P(mm H_20) = 174, L(mm) = 38, W($10E^{-4}$ J) = 297

Physical Dough Tests - Alveograms

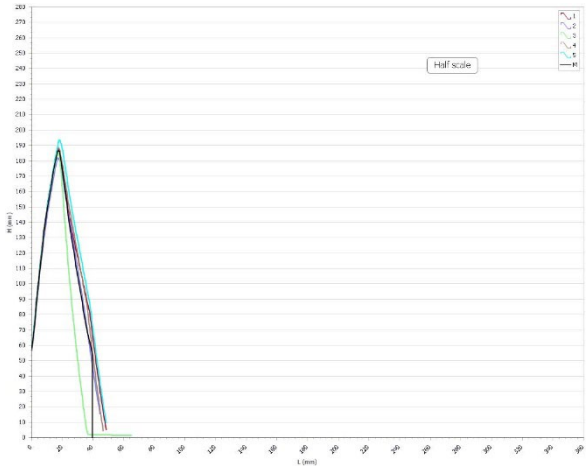
2025 (Small Scale) Samples – Southern Growout (Continued)



25-2409, WB4650_WB
P(mm H_20) = 109, L(mm) = 60, W($10E^{-4}$ J) = 245



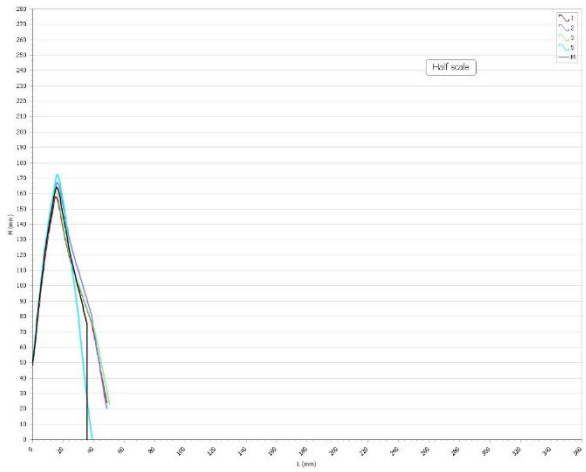
25-2410, XH4002_WB
P(mm H_20) = 105, L(mm) = 55, W($10E^{-4}$ J) = 214



25-2411, KS22U7907.13.RS002_UM
P(mm H_20) = 205, L(mm) = 39, W($10E^{-4}$ J) = 323

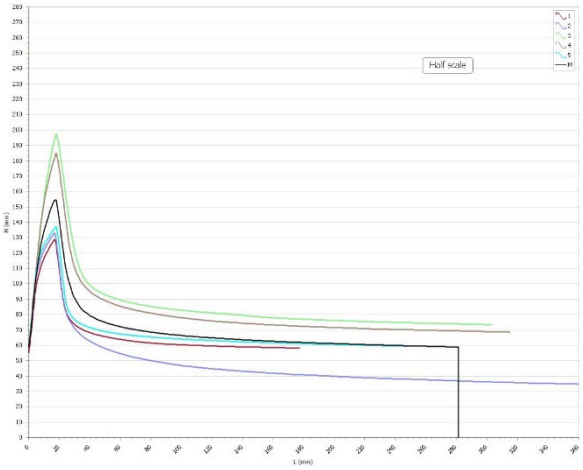
Physical Dough Tests - Alveograms

2025 (Small Scale) Samples – Southern Growout (Continued)



25-2412, OK20738_OK

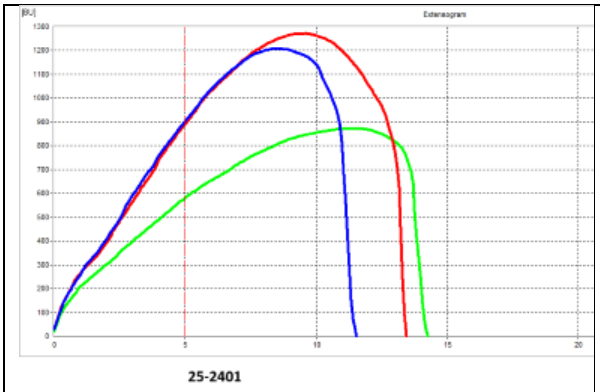
P(mm H_20) = 181, L(mm) = 36, W($10E^{-4}$ J) = 276



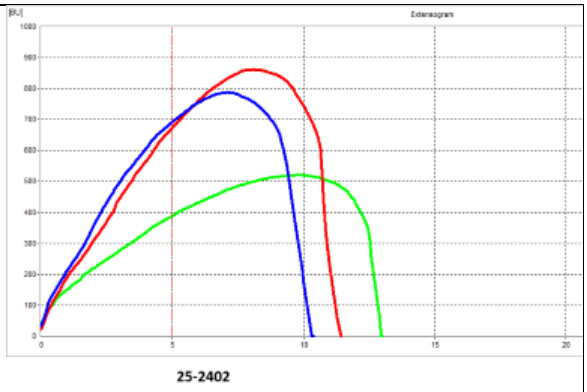
25-2413, OK15Bx7-8-34-20-3_OK

Physical Dough Tests - Extensigrams

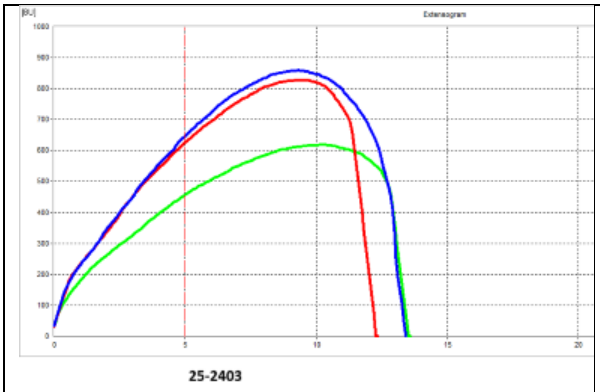
2025 (Small Scale) Samples – Southern Growout



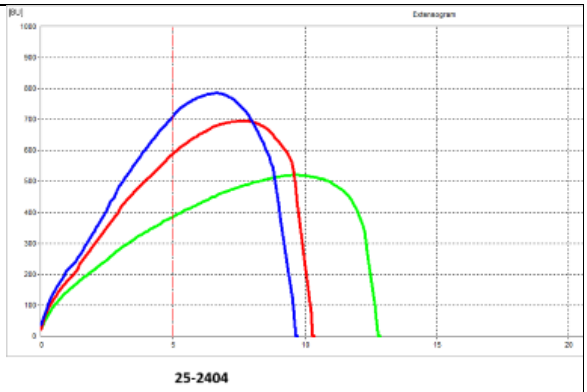
25-2401, CO19D087R_CO
R (BU) = 900, E (mm) = 135, W (cm^2) = 208
Rmax (BU) = 1271, Ratio = 6.7 at 90 min



25-2402, CO200037R_CO
R (BU) = 673, E (mm) = 114, W (cm^2) = 116
Rmax (BU) = 861, Ratio = 5.9 at 90 min



25-2403, TX18DH287_TX
R (BU) = 626, E (mm) = 124, W (cm^2) = 126
Rmax (BU) = 827, Ratio = 5.0 at 90 min

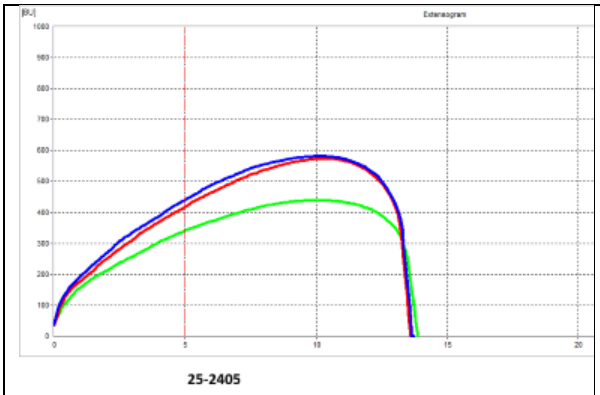


25-2404, LCH22-7138_LM
R (BU) = 591, E (mm) = 105, W (cm^2) = 87
Rmax (BU) = 695, Ratio = 5.7 at 90 min

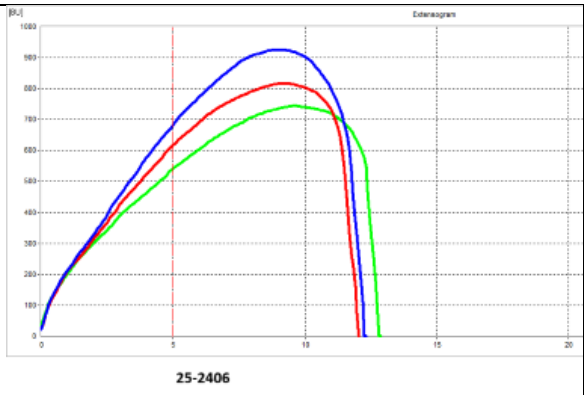
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Physical Dough Tests - Extensigrams

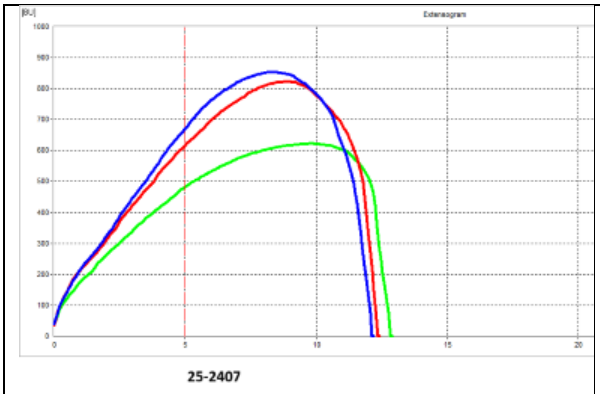
2025 (Small Scale) Samples – Southern Growout (Continued)



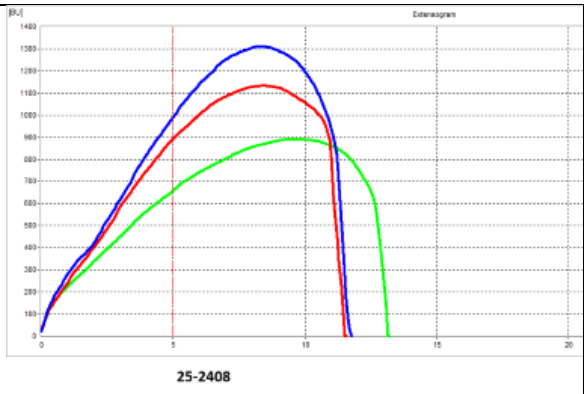
25-2405, LCH21-1343_LM
R (BU) = 421, E (mm) = 136, W (cm^2) = 101
Rmax (BU) = 573, Ratio = 3.1 at 90 min



25-2406, KS20HD134_KH
R (BU) = 620, E (mm) = 121, W (cm^2) = 121
Rmax (BU) = 816, Ratio = 5.1 at 90 min



25-2407, KS21H30_KH
R (BU) = 620, E (mm) = 125, W (cm^2) = 124
Rmax (BU) = 822, Ratio = 5.0 at 90 min

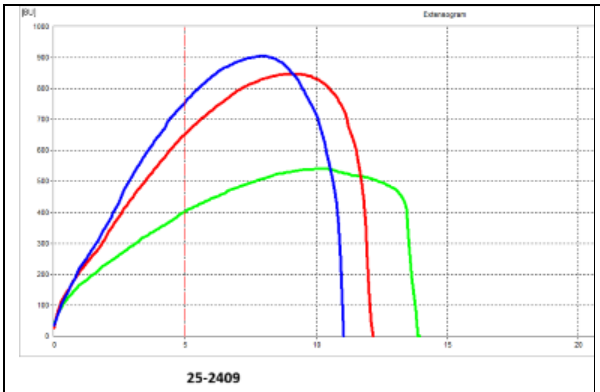


25-2408, SY Monument_CK
R (BU) = 898, E (mm) = 117, W (cm^2) = 160
Rmax (BU) = 1132, Ratio = 7.7 at 90 min

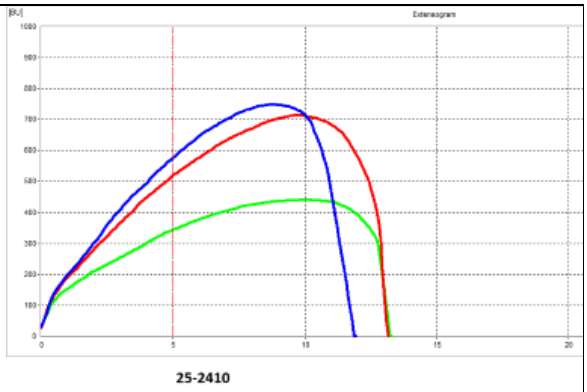
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Physical Dough Tests - Extensigrams

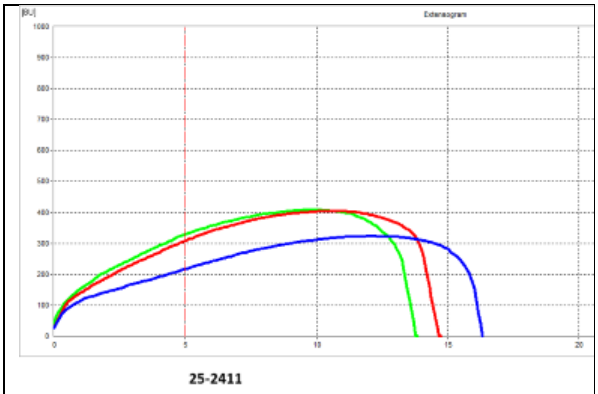
2025 (Small Scale) Samples – Southern Growout (Continued)



25-2409, WB4650_WB
R (BU) = 654, E (mm) = 122, W (cm^2) = 128
Rmax (BU) = 846, Ratio = 5.4 at 90 min



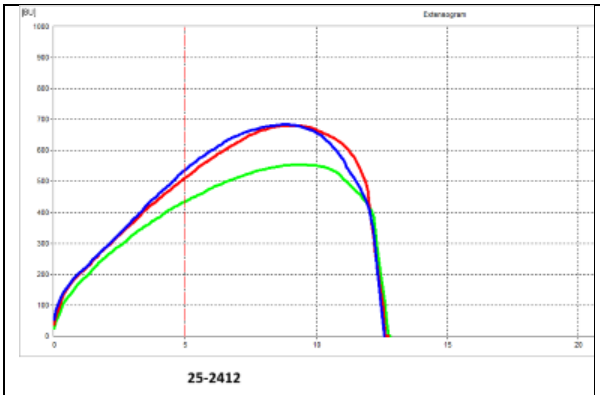
25-2410, XH4002_WB
R (BU) = 524, E (mm) = 132, W (cm^2) = 117
Rmax (BU) = 713, Ratio = 4.0 at 90 min



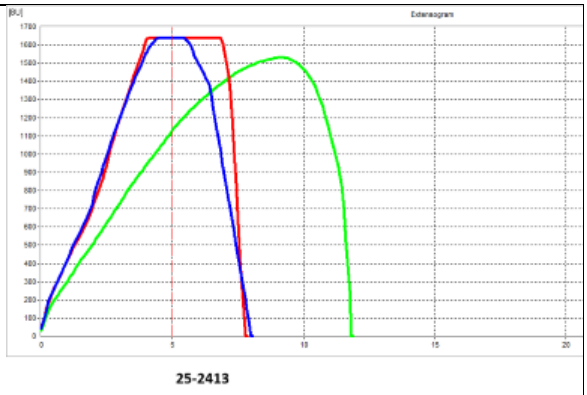
25-2411, KS22U7907.13.RS002_UM
R (BU) = 308, E (mm) = 148, W (cm^2) = 80
Rmax (BU) = 404, Ratio = 2.1 at 90 min

Physical Dough Tests - Extensigrams

2025 (Small Scale) Samples – Southern Growout (Continued)

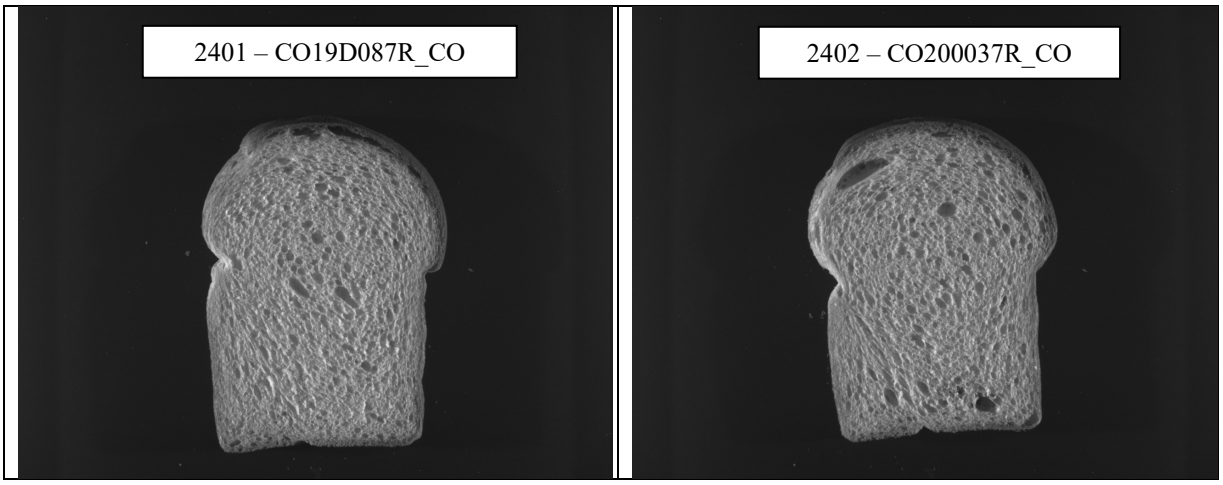


25-2412, OK20738_OK
R (BU) = 514, E (mm) = 128, W (cm^2) = 108
Rmax (BU) = 680, Ratio = 4.0 at 90 min

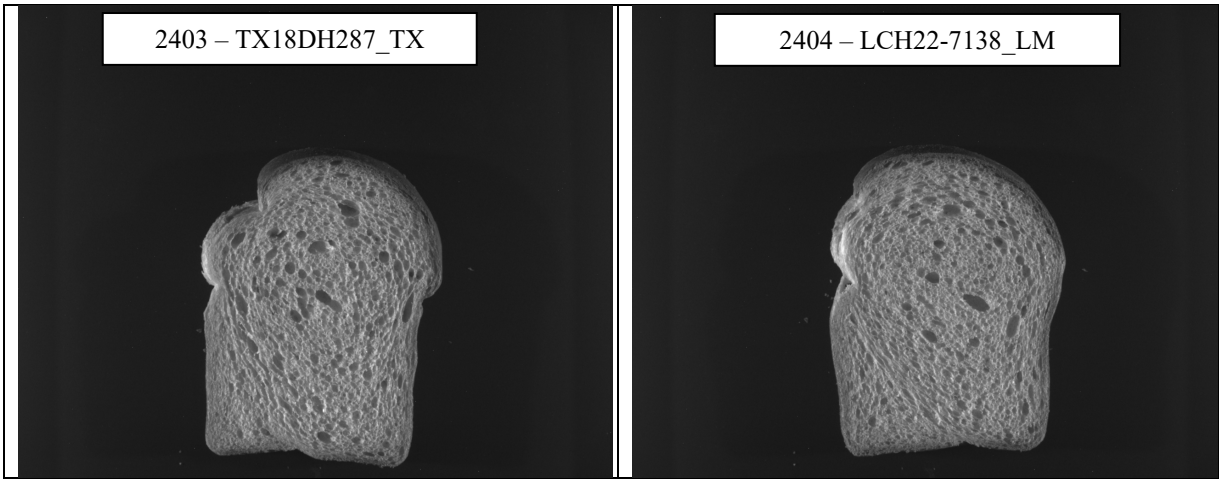


25-2413, OK15Bx7-8-34-20-3_OK
R (BU) = 1638, E (mm) = 79, W (cm^2) = 156
Rmax (BU) = 1638, Ratio = 20.6 at 90 min

Southern Growout: C-Cell Bread Images and Analysis
2025 (Small-Scale) Samples

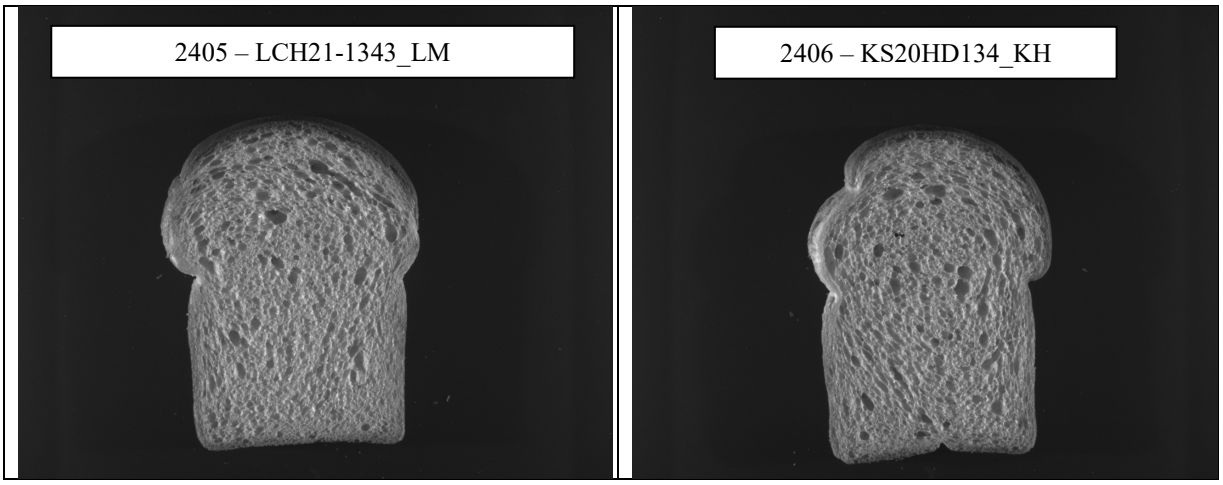


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2401	6518	119	3794	0.430	2.160	1.545	1.760	-6.15
2402	6198	119	3605	0.430	2.105	2.965	1.780	-3.85

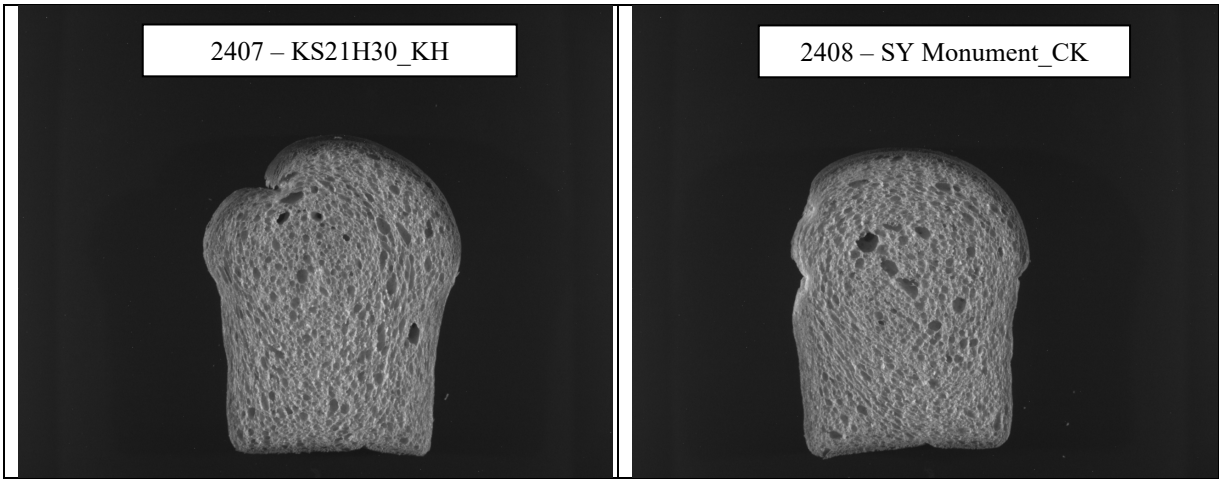


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2403	5919	116	3215	0.435	2.315	1.250	1.810	-9.60
2404	5863	115	3639	0.420	1.940	1.945	1.760	-6.20

Southern Growout: C-Cell Bread Images and Analysis
2025 (Small-Scale) Samples (Continued)

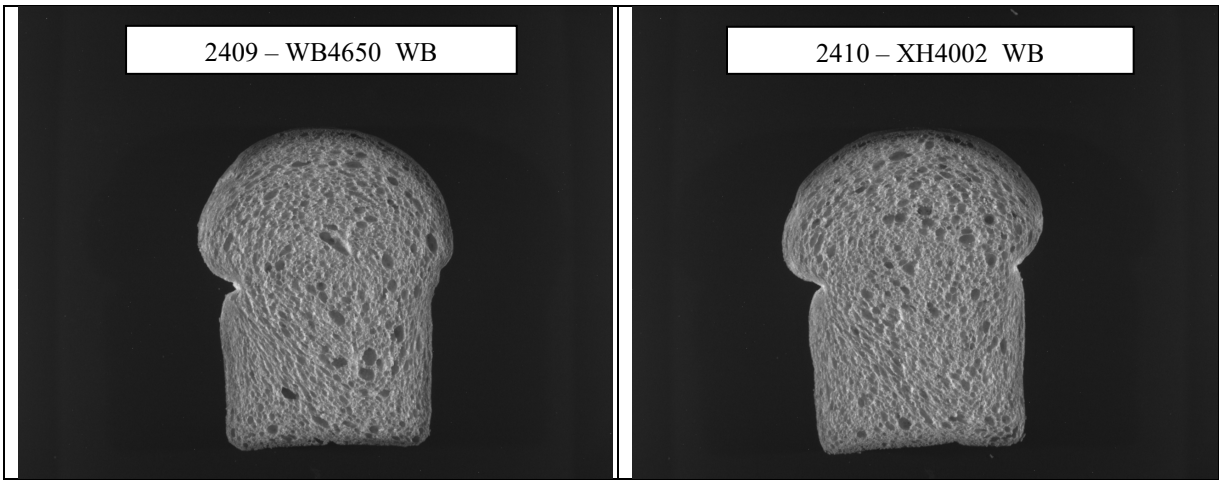


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2405	6669	117	3867	0.435	2.195	5.365	1.735	1.65
2406	6329	115	3302	0.440	2.355	1.760	1.790	-6.55



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2407	5917	114	3389	0.430	2.140	6.220	1.810	-1.90
2408	5847	114	3486	0.425	2.015	3.055	1.755	-3.45

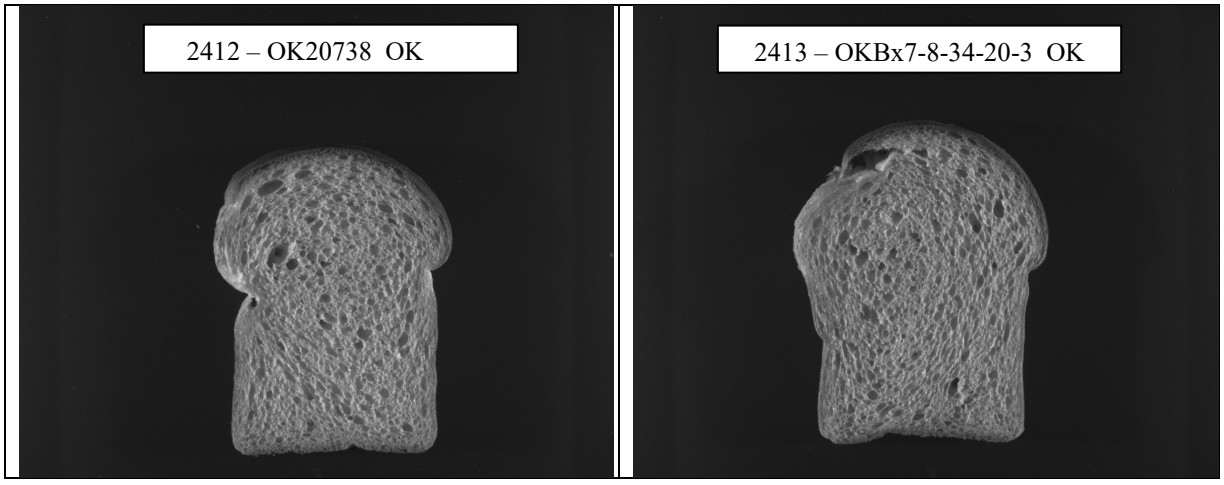
Southern Growout: C-Cell Bread Images and Analysis
2025 (Small-Scale) Samples (Continued)



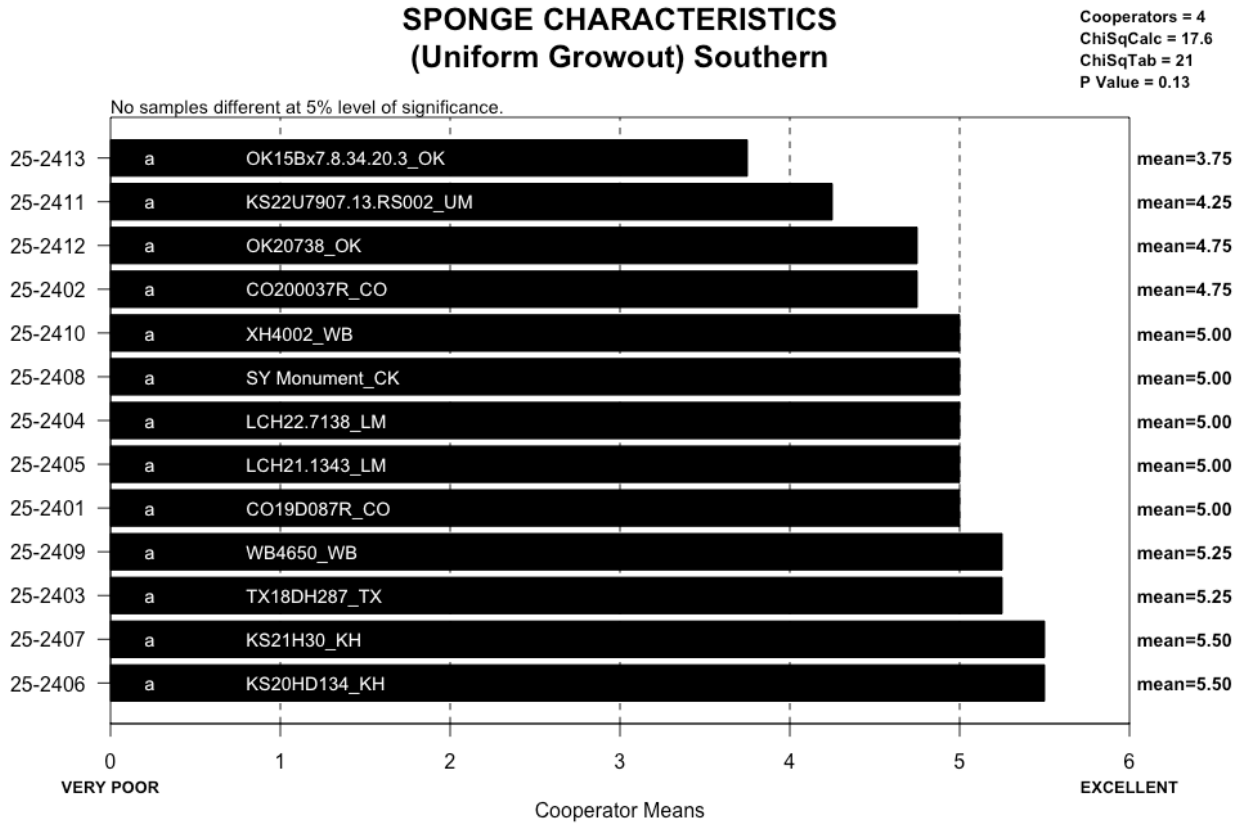
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2409	6265	115	3498	0.440	2.170	1.735	1.790	-6.30
2410	6421	119	3845	0.430	2.105	0.690	1.725	-5.40

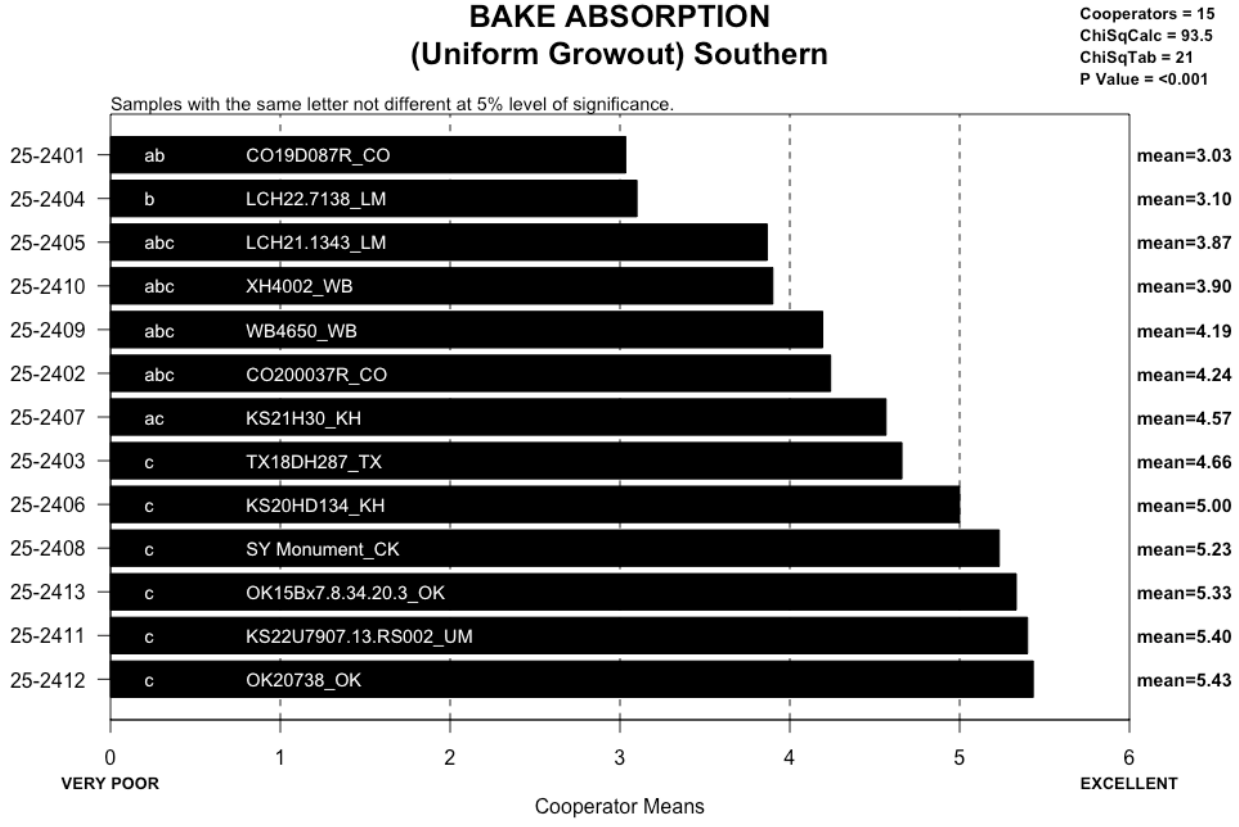
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2411	5707	109	2715	0.460	2.600	1.450	1.720	-4.25

Southern Growout: C-Cell Bread Images and Analysis
2025 (Small-Scale) Samples (Continued)



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2412	5872	113	3269	0.435	2.275	1.625	1.715	-2.95
2413	6137	110	3397	0.430	2.105	1.955	1.920	0.90


SPONGE CHARACTERISTICS
(Uniform Growout) Southern
Cooperators = 4
ChiSqCalc = 17.6
ChiSqTab = 21
P Value = 0.13
No samples different at 5% level of significance.
25-2413 a OK15Bx7.8.34.20.3_OK mean=3.75
25-2411 a KS22U7907.13.RS002_UM mean=4.25
25-2412 a OK20738_OK mean=4.75
25-2402 a CO200037R_CO mean=4.75
25-2410 a XH4002_WB mean=5.00
25-2408 a SY Monument_CK mean=5.00
25-2404 a LCH22.7138_LM mean=5.00
25-2405 a LCH21.1343_LM mean=5.00
25-2401 a CO19D087R_CO mean=5.00
25-2409 a WB4650_WB mean=5.25
25-2403 a TX18DH287_TX mean=5.25
25-2407 a KS21H30_KH mean=5.50
25-2406 a KS20HD134_KH mean=5.50
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

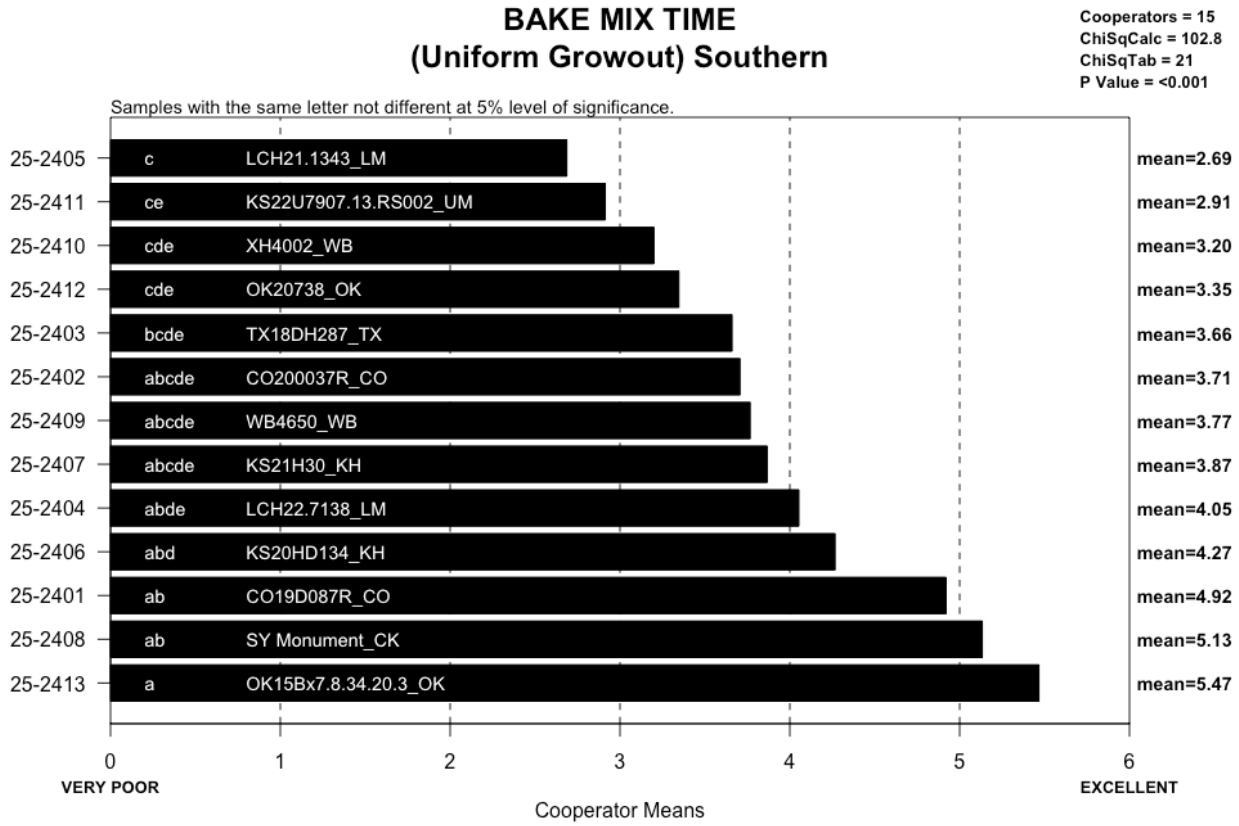

BAKE ABSORPTION
(Uniform Growout) Southern
Cooperators = 15
ChiSqCalc = 93.5
ChiSqTab = 21
P Value = <0.001
Samples with the same letter not different at 5% level of significance.
25-2401 ab CO19D087R_CO mean=3.03
25-2404 b LCH22.7138_LM mean=3.10
25-2405 abc LCH21.1343_LM mean=3.87
25-2410 abc XH4002_WB mean=3.90
25-2409 abc WB4650_WB mean=4.19
25-2402 abc CO200037R_CO mean=4.24
25-2407 ac KS21H30_KH mean=4.57
25-2403 c TX18DH287_TX mean=4.66
25-2406 c KS20HD134_KH mean=5.00
25-2408 c SY Monument_CK mean=5.23
25-2413 c OK15Bx7.8.34.20.3_OK mean=5.33
25-2411 c KS22U7907.13.RS002_UM mean=5.40
25-2412 c OK20738_OK mean=5.43
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

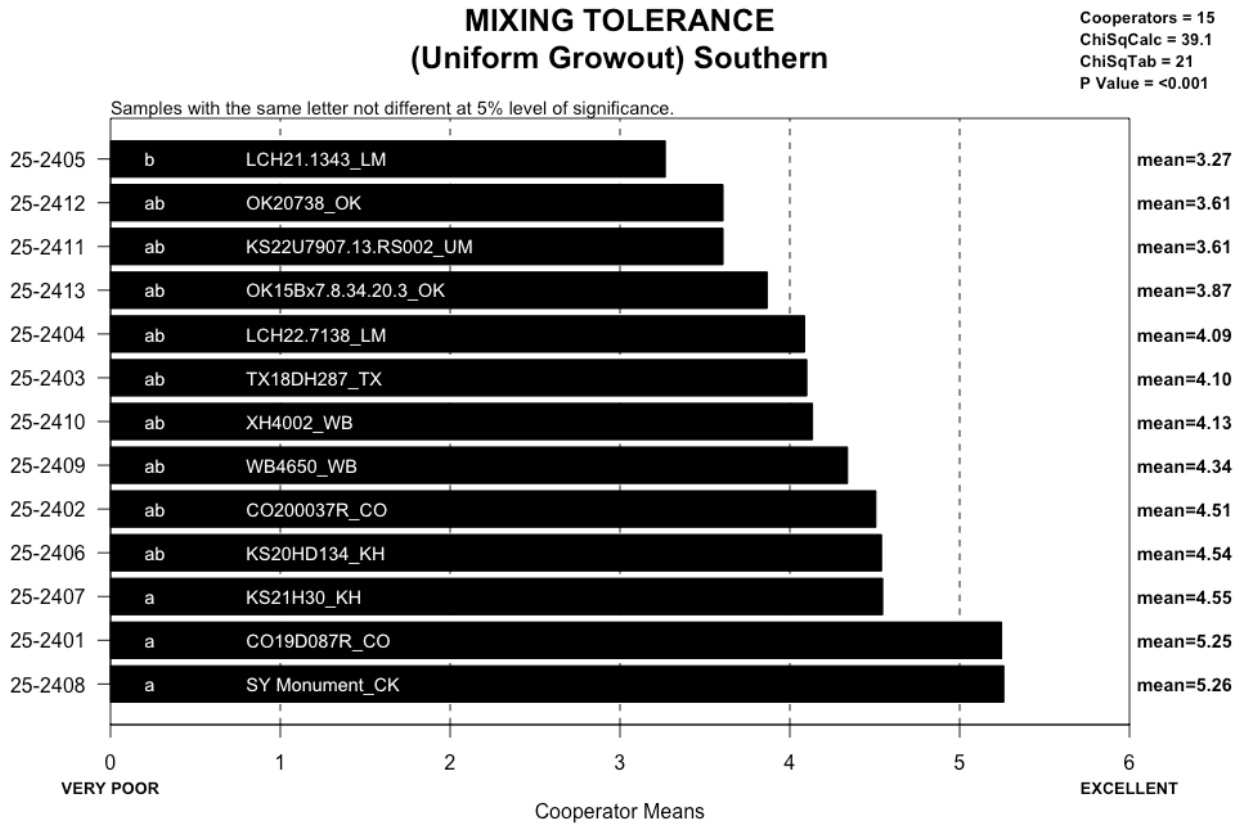
BAKE ABSORPTION, ACTUAL (14% MB)
(Uniform Growout) Southern
Cooperators A – O

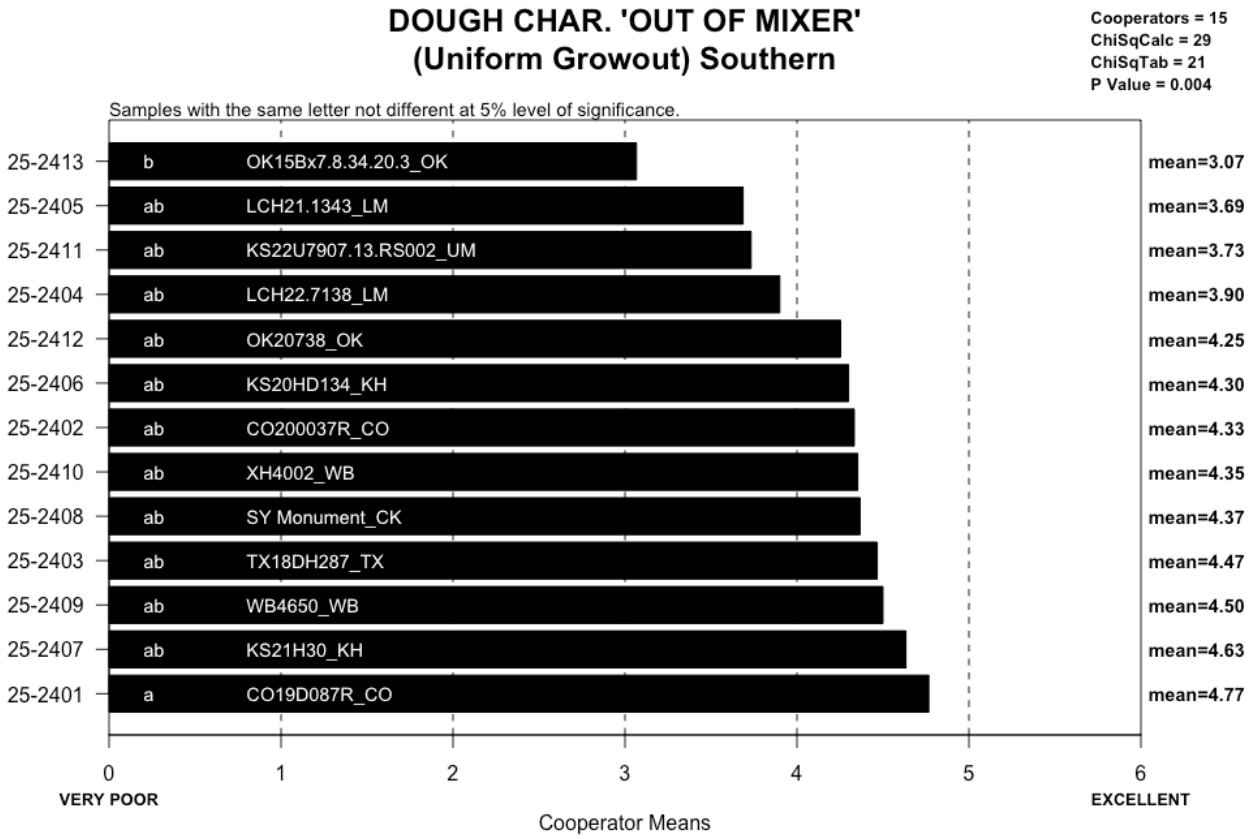
IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
25-2401	CO19D087R_CO	64.9	60	63.7	57.1	63.1	59	57	61.1	61.8	58.9	61.0	63.4	61.5	63.2	57.0
25-2402	CO200037R_CO	65.7	63	63.7	62.6	65.6	61	57	60.4	63.8	65.2	64.9	65.1	65.3	65.2	63.2
25-2403	TX18DH287_TX	68.4	65	66.8	62.4	64.7	60	57	62.3	66.0	65.4	67.0	64.7	67.4	64.7	63.4
25-2404	LCH22.7138_LM	66.6	60	61.9	59.1	61.5	59	56	59.7	61.3	60.7	61.3	61.5	61.9	61.5	58.2
25-2405	LCH21.1343_LM	66.8	61	64.1	61.0	63.7	61	57	61.1	64.7	63.8	64.8	63.5	65.8	64.7	62.2
25-2406	KS20HD134_KH	68.9	65	66.8	63.5	66.7	62	57	62.5	67.7	67.0	68.6	66.3	69.0	67.3	64.8
25-2407	KS21H30_KH	68.7	65	64.2	64.0	64.5	61	57	60.7	66.1	66.8	67.4	64.7	68.0	65.1	64.7
25-2408	SY Monument_CK	71.0	67	67.3	66.4	66.3	62	57	63.1	68.6	68.9	70.1	66.4	70.3	66.9	67.0
25-2409	WB4650_WB	66.3	63	64.9	61.9	63.8	61	57	59.6	65.0	64.4	66.6	64.3	66.3	65.1	62.3
25-2410	XH4002_WB	64.4	63	64.0	62.5	63.6	61	57	60.7	63.5	64.9	64.9	63.2	65.9	63.4	62.7
25-2411	KS22U7907.13.RS002_UM	73.7	75	68.2	68.5	73.5	64	59	68.2	78.9	78.6	79.1	72.0	80.9	73.3	67.6
25-2412	OK20738_OK	72.0	69	67.8	66.7	68.8	63	58	62.6	72.7	71.4	72.3	70.0	73.3	70.9	68.3
25-2413	OK15Bx7.8.34.20.3_OK	75.8	73	72.7	67.0	70.8	63	57	65.8	74.4	75.5	75.4	70.7	76.3	71.8	68.0

BAKE MIX TIME, ACTUAL
(Uniform Growout) Southern Cooperators A – O

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
25-2401	CO19D087R_CO	7.0	25	6.3	6.8	8.8	5.8	11	6.8	5.0	20	14.0	7.5	8	8.5	14.0
25-2402	CO200037R_CO	5.1	25	4.5	6.1	5.5	5.0	11	4.5	3.8	14	7.0	5.8	6	6.5	12.0
25-2403	TX18DH287_TX	5.4	13	4.8	5.9	6.9	4.0	8	5.0	4.5	10	7.0	6.5	6	4.4	10.0
25-2404	LCH22.7138_LM	6.4	13	5.5	6.9	7.1	5.0	7	5.5	5.0	10	8.0	6.5	6	6.9	11.0
25-2405	LCH21.1343_LM	3.6	13	3.3	4.3	4.1	3.0	6	3.5	3.8	8	7.0	3.8	6	3.5	10.0
25-2406	KS20HD134_KH	5.8	25	5.3	7.6	7.5	4.7	11	5.3	5.0	14	9.0	6.3	7	7.0	11.0
25-2407	KS21H30_KH	5.8	13	5.0	8.0	7.9	4.5	11	5.0	4.8	14	8.0	6.3	6	5.0	12.0
25-2408	SY Monument_CK	10.5	25	7.3	13.2	11.1	6.5	10	7.3	5.0	20	14.0	8.5	6	10.0	13.0
25-2409	WB4650_WB	4.9	20	4.3	6.0	5.8	4.3	9	4.5	4.3	11	9.0	5.0	8	5.5	13.0
25-2410	XH4002_WB	4.4	25	3.8	5.5	4.8	3.8	6	3.3	4.0	8	8.0	4.3	8	4.0	12.0
25-2411	KS22U7907.13.RS002_UM	4.1	12	4.0	4.2	4.8	3.3	8	4.0	4.3	10	6.5	4.8	5	3.5	10.5
25-2412	OK20738_OK	4.1	12	4.3	6.2	5.4	3.5	7	4.0	5.0	8	7.0	5.5	6	4.6	11.0
25-2413	OK15Bx7.8.34.20.3_OK	19.6	30	13.5	19.5	24.5	10.0	22	12.5	4.5	5	11.0	15.0	27	22.0	25.0

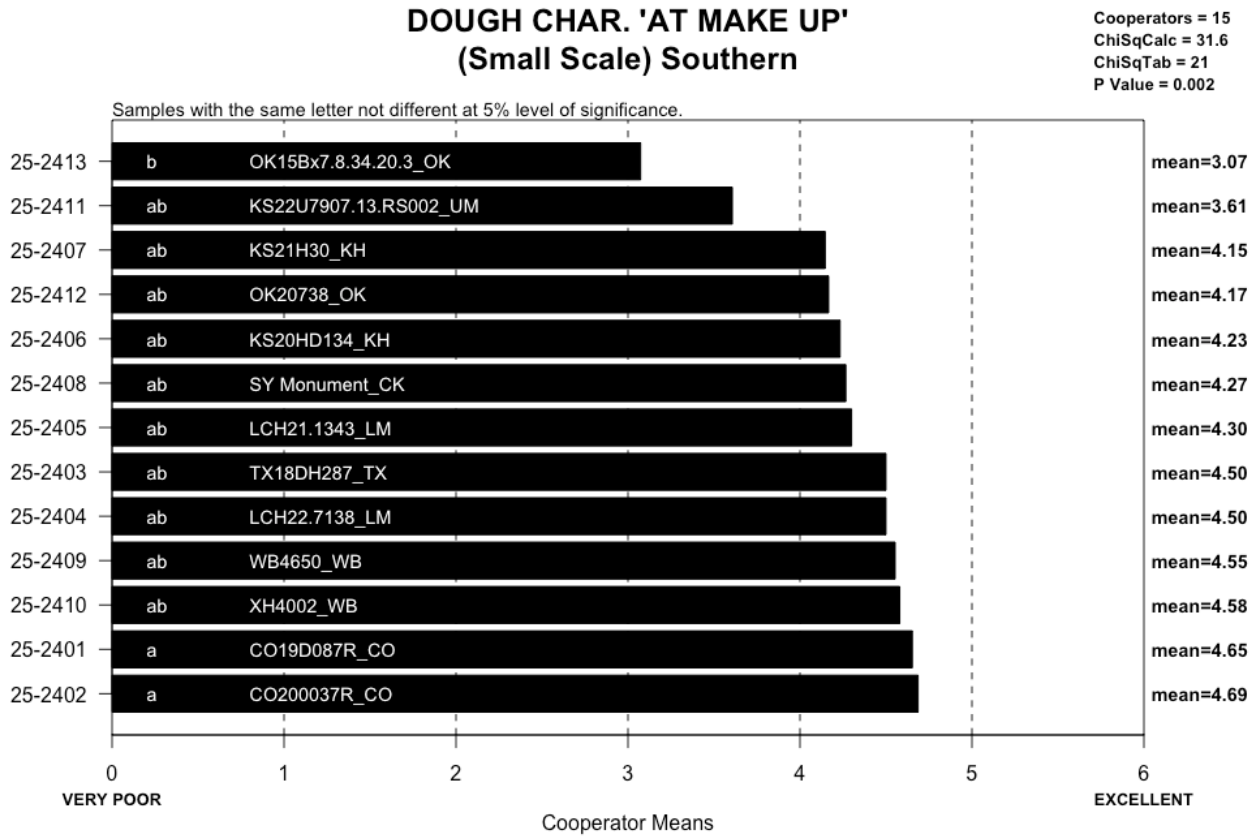

BAKE MIX TIME
(Uniform Growout) Southern
Cooperators = 15
ChiSqCalc = 102.8
ChiSqTab = 21
P Value = <0.001
Samples with the same letter not different at 5% level of significance.
25-2405 c LCH21.1343_LM mean=2.69
25-2411 ce KS22U7907.13.RS002_UM mean=2.91
25-2410 cde XH4002_WB mean=3.20
25-2412 cde OK20738_OK mean=3.35
25-2403 bcde TX18DH287_TX mean=3.66
25-2402 abcde CO200037R_CO mean=3.71
25-2409 abcde WB4650_WB mean=3.77
25-2407 abcde KS21H30_KH mean=3.87
25-2404 abde LCH22.7138_LM mean=4.05
25-2406 abd KS20HD134_KH mean=4.27
25-2401 ab CO19D087R_CO mean=4.92
25-2408 ab SY Monument_CK mean=5.13
25-2413 a OK15Bx7.8.34.20.3_OK mean=5.47
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means


MIXING TOLERANCE
(Uniform Growout) Southern
Cooperators = 15
ChiSqCalc = 39.1
ChiSqTab = 21
P Value = <0.001
Samples with the same letter not different at 5% level of significance.
25-2405 b LCH21.1343_LM mean=3.27
25-2412 ab OK20738_OK mean=3.61
25-2411 ab KS22U7907.13.RS002_UM mean=3.61
25-2413 ab OK15Bx7.8.34.20.3_OK mean=3.87
25-2404 ab LCH22.7138_LM mean=4.09
25-2403 ab TX18DH287_TX mean=4.10
25-2410 ab XH4002_WB mean=4.13
25-2409 ab WB4650_WB mean=4.34
25-2402 ab CO200037R_CO mean=4.51
25-2406 ab KS20HD134_KH mean=4.54
25-2407 a KS21H30_KH mean=4.55
25-2401 a CO19D087R_CO mean=5.25
25-2408 a SY Monument_CK mean=5.26
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means



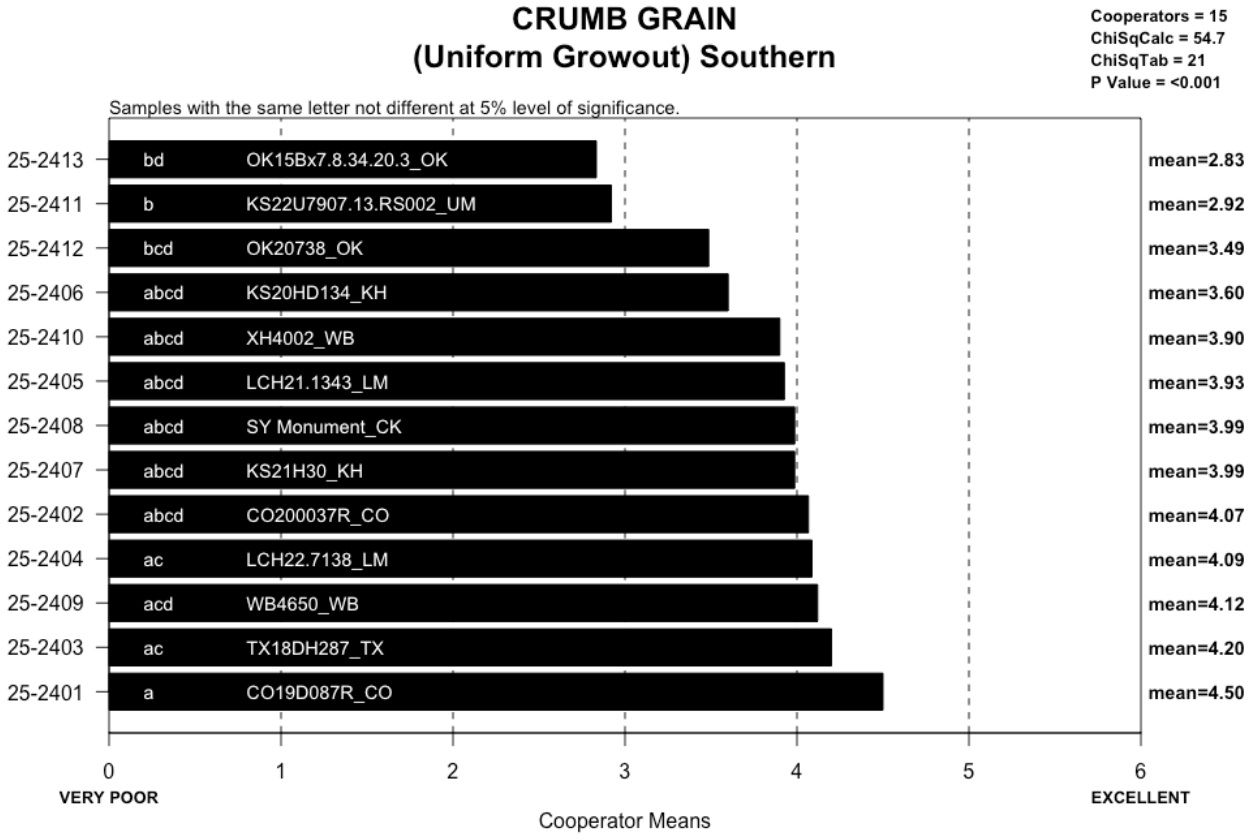
DOUGH CHAR. 'OUT OF MIXER', DESCRIBED
(Uniform Growout) Southern

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
25-2401	CO19D087R_CO	0	0	3	7	5
25-2402	CO200037R_CO	2	1	1	9	2
25-2403	TX18DH287_TX	2	1	1	7	4
25-2404	LCH22.7138_LM	5	2	1	5	2
25-2405	LCH21.1343_LM	5	1	1	6	2
25-2406	KS20HD134_KH	2	0	3	8	2
25-2407	KS21H30_KH	0	0	3	9	3
25-2408	SY Monument_CK	2	1	3	7	2
25-2409	WB4650_WB	3	2	0	8	2
25-2410	XH4002_WB	5	1	0	5	4
25-2411	KS22U7907.13.RS002_UM	6	0	4	3	2
25-2412	OK20738_OK	3	1	1	7	3
25-2413	OK15Bx7.8.34.20.3_OK	2	2	6	5	0



DOUGH CHAR. 'AT MAKE UP', DESCRIBED (Uniform Growout) Southern

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
25-2401	CO19D087R_CO	0	0	1	12	2
25-2402	CO200037R_CO	1	0	1	11	2
25-2403	TX18DH287_TX	1	0	1	10	3
25-2404	LCH22.7138_LM	0	2	2	7	4
25-2405	LCH21.1343_LM	0	4	1	7	3
25-2406	KS20HD134_KH	1	1	5	5	3
25-2407	KS21H30_KH	0	0	5	8	2
25-2408	SY Monument_CK	2	0	2	8	3
25-2409	WB4650_WB	2	0	2	9	2
25-2410	XH4002_WB	1	2	1	7	4
25-2411	KS22U7907.13.RS002_UM	6	2	0	7	0
25-2412	OK20738_OK	2	0	3	9	1
25-2413	OK15Bx7.8.34.20.3_OK	2	2	8	3	0

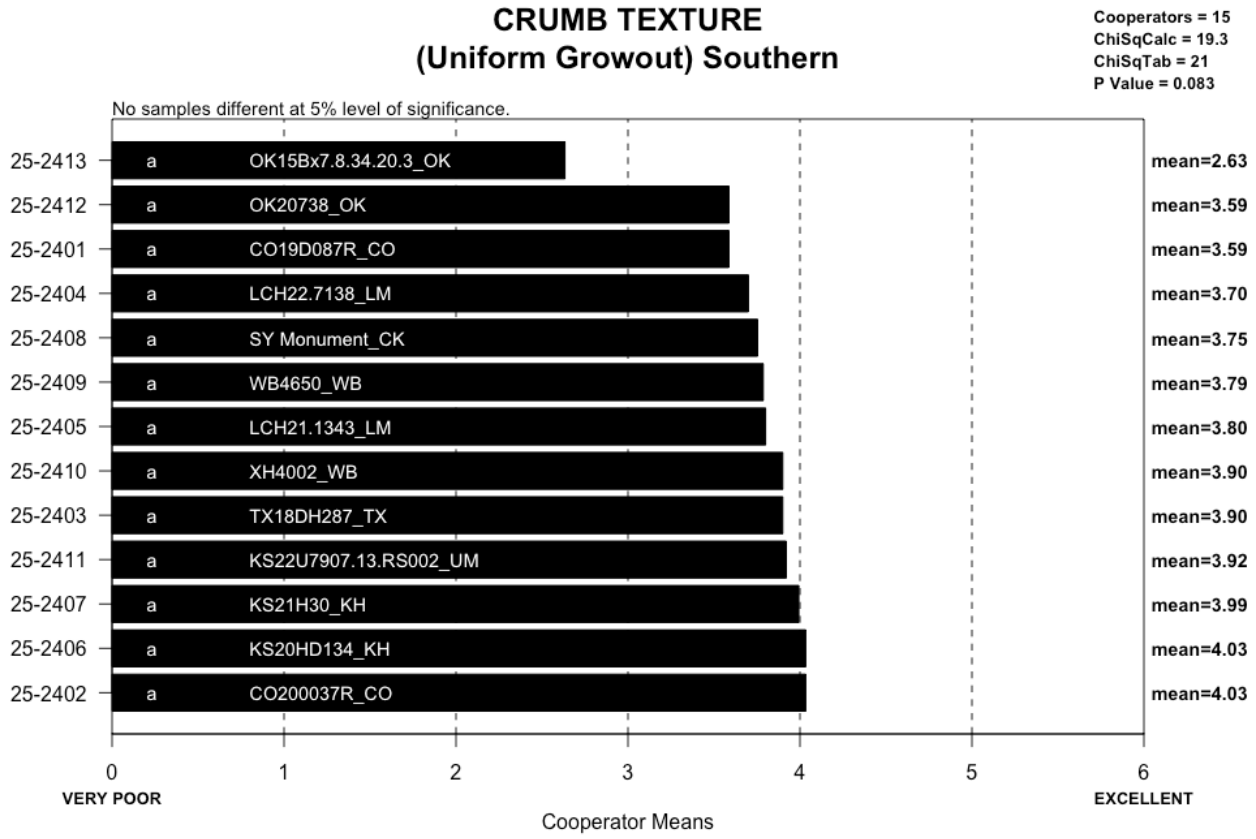


CRUMB GRAIN, DESCRIBED
(Uniform Growout) Southern

IDCODE	ID	Open	Fine	Dense
25-2401	CO19D087R_CO	6	9	0
25-2402	CO200037R_CO	6	8	1
25-2403	TX18DH287_TX	11	4	0
25-2404	LCH22.7138_LM	9	5	1
25-2405	LCH21.1343_LM	10	5	0
25-2406	KS20HD134_KH	11	3	1
25-2407	KS21H30_KH	4	8	3
25-2408	SY Monument_CK	6	5	4
25-2409	WB4650_WB	6	6	3
25-2410	XH4002_WB	5	7	3
25-2411	KS22U7907.13.RS002_UM	11	1	3
25-2412	OK20738_OK	10	3	2
25-2413	OK15Bx7.8.34.20.3_OK	9	1	5

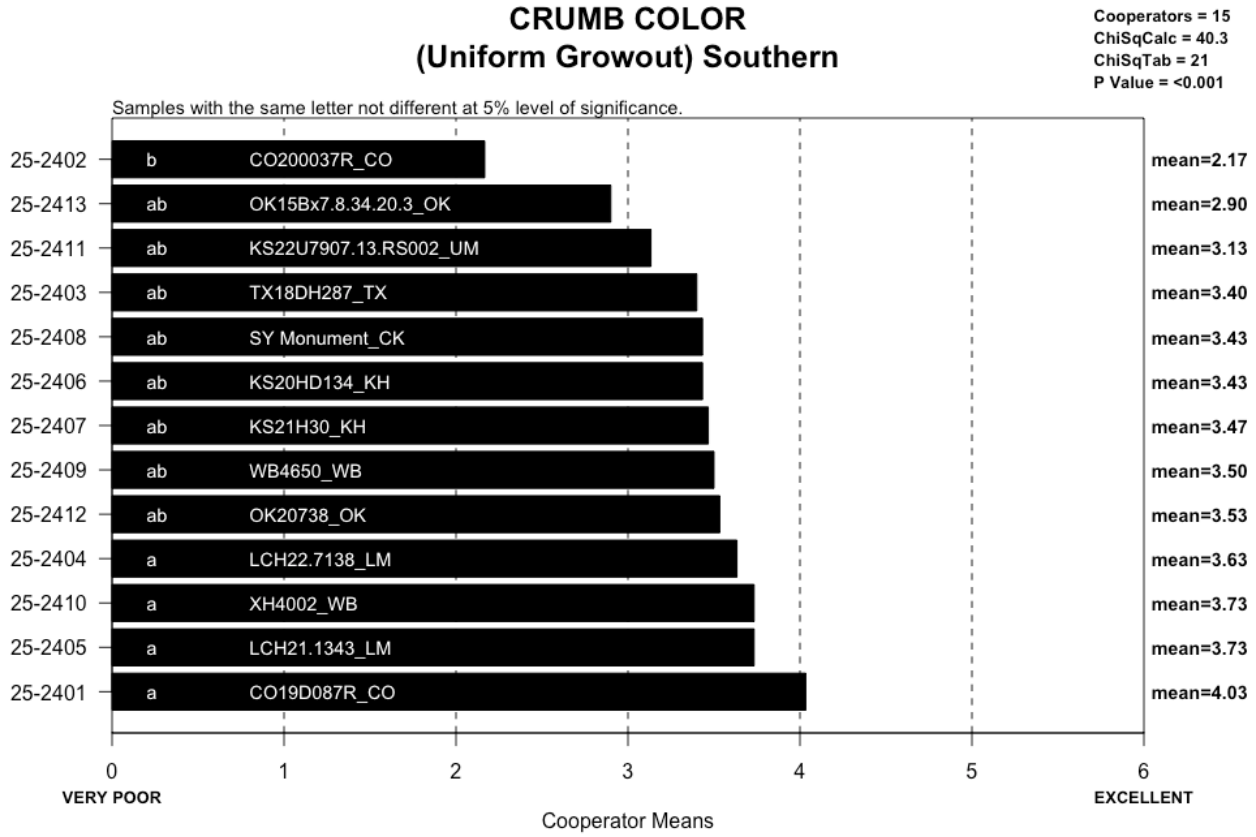
CELL SHAPE, DESCRIBED
(Uniform Growout) Southern

IDCODE	ID	Round	Irregular	Elongated
25-2401	CO19D087R_CO	7	4	4
25-2402	CO200037R_CO	6	7	2
25-2403	TX18DH287_TX	4	8	3
25-2404	LCH22.7138_LM	2	6	7
25-2405	LCH21.1343_LM	9	4	2
25-2406	KS20HD134_KH	6	7	2
25-2407	KS21H30_KH	5	6	4
25-2408	SY Monument_CK	5	2	8
25-2409	WB4650_WB	8	6	1
25-2410	XH4002_WB	7	5	3
25-2411	KS22U7907.13.RS002_UM	7	6	2
25-2412	OK20738_OK	7	6	2
25-2413	OK15Bx7.8.34.20.3_OK	4	8	3



CRUMB TEXTURE, DESCRIBED
(Uniform Growout) Southern

IDCODE	ID	Harsh	Smooth	Silky
25-2401	CO19D087R_CO	4	8	3
25-2402	CO200037R_CO	2	11	2
25-2403	TX18DH287_TX	2	10	3
25-2404	LCH22.7138_LM	4	8	3
25-2405	LCH21.1343_LM	3	10	2
25-2406	KS20HD134_KH	4	6	5
25-2407	KS21H30_KH	3	9	3
25-2408	SY Monument_CK	3	8	4
25-2409	WB4650_WB	4	8	3
25-2410	XH4002_WB	3	9	3
25-2411	KS22U7907.13.RS002_UM	4	7	4
25-2412	OK20738_OK	6	6	3
25-2413	OK15Bx7.8.34.20.3_OK	9	5	1



CRUMB COLOR, DESCRIBED
(Uniform Growout) Southern

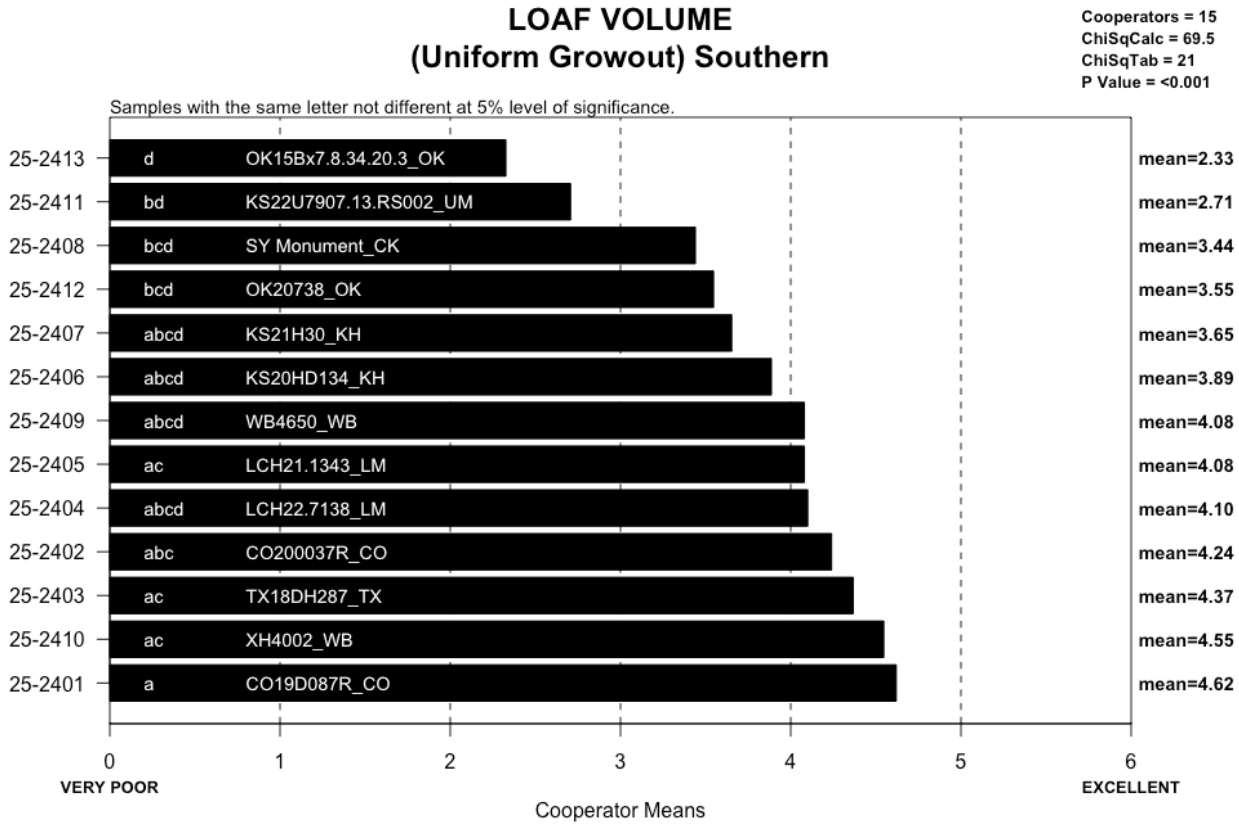
IDCODE	ID	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
25-2401	CO19D087R_CO	0	2	1	1	5	5	1
25-2402	CO200037R_CO	0	6	7	0	2	0	0
25-2403	TX18DH287_TX	1	1	3	1	6	3	0
25-2404	LCH22.7138_LM	0	1	2	3	6	3	0
25-2405	LCH21.1343_LM	1	0	2	2	7	3	0
25-2406	KS20HD134_KH	2	1	1	2	7	1	1
25-2407	KS21H30_KH	1	1	2	2	7	2	0
25-2408	SY Monument_CK	1	0	1	3	10	0	0
25-2409	WB4650_WB	0	1	3	2	8	1	0
25-2410	XH4002_WB	0	1	1	3	6	4	0
25-2411	KS22U7907.13.RS002_UM	1	2	1	3	8	0	0
25-2412	OK20738_OK	0	2	2	1	8	2	0
25-2413	OK15Bx7.8.34.20.3_OK	0	4	1	3	6	1	0

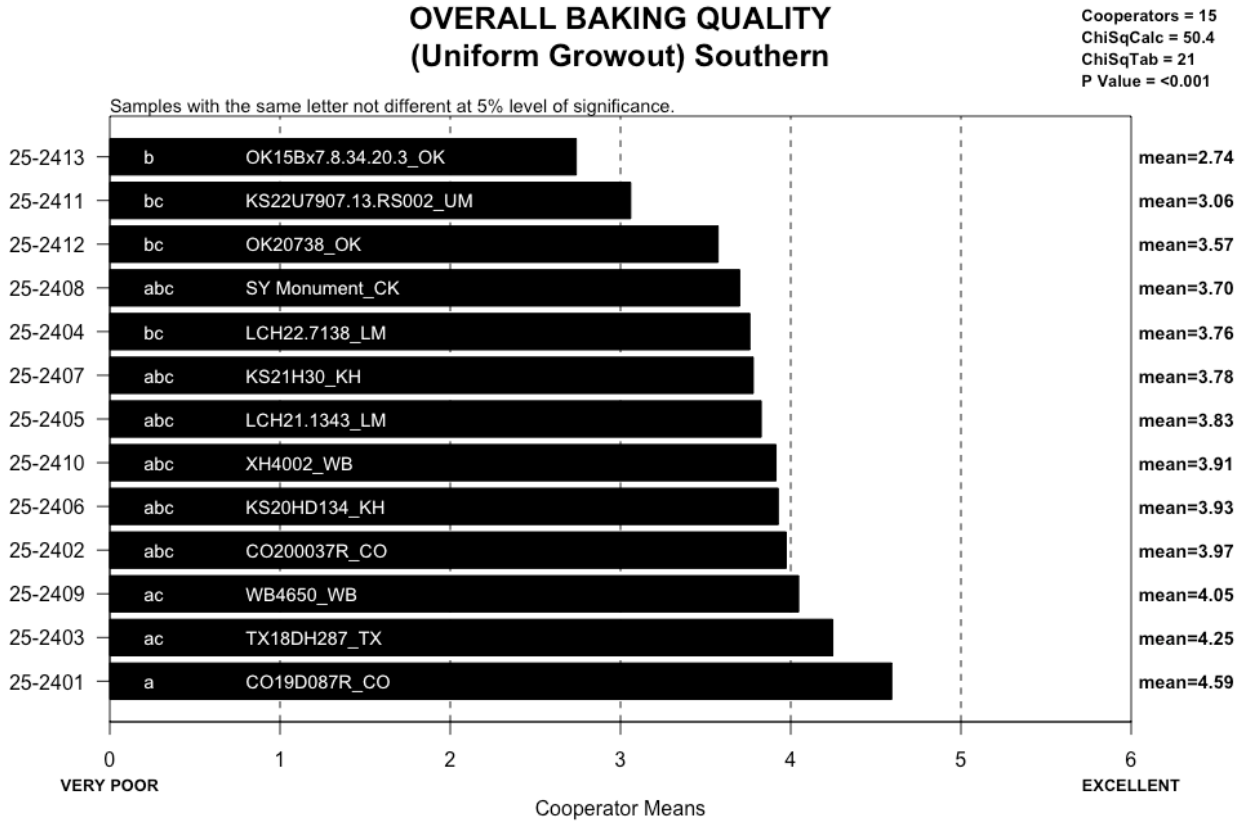
LOAF WEIGHT, ACTUAL
(Uniform Growout) Southern
Cooperators A – O

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
25-2401	CO19D087R_CO	139.8	473.8	139.4	137.6	148.8	143.7	395.6	151.4	129.7	432.6	440	138.8	451	133.0	448.4
25-2402	CO200037R_CO	138.7	470.9	142.5	139.9	154.2	144.7	399.4	150.4	132.1	417.6	435	138.8	446	123.0	443.1
25-2403	TX18DH287_TX	141.3	471.5	145.7	138.0	151.2	145.8	391.6	149.7	132.3	416.6	435	137.0	447	140.2	441.8
25-2404	LCH22.7138_LM	138.4	473.9	139.4	140.6	148.0	145.3	388.9	149.2	131.9	419.6	436	140.2	453	134.1	447.2
25-2405	LCH21.1343_LM	140.9	471.0	144.1	138.8	152.3	145.8	397.4	152.4	131.6	430.3	433	139.7	451	135.8	446.5
25-2406	KS20HD134_KH	140.5	472.2	143.4	140.4	152.8	146.5	390.8	153.4	133.9	416.3	432	137.2	449	133.7	445.2
25-2407	KS21H30_KH	137.8	467.8	146.1	142.2	151.2	145.8	386.8	150.1	135.7	423.5	438	137.8	451	142.3	448.4
25-2408	SY Monument_CK	144.6	468.7	144.6	142.0	151.7	147.5	393.4	153.3	137.2	461.3	440	140.5	462	138.4	454.4
25-2409	WB4650_WB	138.0	472.0	145.9	140.8	149.8	147.3	392.3	140.3	133.1	417.1	440	138.8	454	137.7	451.4
25-2410	XH4002_WB	137.5	471.3	142.5	141.8	150.7	145.8	390.1	148.7	134.3	417.0	434	138.6	455	138.2	450.3
25-2411	KS22U7907.13.RS002_UM	147.2	459.7	145.5	146.3	159.4	149.3	394.2	155.1	141.4	416.5	420	137.4	436	146.0	448.1
25-2412	OK20738_OK	141.6	465.1	148.5	142.4	156.2	149.2	385.7	152.8	138.5	414.2	433	139.4	456	143.7	427.5
25-2413	OK15Bx7.8.34.20.3_OK	145.9	471.4	144.6	136.0	154.2	148.6	386.3	152.4	145.8	430.1	433	138.1	450	139.4	433.6

LOAF VOLUME, ACTUAL (Uniform Growout) Southern Cooperators A – O

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
25-2401	CO19D087R_CO	970	3132	950	880	895	875	2775	902	880	2725	2245	837	2482	920	2027
25-2402	CO200037R_CO	885	3042	900	909	845	875	2750	840	895	2700	2292	797	2387	925	2079
25-2403	TX18DH287_TX	860	3012	935	853	830	900	2825	844	910	3000	2312	784	2305	850	2103
25-2404	LCH22.7138_LM	780	3012	935	845	765	825	2675	782	875	2850	2351	749	2341	795	2122
25-2405	LCH21.1343_LM	935	3012	865	924	850	800	2875	848	935	2300	2317	832	2328	910	2044
25-2406	KS20HD134_KH	825	2937	805	878	905	775	2625	804	900	2750	2246	848	2221	795	1862
25-2407	KS21H30_KH	900	3042	940	833	805	725	2550	801	870	2600	2304	789	2193	710	1951
25-2408	SY Monument_CK	820	2997	945	905	750	725	2550	781	840	2650	2218	773	2081	750	1854
25-2409	WB4650_WB	910	3057	900	870	845	750	2725	809	853	2725	2202	815	2338	885	1996
25-2410	XH4002_WB	910	2997	875	916	850	875	2925	925	890	2700	2253	861	2307	968	2033
25-2411	KS22U7907.13.RS002_UM	725	2637	855	861	805	700	2550	760	900	2375	2076	740	1907	795	1989
25-2412	OK20738_OK	840	2997	825	819	790	725	2600	742	890	2825	2200	760	2078	840	1958
25-2413	OK15Bx7.8.34.20.3_OK	810	2877	950	489	805	600	2625	723	570	1675	1885	752	2256	755	1832


LOAF VOLUME
(Uniform Growout) Southern
Cooperators = 15
ChiSqCalc = 69.5
ChiSqTab = 21
P Value = <0.001
Samples with the same letter not different at 5% level of significance.
25-2413 d OK15Bx7.8.34.20.3_OK mean=2.33
25-2411 bd KS22U7907.13.RS002_UM mean=2.71
25-2408 bcd SY Monument_CK mean=3.44
25-2412 bcd OK20738_OK mean=3.55
25-2407 abcd KS21H30_KH mean=3.65
25-2406 abcd KS20HD134_KH mean=3.89
25-2409 abcd WB4650_WB mean=4.08
25-2405 ac LCH21.1343_LM mean=4.08
25-2404 abcd LCH22.7138_LM mean=4.10
25-2402 abc CO200037R_CO mean=4.24
25-2403 ac TX18DH287_TX mean=4.37
25-2410 ac XH4002_WB mean=4.55
25-2401 a CO19D087R_CO mean=4.62
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


OVERALL BAKING QUALITY
(Uniform Growout) Southern
Cooperators = 15
ChiSqCalc = 50.4
ChiSqTab = 21
P Value = <0.001
Samples with the same letter not different at 5% level of significance.
25-2413 b OK15Bx7.8.34.20.3_OK mean=2.74
25-2411 bc KS22U7907.13.RS002_UM mean=3.06
25-2412 bc OK20738_OK mean=3.57
25-2408 abc SY Monument_CK mean=3.70
25-2404 bc LCH22.7138_LM mean=3.76
25-2407 abc KS21H30_KH mean=3.78
25-2405 abc LCH21.1343_LM mean=3.83
25-2410 abc XH4002_WB mean=3.91
25-2406 abc KS20HD134_KH mean=3.93
25-2402 abc CO200037R_CO mean=3.97
25-2409 ac WB4650_WB mean=4.05
25-2403 ac TX18DH287_TX mean=4.25
25-2401 a CO19D087R_CO mean=4.59
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

COOPERATOR'S COMMENTS
(Uniform Growout) Southern
Cooperators A – O

2S-2401	CO19D087R_CO
A	Longer mix time, but very good tolerance, very good dough feel out of the mixer and at make up, and larger loaf volume than predicted with protein. Overall acceptable quality.
B	Excellent sponge rating, mix time, and volume. Average absorption.
C	nice loaf externals
D	Low Water Abs, Long MT, Slightly Sticky & Strong Dough, High Loaf Volume, Dark Yellow Crumb Grain, Fine Elongated Cells, Good Resilient & Smooth Texture
E	Long mix time, low absorp. Good dough throughout, open best grain. Good volume. Excellent mix toler.
F	No comment.
G	Good volume, mix time, and interior
H	No comment.
I	No comment.
J	Good protein, absorption, and volume. High stability and mix time.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	Cohesive texture
2S-2402	CO200087R_CO
A	Dark yellow flour and bread crumb, but overall acceptable quality.
B	Long hydration; help with clean-up. Excellent absorption, mix time, and volume.
C	yellow
D	Medium Water Abs, Good MT, Slightly Sticky & Strong Dough, High Loaf Volume, Yellow Crumb Grain, Open Elongated Cells, Good Resilient & Smooth Texture
E	Good mix time & toler., avg absorp. Tough dough. Avg open, irregular dark yellow crumb grain. Lower volume.
F	No comment.
G	Good volume, mix time, very yellow interior
H	No comment.
I	No comment.
J	High protein, absorption, and mix time. Good stability and volume. Yellow color.
K	No comment.
L	No comment.
M	very yellow crumb
N	No comment.
O	Cohesive texture
2S-2403	TX18DH087_TX
A	Yellow flour and bread crumb, but overall acceptable quality.
B	Excellent sponge rating, absorption, and volume. Average mix time.
C	dry?, slight cap, rough break
D	Medium Water Abs, Normal MT, Slightly Sticky & Strong Dough, High Loaf Volume, Dark Yellow Crumb Grain, Slightly Open Elongated Cells, Good Resilient & Smooth Texture
E	Long mix time, lower absorp. Tough dough. Avg open, round grain. Lower volume. Avg mix toler.
F	No comment.
G	Good volume, shorter mix time, slightly sticky
H	No comment.
I	No comment.
J	Good protein, stability, and mix time. High absorption and volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	No comment.

COOPERATOR'S COMMENTS
(Uniform Growout) Southern
Cooperators A – O

25-2404	LCH22-7138_LM
A	Yellow flour and bread crumb, but good mixing tolerance, and overall acceptable quality.
B	Optimum dough handling with average mix and absorption. Excellent volume.
C	slight cap
D	Low Water Abs, Long MT, Slightly Sticky & Weak Dough, Medium Loaf Volume, Yellow Crumb Grain, Slightly Open Elongated Cells, Good Resilient & Smooth Texture
E	Long mix time, lowest asorp. Tougher dough. Avg open, dull colored grain. Very low volume. Excellent mix toler.
F	No comment.
G	Lower volume, short mix time, sticky
H	No comment.
I	No comment.
J	Good protein, stability, and mix time. High absorption and volume.
K	No comment.
L	sidewall collapse on final loaves
M	No comment.
N	No comment.
O	No comment.
25-2405	LCH21-1343_LM
A	Overall acceptable quality.
B	Optimum dough handling with average mix and absorption. Excellent volume.
C	left and right break
D	Medium Water Abs, Normal MT, Slightly Sticky & Strong Dough, High Loaf Volume, Yellow Crumb Grain, Open Elongated Cells, Good Resilient & Smooth Texture
E	Shorter mix time, low absorp. Wet dough at make up. Avg open smooth texture grain. Avg volume & mix toler.
F	No comment.
G	Good volume, short mix time, sticky
H	No comment.
I	No comment.
J	High protein and absorption. Good stability and mix time. Fair volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	No comment.
25-2406	KS20HD134_KH
A	Tough dough out of mixer that improved at make up, slightly poor bread grain and slightly lower volume than predicted with protein. Overall acceptable quality.
B	Optimum dough handling with excellent absorption rating, mix time and volume.
C	left and right break
D	High Water Abs, Long MT, Slightly Sticky & Strong Dough, High Loaf Volume, Dark Yellow Crumb Grain, Open Elongated Cells, Good Resilient & Slightly Harsh Texture
E	Long mix time, avg absorp. Tough dough. Avg open smooth texture grain. Excellent volume & mix toler.
F	No comment.
G	Lower volume, good mix time, excelent out of mixer
H	No comment.
I	No comment.
J	High protein and absorption. Good stability, mix time, and volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	less no.of cells

COOPERATOR'S COMMENTS
(Uniform Growout) Southern
Cooperators A – O

25-2407	KS21H30_KH
A	Very good dough feel, acceptable volume, and dull color crumb. Overall acceptable quality.
B	Excellent bake absorption with average mix time and excellent volume.
C	slight cap
D	High Water Abs, Very Long MT, Slightly Sticky & Weak Dough, Medium Loaf Volume, Dull Crumb Grain, Fine Elongated Cells, Good Resilient & Smooth Texture
E	Long mix time, lower absorp. Tough dough. Avg open, round grain. Lower volume. Avg mix toler.
F	No comment.
G	Lower volume, good mix time, excelent out of mixer
H	No comment.
I	No comment.
J	High protein, absorption, and mix time. Good stability. Fair volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	less no.of cells, Grainy Crumb
25-2408	SY Monument_CK
A	Very long mix time, good dough feel and bread crumb, but slightly lower loaf volume than predicted with protein. Overall acceptable quality.
B	Slightly tight dough with excellent absorption and mix time. Excellent volume.
C	tough, nice loaf externals
D	High Water Abs, Very Long MT, Slightly Sticky & Strong Dough, High Loaf Volume, Dull Crumb Grain, Fine Elongated Cells, Good Resilient & Smooth Texture
E	Longer mix time, avg absorp. Tough dough. Avg open, dull colored grain. Lowest volume. Excellent mix toler.
F	No comment.
G	Lower volume, good mix time, excelent out of mixer
H	No comment.
I	No comment.
J	High protein, absorption, and mix time. Good stability. Fair volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	No comment.
25-2409	WB4650_WB
A	Good dough feel and acceptable bread product. Overall acceptable quality.
B	Good absorption, excellent mix time and volume.
C	slight cap
D	Medium Water Abs, Normal MT, Slightly Sticky & Weak Dough, High Loaf Volume, Yellow Crumb Grain, Fine Elongated Cells, Good Resilient & Smooth Texture
E	Good mix time, low absorp. Good dough at make up. Avg open grain. Lower volume & mix toler.
F	No comment.
G	Good volume, good mix time, good dough out of mixer
H	No comment.
I	No comment.
J	Good protein, high absorption, stability, mix time and volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	No comment.

COOPERATOR'S COMMENTS (Uniform Growout) Southern Cooperators A – O

25-2410	XH4002_WB
A	Overall acceptable quality.
B	Slightly tight doug with good absorption, excellent mix time and volume.
C	left and right break
D	High Water Abs, Normal MT, Slightly Sticky & Strong Dough, High Loaf Volume, Dull Crumb Grain, Open Irregular Cells, Soft Resilient & Slightly Harsh Texture
E	Shorter mix time, low absorp. Good dough at make up. Avg open smooth texture grain. Avg volume & mix toler.
F	No comment.
G	Great volume, short mix time, slightly sticky dough
H	No comment.
I	No comment.
J	High protein and absorption. Good stability, mix time, and volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	No comment.
25-2411	KS22U7907.13.RS002_UM
A	Tough dough out of mixer but improved at make up, poorer crumb grain and poor loaf volume. Overall poorer quality.
B	Likely overhydrated with shorter mix time and sticky dough handling.
C	tough, left and right break
D	Very High Water Abs, Normal MT, Slightly Sticky & Strong Dough, High Loaf Volume, Dark Yellow Crumb Grain, Open Round Cells, Good Resilient & Slightly Harsh Texture
E	Shorter mix time, highest absorp. Sticky dough throughout. Lowest rated crumb grain. Low volume. Avg mix toler.
F	No comment.
G	Lower volume, short mix time, slightly sticky dough
H	No comment.
I	No comment.
J	High protein and absorption. Good stability and mix time. Fair volume.
K	No comment.
L	No comment.
M	very wet
N	No comment.
O	Very Dark Crust Color, cohesive texture
25-2412	OK20738_OK
A	Slightly poor loaf volume but overall aceeptable quality.
B	Slightly soft dough handling with shorter mix time. Excellent loaf volume.
C	left and right break
D	Very High Water Abs, Normal MT, Slightly Sticky & Strong Dough, Fair Loaf Volume, Dark Yellow Crumb Grain, Open Irregular Cells, Soft Resilient & Slightly Harsh Texture
E	Good mix time, high absorp. Sticky dough throughout. Avg open crumb grain. Very low volume. Avg mix toler.
F	No comment.
G	Lower volume, short mix time, very sticky dough
H	No comment.
I	No comment.
J	High protein and absorption. Good stability, mix time, and volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	Very Dark Crust Color

COOPERATOR'S COMMENTS (Uniform Growout) Southern Cooperators A – O

25-2413	OK15Bx7-8-34-20-3_OK
A	Extremely long mix time, tough dough, poorer crumb grain, slightly harsh texture, and poorer loaf volume than predicted with protein. Overall, poor quality.
B	Sponge underhydrated / crumbled appearance.Didn't reach full hydration within 30 minute mix time; helped dough clean-up. High absorption with long mix time and average volume.
C	long time to pick up, tough, bucky, rough break
D	Very High Water Abs, Extremely Long MT, Very Sticky & Weak Dough, Very Low Loaf Volume, Dark Yellow Crumb Grain, Open Irregular Cells, Hard Resilient & Harsh Texture
E	Extremely long-longest mix time, higher absorp. Tougher dough. Avg open dull colored grain. Lower volume.
F	No comment.
G	Lower volume, long mix time, tougher dough
H	No comment.
I	No comment.
J	High protein and very high absorption. Low stability, mix time, and volume. Negative bench comments. Dark yellow color.
K	No comment.
L	No comment.
M	No comment.
N	The dough developed well at a mixing time of 22 minutes, but remained sticky and wet until about 15–18 minutes.
O	No comment.

SOUTHERN MICRO-QUALITY ANALYSIS

1. LOCATIONS AND ENTRIES

Entry_Code	Entry_ID	Entry_No	Breeding Programs	Locations*
25-LM2401	CO19D087R	2401	CSU	LM
25-LM2402	CO200037R	2402	CSU	LM
25-LM2403	TX18DH287	2403	Texas A&M AgriLife	LM
25-LM2404	LCH22-7138	2404	LCS	LM
25-LM2405	LCH21-1343	2405	LCS	LM
25-LM2406	KS20HD134	2406	KSU-Hays	LM
25-LM2407	KS21H30	2407	KSU-Hays	LM
25-LM2408	SY Monument	2408	CHECK	LM
25-LM2409	WB4650	2409	Bayer/WestBred	LM
25-LM2410	XH4002	2410	Bayer/WestBred	LM
25-LM2411	KS22U7907.13.RS002	2411	USDA Manhattan	LM
25-LM2412	OK20738	2412	OSU	LM
25-LM2413	OK15Bx7-8-34-20-3	2413	OSU	LM
25-UM2401	CO19D087R	2401	CSU	UM
25-UM2402	CO200037R	2402	CSU	UM
25-UM2403	TX18DH287	2403	Texas A&M AgriLife	UM
25-UM2404	LCH22-7138	2404	LCS	UM
25-UM2405	LCH21-1343	2405	LCS	UM
25-UM2406	KS20HD134	2406	KSU-Hays	UM
25-UM2407	KS21H30	2407	KSU-Hays	UM
25-UM2408	SY Monument	2408	CHECK	UM
25-UM2409	WB4650	2409	Bayer/WestBred	UM
25-UM2410	XH4002	2410	Bayer/WestBred	UM
25-UM2411	KS22U7907.13.RS002	2411	USDA Manhattan	UM
25-UM2412	OK20738	2412	OSU	UM
25-UM2413	OK15Bx7-8-34-20-3	2413	OSU	UM
25-OK2401	CO19D087R	2401	CSU	OK
25-OK2402	CO200037R	2402	CSU	OK
25-OK2403	TX18DH287	2403	Texas A&M AgriLife	OK
25-OK2404	LCH22-7138	2404	LCS	OK
25-OK2405	LCH21-1343	2405	LCS	OK
25-OK2406	KS20HD134	2406	KSU-Hays	OK
25-OK2407	KS21H30	2407	KSU-Hays	OK
25-OK2408	SY Monument	2408	CHECK	OK
25-OK2409	WB4650	2409	Bayer/WestBred	OK
25-OK2410	XH4002	2410	Bayer/WestBred	OK

25-OK2411	KS22U7907.13.RS002	2411	USDA Manhattan	OK
25-OK2412	OK20738	2412	OSU	OK
25-OK2413	OK15Bx7-8-34-20-3	2413	OSU	OK
25-CO2401	CO19D087R	2401	CSU	CO
25-CO2402	CO200037R	2402	CSU	CO
25-CO2403	TX18DH287	2403	Texas A&M AgriLife	CO
25-CO2404	LCH22-7138	2404	LCS	CO
25-CO2405	LCH21-1343	2405	LCS	CO
25-CO2406	KS20HD134	2406	KSU-Hays	CO
25-CO2407	KS21H30	2407	KSU-Hays	CO
25-CO2408	SY Monument	2408	CHECK	CO
25-CO2409	WB4650	2409	Bayer/WestBred	CO
25-CO2410	XH4002	2410	Bayer/WestBred	CO
25-CO2411	KS22U7907.13.RS002	2411	USDA Manhattan	CO
25-CO2412	OK20738	2412	OSU	CO
25-CO2413	OK15Bx7-8-34-20-3	2413	OSU	CO
25-KH2401	CO19D087R	2401	CSU	KM
25-KH2402	CO200037R	2402	CSU	KM
25-KH2403	TX18DH287	2403	Texas A&M AgriLife	KM
25-KH2404	LCH22-7138	2404	LCS	KM
25-KH2405	LCH21-1343	2405	LCS	KM
25-KH2406	KS20HD134	2406	KSU-Hays	KM
25-KH2407	KS21H30	2407	KSU-Hays	KM
25-KH2408	SY Monument	2408	CHECK	KM
25-KH2409	WB4650	2409	Bayer/WestBred	KM
25-KH2410	XH4002	2410	Bayer/WestBred	KM
25-KH2411	KS22U7907.13.RS002	2411	USDA Manhattan	KM
25-KH2412	OK20738	2412	OSU	KM
25-KH2413	OK15Bx7-8-34-20-3	2413	OSU	KM
25-TX2401	CO19D087R	2401	CSU	TX
25-TX2402	CO200037R	2402	CSU	TX
25-TX2403	TX18DH287	2403	Texas A&M AgriLife	TX
25-TX2404	LCH22-7138	2404	LCS	TX
25-TX2405	LCH21-1343	2405	LCS	TX
25-TX2406	KS20HD134	2406	KSU-Hays	TX
25-TX2407	KS21H30	2407	KSU-Hays	TX
25-TX2408	SY Monument	2408	CHECK	TX
25-TX2409	WB4650	2409	Bayer/WestBred	TX
25-TX2410	XH4002	2410	Bayer/WestBred	TX
25-TX2411	KS22U7907.13.RS002	2411	USDA Manhattan	TX
25-TX2412	OK20738	2412	OSU	TX
25-TX2413	OK15Bx7-8-34-20-3	2413	OSU	TX

A. There are 6 locations:

Limagrain = LM;

USDA Manhattan =UM;

Oklahoma = OK;

Colorado = CO;

Kansas Hays = KH;

Texas A&M = TX.

B. There are 13 entries grown in each of the locations:

CO19D087R (CSU) = 2401

CO200037R (CSU) = 2402

TX18DH287 (TAMU) = 2403

LCH22-7138 (LCS) = 2404

LCH21-1343 (LCS) =2405

KS20HD134 (KSU-Hays) = 2406

KS21H30 (KSU-Hays) = 2407

SY Monument (Check) =2408

WB4650 (Bayer/WestBred) = 2409

XH4002 (Bayer/WestBred) = 2410

KS22U7907.13.RS002 (USDA-KS) = 2411

OK20738 (OSU) = 2412

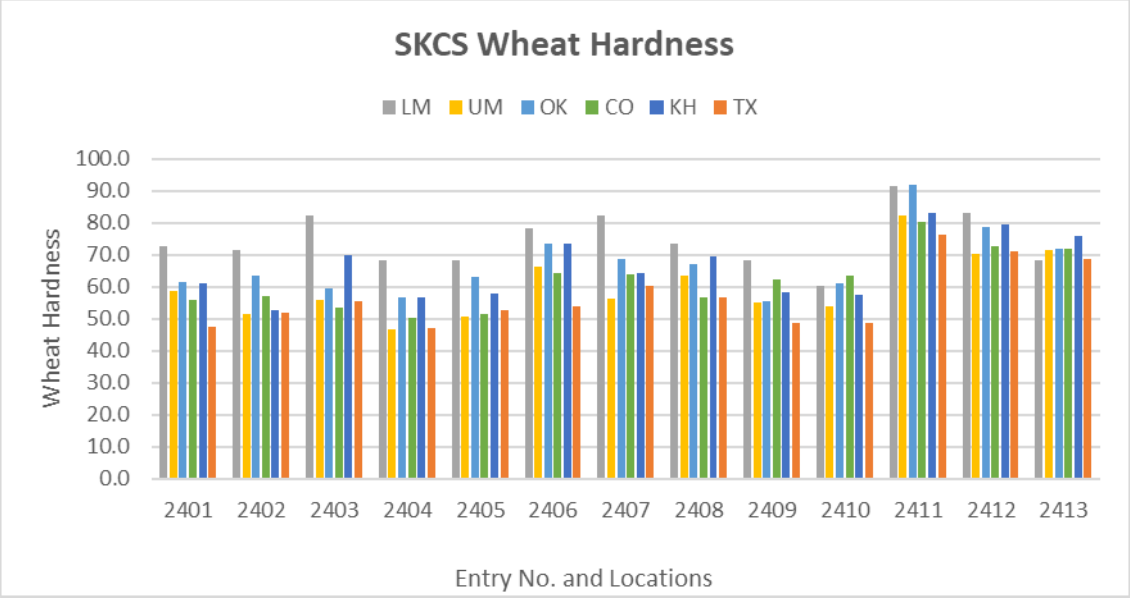
OK15Bx7-8-34-30-3 (OSU) = 2413.

A. Kernel Hardness

SKCS Wheat Kernel Hardness

	LOCATIONS							
Entry No.	**LM**	**UM**	**OK**	**CO**	**KH**	**TX**	**Avg**	**StDev**
2401	72.6	58.7	61.5	55.7	61.2	47.4	59.5	8.23
2402	71.6	51.6	63.7	57.1	52.6	52.1	58.1	8.03
2403	82.5	56.1	59.7	53.6	70.0	55.4	62.9	11.25
2404	68.3	46.8	56.9	50.4	56.8	47.3	54.4	8.13
2405	68.3	50.8	63.2	51.6	57.8	52.7	57.4	7.12
2406	78.5	66.2	73.5	64.3	73.3	54.0	68.3	8.71
2407	82.5	56.2	68.9	63.8	64.4	60.2	66.0	9.14
2408	73.7	63.4	67.0	56.5	69.5	56.6	64.5	6.98
2409	68.2	55.0	55.7	62.4	58.2	48.6	58.0	6.72
2410	60.2	54.1	61.1	63.6	57.6	48.6	57.5	5.44
2411	91.7	82.5	91.9	80.3	83.0	76.3	84.3	6.28
2412	83.0	70.5	78.8	72.9	79.4	71.1	75.9	5.15
2413	68.3	71.3	71.8	72.1	76.1	68.7	71.4	2.82
Avg.	74.6	60.2	67.2	61.9	66.1	56.8		
StDev	8.58	10.07	10.01	9.00	9.76	9.58		

LM=Limagrain; UM=USDA-Manhattan; OK=OSU; CO=CSU; KH=Kansas Hays; TX=Texas A&M

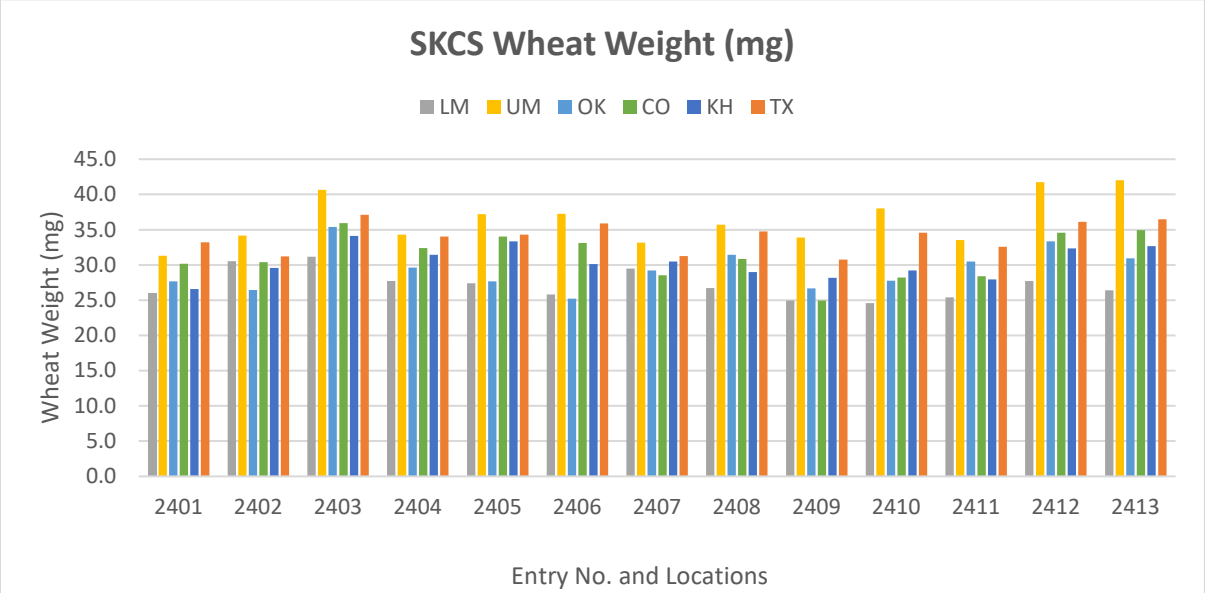


B. Kernel Weight (mg)

SKCS Wheat Kernel Weight (mg)

	LOCATIONS							
Entry No.	LM	UM	OK	CO	KH	TX	Avg	StDev
2401	26.1	31.3	27.7	30.2	26.6	33.2	29.2	2.84
2402	30.6	34.2	26.4	30.4	29.6	31.2	30.4	2.50
2403	31.2	40.7	35.4	35.9	34.1	37.1	35.7	3.15
2404	27.7	34.3	29.6	32.4	31.4	34.1	31.6	2.57
2405	27.4	37.2	27.7	34.0	33.4	34.3	32.3	3.94
2406	25.8	37.3	25.2	33.1	30.1	35.9	31.2	5.08
2407	29.5	33.2	29.2	28.5	30.5	31.3	30.4	1.67
2408	26.7	35.7	31.5	30.8	29.0	34.8	31.4	3.40
2409	24.9	33.9	26.7	25.0	28.2	30.8	28.2	3.54
2410	24.6	38.0	27.8	28.2	29.2	34.6	30.4	4.96
2411	25.4	33.5	30.5	28.4	28.0	32.6	29.7	3.06
2412	27.7	41.7	33.3	34.6	32.3	36.1	34.3	4.62
2413	26.4	42.0	30.9	34.9	32.7	36.5	33.9	5.30
Avg.	27.2	36.4	29.4	31.3	30.4	34.0		
StDev	2.09	3.45	2.91	3.23	2.28	2.11		

LM=Limagrain; UM=USDA-Manhattan; OK=OSU; CO=CSU; KH=Kansas Hays; TX=Texas A&M

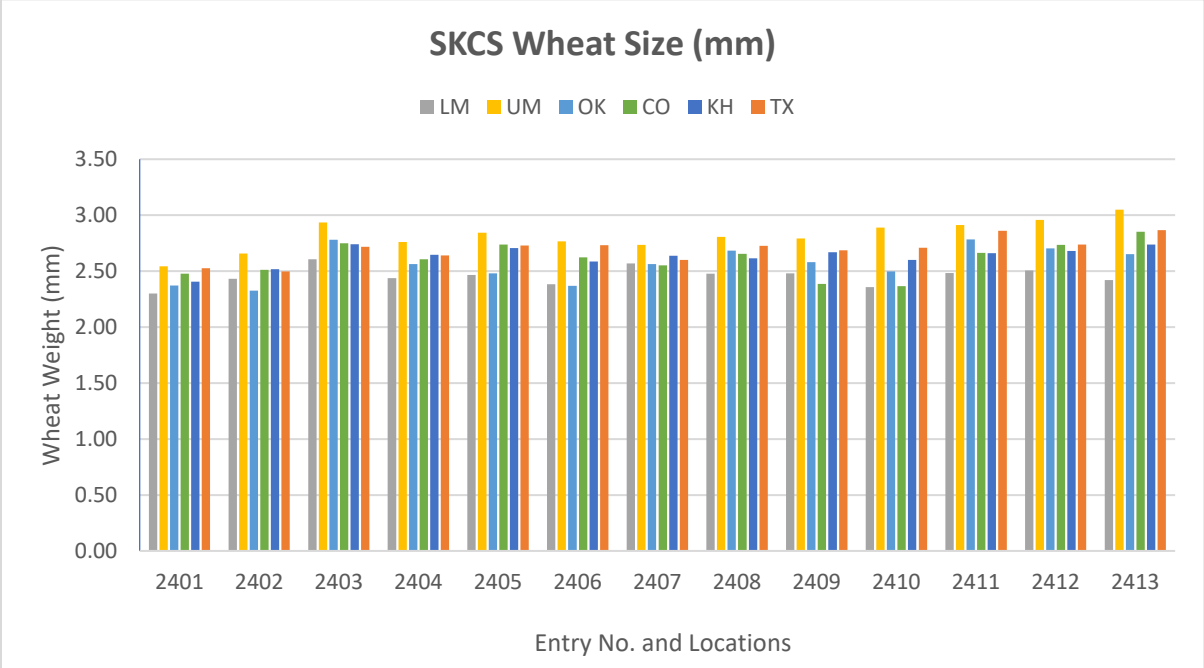


C. Kernel Size

SKCS Wheat Kernel Size (mm)

	LOCATIONS							
Entry No.	LM	UM	OK	CO	KH	TX	Avg	StDev
2401	2.30	2.54	2.37	2.48	2.40	2.53	2.44	0.09
2402	2.43	2.66	2.33	2.51	2.52	2.50	2.49	0.11
2403	2.61	2.94	2.78	2.75	2.74	2.72	2.75	0.11
2404	2.44	2.76	2.56	2.61	2.65	2.64	2.61	0.11
2405	2.47	2.84	2.48	2.74	2.71	2.73	2.66	0.15
2406	2.38	2.77	2.37	2.62	2.59	2.73	2.58	0.17
2407	2.57	2.74	2.56	2.55	2.64	2.60	2.61	0.07
2408	2.48	2.81	2.68	2.66	2.61	2.73	2.66	0.11
2409	2.48	2.79	2.58	2.39	2.67	2.69	2.60	0.15
2410	2.36	2.89	2.50	2.37	2.60	2.71	2.57	0.21
2411	2.48	2.91	2.78	2.66	2.66	2.86	2.73	0.16
2412	2.51	2.96	2.70	2.74	2.68	2.74	2.72	0.14
2413	2.42	3.05	2.65	2.85	2.74	2.87	2.76	0.22
Avg.	2.46	2.82	2.57	2.61	2.63	2.69		
StDev	0.08	0.13	0.15	0.15	0.09	0.11		

LM=Limagrain; UM=USDA-Manhattan; OK=OSU; CO=CSU; KH=Kansas Hays; TX=Texas A&M



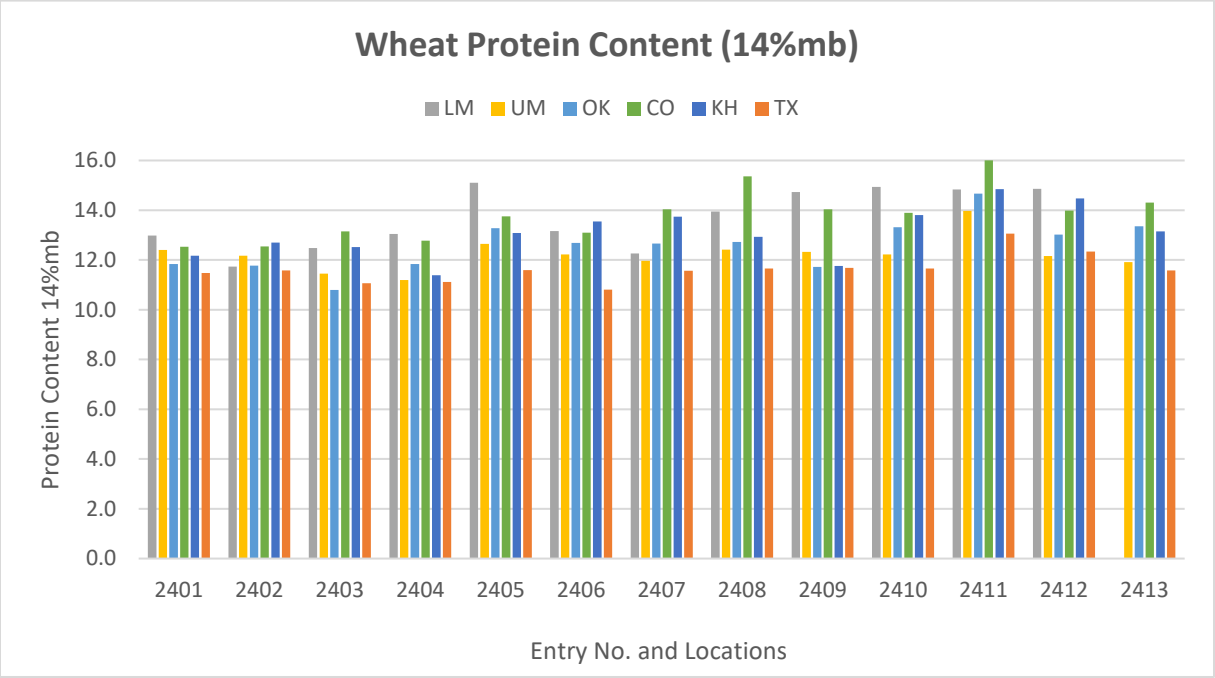
2. PROTEN CONTENT

A. Wheat Protein

Wheat Protein Content (14%mb)

Entry No.	LOCATIONS LM	UM	OK	CO	KH	TX	Avg	StDev
2401	13.0	12.4	11.8	12.5	12.2	11.5	12.2	0.53
2402	11.7	12.2	11.8	12.5	12.7	11.6	12.1	0.46
2403	12.5	11.4	10.8	13.1	12.5	11.1	11.9	0.94
2404	13.0	11.2	11.8	12.8	11.4	11.1	11.9	0.83
2405	15.1	12.7	13.3	13.8	13.1	11.6	13.2	1.17
2406	13.2	12.2	12.7	13.1	13.6	10.8	12.6	0.98
2407	12.3	12.0	12.7	14.0	13.7	11.6	12.7	0.99
2408	13.9	12.4	12.7	15.4	12.9	11.7	13.2	1.31
2409	14.7	12.3	11.7	14.0	11.8	11.7	12.7	1.34
2410	14.9	12.2	13.3	13.9	13.8	11.7	13.3	1.20
2411	14.8	14.0	14.7	16.4	14.8	13.1	14.6	1.12
2412	14.9	12.2	13.0	14.0	14.5	12.3	13.5	1.13
2413	14.7	11.9	13.4	14.3	13.1	11.6	13.2	1.25
Avg.	13.8	12.2	12.6	13.8	13.1	11.6		
StDev	1.19	0.65	0.99	1.12	1.00	0.57		

LM=Limagrain; UM=USDA-Manhattan; OK=OSU; CO=CSU; KH=Kansas Hays; TX=Texas A&M

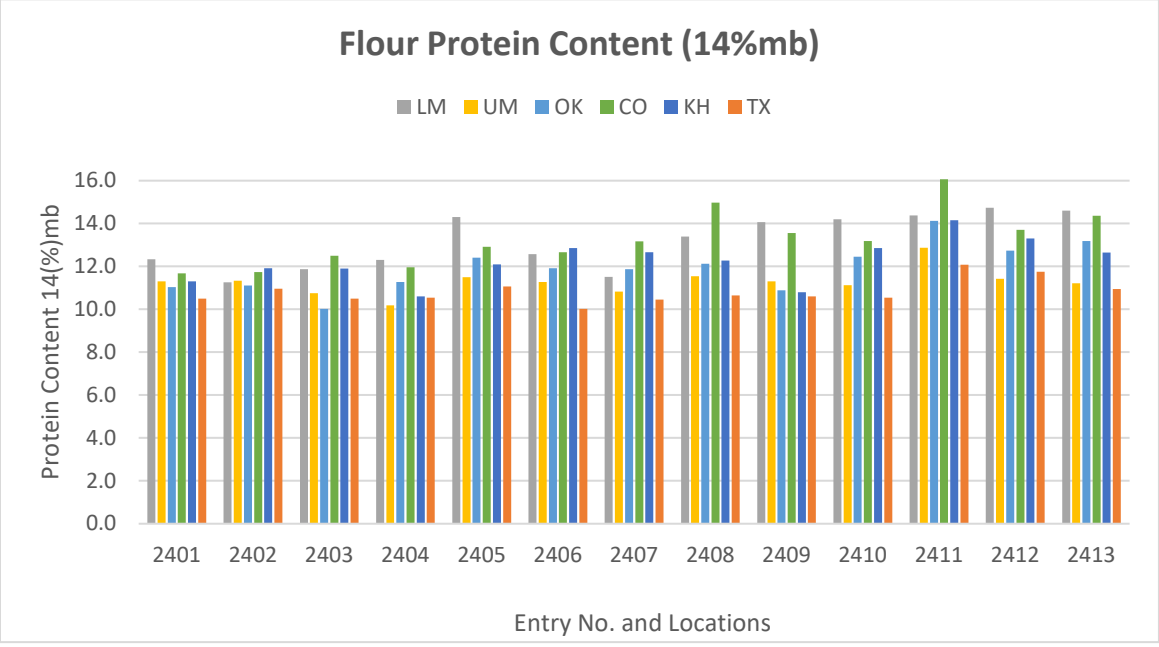


B. Flour Protein

Flour Protein Content (14%)

Entry No.	LOCATIONS LM	UM	OK	CO	KH	TX	Avg	StDev
2401	12.3	11.3	11.0	11.7	11.3	10.5	11.4	0.62
2402	11.3	11.3	11.1	11.7	11.9	11.0	11.4	0.37
2403	11.9	10.8	10.0	12.5	11.9	10.5	11.3	0.97
2404	12.3	10.2	11.3	12.0	10.6	10.5	11.1	0.85
2405	14.3	11.5	12.4	12.9	12.1	11.1	12.4	1.15
2406	12.6	11.3	11.9	12.7	12.9	10.0	11.9	1.08
2407	11.5	10.8	11.9	13.2	12.7	10.5	11.7	1.04
2408	13.4	11.5	12.1	15.0	12.3	10.7	12.5	1.51
2409	14.1	11.3	10.9	13.6	10.8	10.6	11.9	1.53
2410	14.2	11.1	12.5	13.2	12.9	10.6	12.4	1.35
2411	14.4	12.9	14.1	16.1	14.2	12.1	13.9	1.37
2412	14.7	11.4	12.7	13.7	13.3	11.8	12.9	1.24
2413	14.6	11.2	13.2	14.4	12.7	11.0	12.8	1.54
Avg.	13.2	11.3	11.9	13.3	12.3	10.8		
StDev	1.26	0.60	1.09	1.29	0.99	0.56		

LM=Limagrain; UM=USDA-Manhattan; OK=OSU; CO=CSU; KH=Kansas Hays; TX=Texas A&M

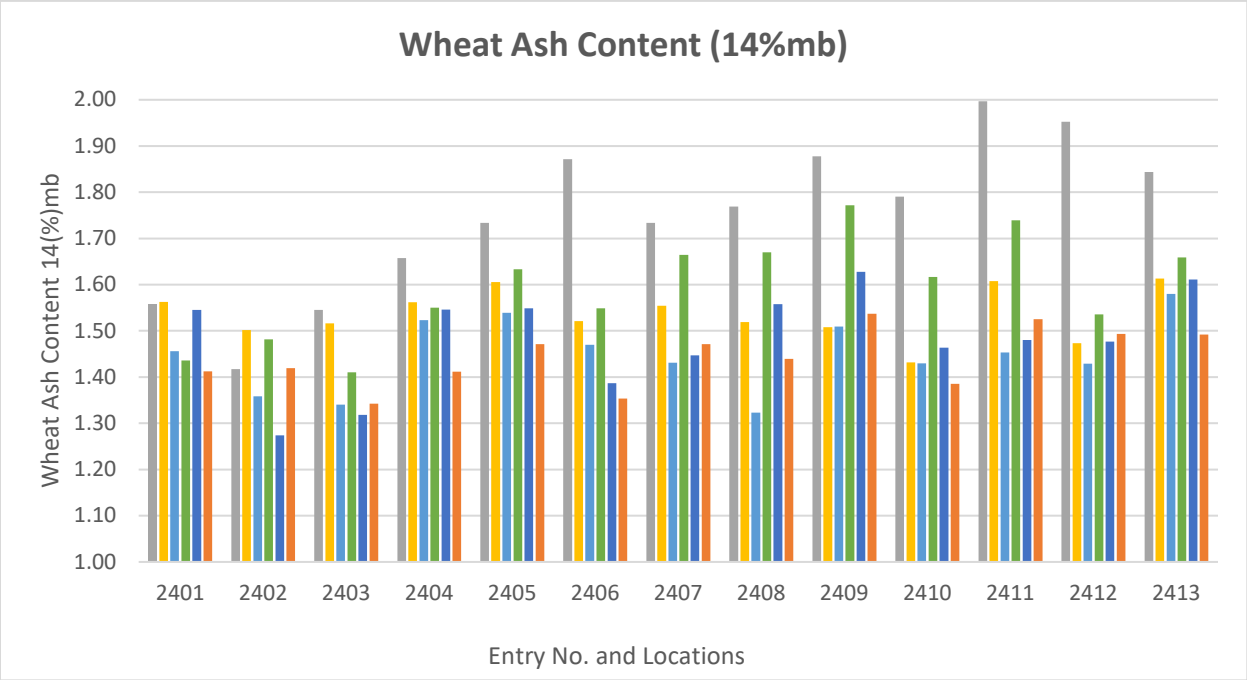


3. WHEAT ASH

Wheat Ash Content (14%)

	LOCATIONS							
Entry No.	LM	UM	OK	CO	KH	TX	Avg	StDev
2401	1.56	1.56	1.46	1.44	1.55	1.41	1.50	0.07
2402	1.42	1.50	1.36	1.48	1.27	1.42	1.41	0.08
2403	1.55	1.52	1.34	1.41	1.32	1.34	1.41	0.10
2404	1.66	1.56	1.52	1.55	1.55	1.41	1.54	0.08
2405	1.73	1.61	1.54	1.63	1.55	1.47	1.59	0.09
2406	1.87	1.52	1.47	1.55	1.39	1.35	1.53	0.19
2407	1.73	1.55	1.43	1.66	1.45	1.47	1.55	0.12
2408	1.77	1.52	1.32	1.67	1.56	1.44	1.55	0.16
2409	1.88	1.51	1.51	1.77	1.63	1.54	1.64	0.15
2410	1.79	1.43	1.43	1.62	1.46	1.39	1.52	0.15
2411	2.00	1.61	1.45	1.74	1.48	1.53	1.63	0.21
2412	1.95	1.47	1.43	1.54	1.48	1.49	1.56	0.20
2413	1.84	1.61	1.58	1.66	1.61	1.49	1.63	0.12
Avg.	1.75	1.54	1.45	1.59	1.48	1.44		
StDev	0.17	0.05	0.08	0.11	0.11	0.06		

LM=Limagrain; UM=USDA-Manhattan; OK=OSU; CO=CSU; KH=Kansas Hays; TX=Texas A&M



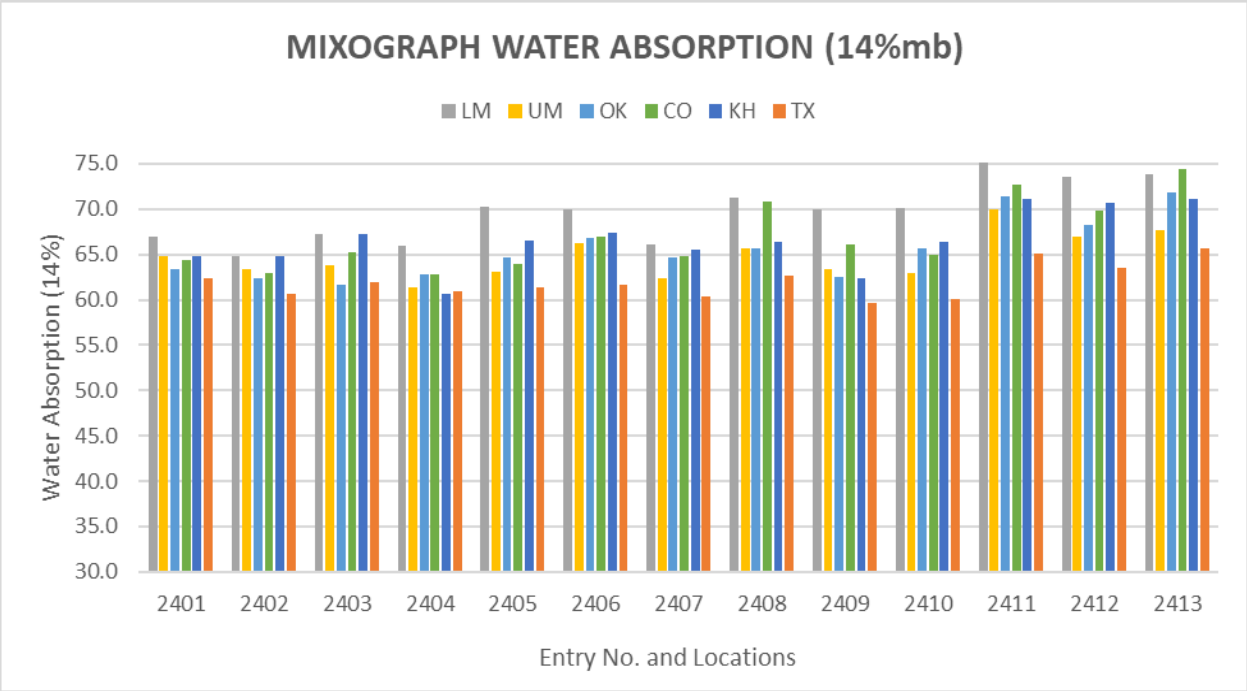
4. MIXOGRAPH TEST RESULTS

A. Mixograph Water Absorption

Mixograph Water Absorption (14%mb)

	LOCATIONS							
Entry No.	LM	UM	OK	CO	KH	TX	Avg	StDev
2401	67.0	64.8	63.4	64.4	64.7	62.4	64.4	1.55
2402	64.7	63.3	62.4	63.0	64.8	60.7	63.2	1.53
2403	67.3	63.9	61.6	65.3	67.3	61.9	64.5	2.49
2404	65.9	61.4	62.8	62.8	60.6	61.0	62.4	1.95
2405	70.3	63.1	64.7	63.9	66.5	61.3	65.0	3.11
2406	69.9	66.2	66.7	67.0	67.3	61.6	66.5	2.72
2407	66.1	62.4	64.7	64.9	65.5	60.4	64.0	2.18
2408	71.3	65.7	65.6	70.9	66.4	62.7	67.1	3.32
2409	69.9	63.3	62.6	66.1	62.4	59.6	64.0	3.56
2410	70.1	63.0	65.6	65.0	66.4	60.0	65.0	3.40
2411	75.4	69.9	71.5	72.8	71.1	65.1	70.9	3.43
2412	73.5	67.0	68.2	69.8	70.6	63.5	68.8	3.42
2413	73.8	67.6	71.9	74.4	71.1	65.7	70.8	3.45
Avg.	69.6	64.7	65.5	66.9	66.5	62.0		
StDev	3.32	2.42	3.31	3.81	3.15	1.87		

LM=Limagrain; UM=USDA-Manhattan; OK=OSU; CO=CSU; KH=Kansas Hays; TX=Texas A&M

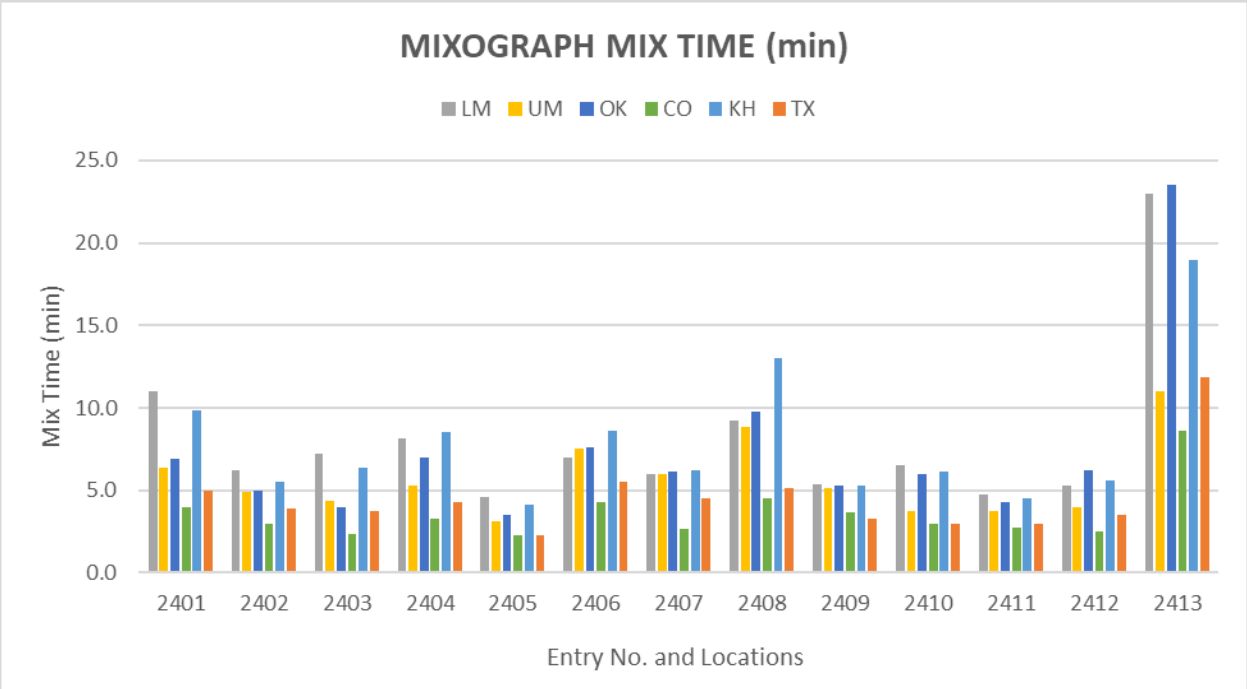


B. Mixograph Mix Time

Mixograph Mix Time (min)

	LOCATIONS							
Entry No.	**LM**	**UM**	**OK**	**CO**	**KH**	**TX**	**Avg**	**StDev**
2401	11.0	6.4	6.9	4.0	9.9	5.0	7.2	2.74
2402	6.3	4.9	5.0	3.0	5.5	3.9	4.8	1.16
2403	7.3	4.4	4.0	2.4	6.4	3.8	4.7	1.80
2404	8.1	5.3	7.0	3.3	8.5	4.3	6.1	2.14
2405	4.6	3.1	3.5	2.3	4.1	2.3	3.3	0.97
2406	7.0	7.5	7.6	4.3	8.6	5.5	6.8	1.60
2407	6.0	6.0	6.1	2.6	6.3	4.5	5.3	1.44
2408	9.3	8.9	9.8	4.5	13.0	5.1	8.4	3.16
2409	5.4	5.1	5.3	3.6	5.3	3.3	4.6	0.95
2410	6.5	3.8	6.0	3.0	6.1	3.0	4.7	1.65
2411	4.8	3.8	4.3	2.8	4.5	3.0	3.8	0.82
2412	5.3	4.0	6.3	2.5	5.6	3.5	4.5	1.42
2413	23.0	11.0	23.5	8.6	19.0	11.9	16.2	6.49
Avg.	8.0	5.7	7.3	3.6	7.9	4.5		
StDev	4.85	2.27	5.14	1.68	4.14	2.40		

LM=Limagrain; UM=USDA-Manhattan; OK=OSU; CO=CSU; KH=Kansas Hays; TX=Texas A&M

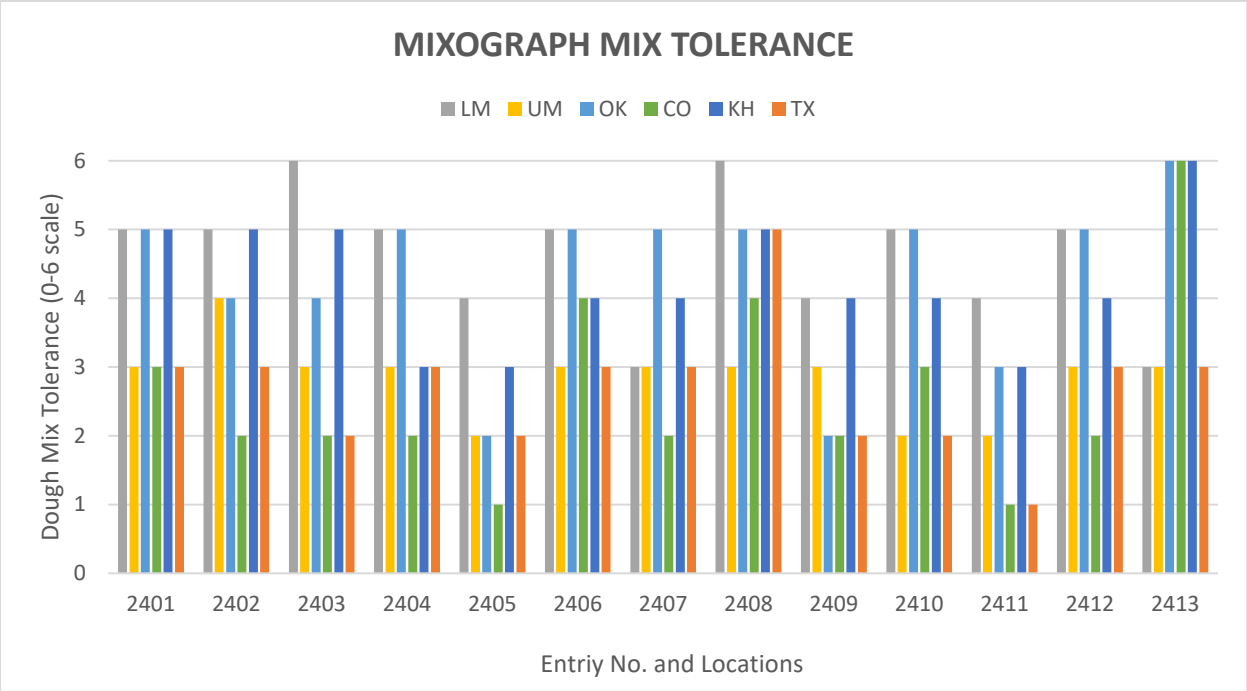


C. Mixograph Mix Tolerance

Mixograph Mix Tolerance

	LOCATIONS							
Entry No.	LM	UM	OK	CO	KH	TX	Avg	StDev
2401	5	3	5	3	5	3	4.0	1.1
2402	5	4	4	2	5	3	3.8	1.2
2403	6	3	4	2	5	2	3.7	1.6
2404	5	3	5	2	3	3	3.5	1.2
2405	4	2	2	1	3	2	2.3	1.0
2406	5	3	5	4	4	3	4.0	0.9
2407	3	3	5	2	4	3	3.3	1.0
2408	6	3	5	4	5	5	4.7	1.0
2409	4	3	2	2	4	2	2.8	1.0
2410	5	2	5	3	4	2	3.5	1.4
2411	4	2	3	1	3	1	2.3	1.2
2412	5	3	5	2	4	3	3.7	1.2
2413	3	3	6	6	6	3	4.5	1.6
Avg.	4.6	2.8	4.3	2.6	4.2	2.7		
StDev	0.96	0.55	1.25	1.39	0.93	0.95		

LM=Limagrain; UM=USDA-Manhattan; OK=OSU; CO=CSU; KH=Kansas Hays; TX=Texas A&M

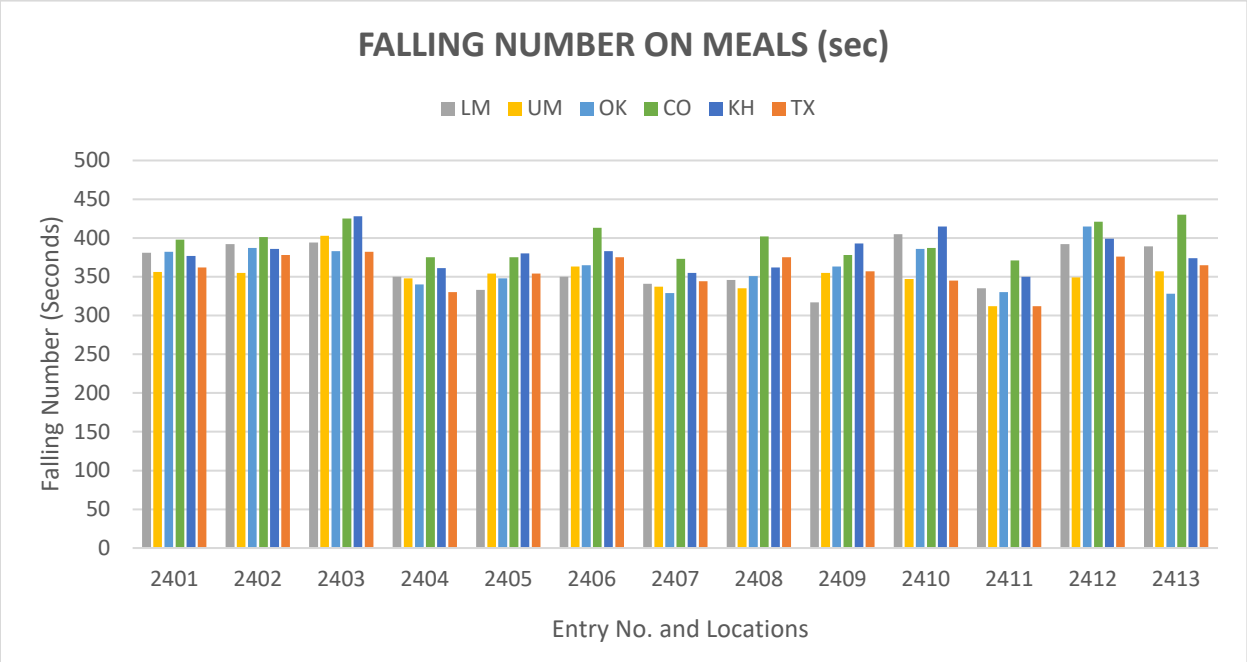


5. FALLING NUMBER TEST

Falling Number on Meals (sec)

	LOCATIONS							
Entry No.	LM	UM	OK	CO	KH	TX	Avg	StDev
2401	381	356	382	398	377	362	376	15
2402	392	355	387	401	386	378	383	16
2403	394	403	383	425	428	382	403	20
2404	350	348	340	375	361	330	351	16
2405	333	354	348	375	380	354	357	17
2406	350	363	365	413	383	375	375	22
2407	341	337	329	373	355	344	347	16
2408	346	335	351	402	362	375	362	24
2409	317	355	363	378	393	357	361	26
2410	405	347	386	387	415	345	381	29
2411	335	312	330	371	350	312	335	23
2412	392	349	415	421	399	376	392	27
2413	389	357	328	430	374	365	374	34
Avg.	363	352	362	396	382	358		
StDev	29	20	27	21	23	21		

LM=Limagrain; UM=USDA-Manhattan; OK=OSU; CO=CSU; KH=Kansas Hays; TX=Texas A&M

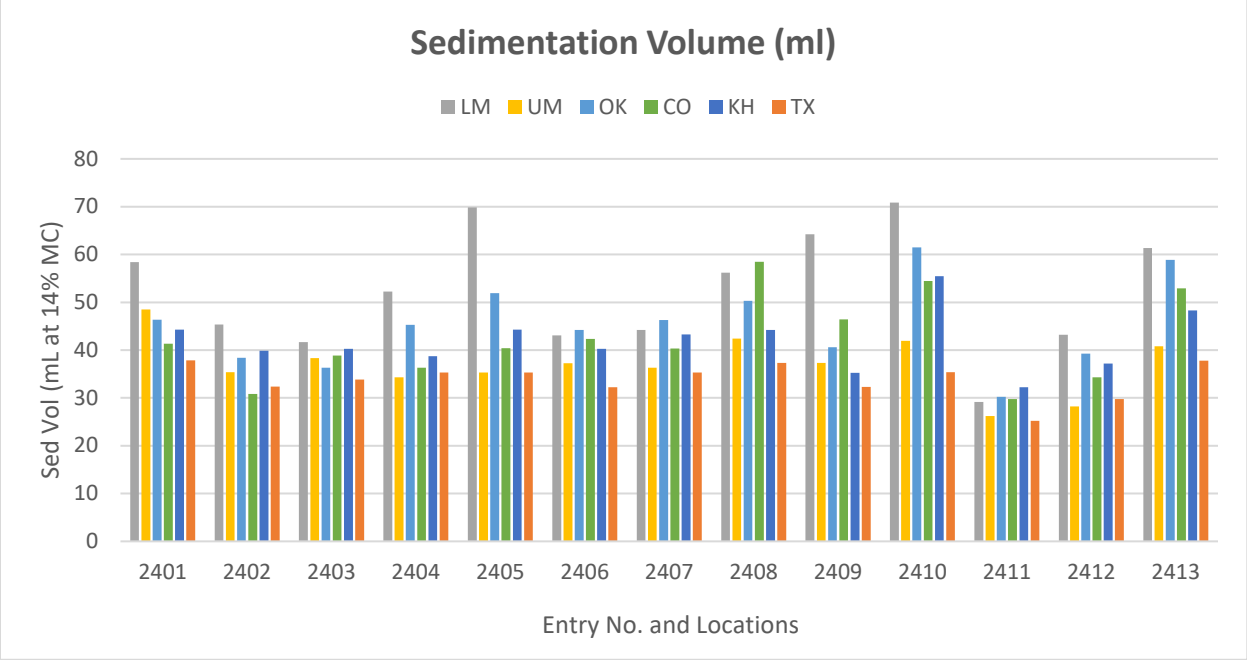


6. SEDIMENTATION TEST

Sedimentation Volume (ml)

	LOCATIONS							
Entry No.	LM	UM	OK	CO	KH	TX	Avg	StDev
2401	58.4	48.5	46.4	41.4	44.3	37.8	46.1	7.08
2402	45.3	35.4	38.4	30.8	39.9	32.4	37.0	5.33
2403	41.7	38.3	36.3	38.9	40.3	33.8	38.2	2.80
2404	52.3	34.3	45.3	36.3	38.8	35.3	40.4	7.03
2405	69.8	35.3	51.9	40.4	44.3	35.3	46.2	13.16
2406	43.1	37.2	44.2	42.3	40.3	32.2	39.9	4.50
2407	44.2	36.3	46.3	40.4	43.3	35.3	41.0	4.45
2408	56.2	42.4	50.3	58.4	44.2	37.3	48.1	8.26
2409	64.3	37.3	40.6	46.4	35.2	32.3	42.7	11.63
2410	70.9	41.9	61.5	54.5	55.4	35.4	53.3	12.90
2411	29.1	26.2	30.2	29.8	32.2	25.2	28.8	2.62
2412	43.2	28.2	39.3	34.3	37.2	29.8	35.3	5.73
2413	61.3	40.8	58.9	52.9	48.3	37.8	50.0	9.51
Avg.	52.3	37.1	45.4	42.1	41.8	33.8		
StDev	12.45	5.84	8.81	8.89	5.93	3.55		

LM=Limagrain; UM=USDA-Manhattan; OK=OSU; CO=CSU; KH=Kansas Hays; TX=Texas A&M



NORTHERN GROWOUT

25-2414	23Nord-191_ND
25-2415	SD20D009-9_SD
25-2416	SD21B102-4_SD
25-2417	SY Monument_CK
25-2418	NE20620_NE
25-2419	NEB 148-42_NE
25-2420	X4027_WB
25-2421	WB4650_WB

CK=Check; ND=North Dakota; SD=South Dakota; WB =Westbred (Bayer); NE=Nebraska.

Description of Test Plots and Breeder Entries

Northern Growout:

There are 8 composited entries including one control and 7 breeding lines from 4 breeding programs (NE, ND, SD, and WB). The Northern growout consisted of 5 locations (ND, SD, NE, UM, and AP), but 2 locations (UM and SD) submitted the entries for the composites used for end-use quality testing.

NORTH DAKOTA by Francois Marais and Bradley Bisek

23Nord-191

23NORD-191 is a NDSU experimental line derived from a winter wheat project cross (21CP-64C-17YR251-5-2-C, Pedigree: 10X028-0-0-34-103L (=ID9222407A/ORNB553//MDM)/2*Jerry (ex WSU backcrosses)). 23NORD-191 has shown to have generally good standability. 23NORD-191 has performed competitively in grain yield in North Dakota. In the NDSU winter wheat project disease screenings, 23NORD-191exhibits very good yellow rust resistance. In 2025, 23NORD-191 is included in the NDSU Elite trial, as well as a first-year entry to the 2025 NRPN trial.

SOUTH DAKOTA by Sunish Sehgal

Growing Location and Conditions

Twelve entries, including the check variety SY Monument, were evaluated in the 2025 Northern Wheat Quality Council (WQC) growout test. At Brookings (SD), all entries were timely planted in low moisture on October 2, 2024, as 200' long and 5' wide strips (7-rows) in oat stubble (no-till). A starter fertilizer 10-34-0 (10 gallons/ac) was applied at seeding. All entries emerged slowly in the dry fall; however, there was no visible winter kill. In spring, 28-0-0 (39 gallons/acre) fertilizer was stream-bar applied at Feekes 5. The growout strips were also sprayed with 1.5 pt/acre Bison and 24 oz Prowl H2O. All entries were sprayed with Prosaro at the anthesis. The grow-out trial was harvested on July 26, 2025, with total grain weight for entries ranging from 78 lbs to 110 lbs. The grain protein content ranged from 12.1% to 14.7% and the test weight ranged from 58.4 lb/bu to 62.4 lb/bu among the 12 entries.

SD20D009-9

SD20D009-9 was developed from a cross Ideal/SY Monument. It exhibits medium-tall stature (Rht-B1b, Rht25b) and medium-late maturity. SD20D009-9 is a high-yielding line with good test

weight and grain protein content. It has been evaluated for 32-year location trials to date. Overall, in the last 2 years at 24 South Dakota State Variety Trials (CPT) locations, SD20D009-9 ranked 10th in eastern SD (5 locations), 3rd in central SD (11 locations), and 3rd in western SD (5 locations) among 24 varieties. Additionally, in the 2024 USDA North Regional Performance Nursery (NRPN), SD20D009-9 ranked 22nd among 45 entries evaluated across 15 locations. It was rated moderately resistant to stem rust. SD20D009-9 was rated overall good milling and baking quality in USDA and SDSU evaluations. Across multiple trial locations (2023 and 2024), its milling quality parameters (average flour yield 67.2 %), mixograph mix time of 10.2 minutes, and mix tolerance of 6.0 and baking quality parameters (average loaf volume 973 cm^3 and specific volume 6.5 cc/g) were comparable to SY Monument (average flour yield 65.8%, mix time 10.3 and mix tolerance 6.0, average loaf volume 1000 cm^3, and specific volume 6.7 cc/g).

SD21B102-4

SD21B102-4 was developed from a cross Larry/SD110060-7 and it has a medium height (Rht-B1b, Rht25b) and late maturity. SD21B102-4 has high-yield potential, good test weight, and good grain protein content. In the last 2 years, it has been evaluated in 18 locations in South Dakota. In 2025, State Variety Trials (CPT) locations, SD21B102-4 ranked 15th in eastern SD (2 locations), 9th in central SD (5 locations), and 9th in western SD (5 locations) among 42 varieties. It shows moderate resistance to leaf rust (*Lr37*/*Sr38*/*Yr17*) and stem rust, along with above-average tolerance to Fusarium head blight (FHB). SD21B102-4 was rated overall good milling and baking quality in USDA and SDSU evaluations. Across multiple trial locations (2025), its milling quality parameters (average flour yield 69.9 %), mixograph mix time of 3.3 minutes and mix tolerance of 3.5 and baking quality parameters (average loaf volume 880 cm^3 and specific volume 5.9 cc/g) were comparable to SY Monument (average flour yield 69.6%, mix time 6.0 and mix tolerance 5.5, average loaf volume 866 cm^3, and specific volume 5.9 cc/g).

Table 1. Yield, test weight, and grain protein content of some of the lines tested in the South Dakota winter wheat variety performance trials (central and western South Dakota, 2025).

Variety	Central			Variety	Western		
	Yield (bu/a)	Test Wt (lbs)	Protein %		Yield (bu/a)	Test Wt (lbs)	Protein %
SD21B021-2	63.6	56.4	13.5	SD21B102-5	63.6	58.4	12.5
SDPheasant	63.5	57.6	14.1	**SD20D009-9**	63.3	58.5	12.3
SD20D009-9	63.0	56.7	13.2	Ideal	62.6	59.2	12.7
APSunbird	62.9	58.2	13.6	SD22D122-8	62.6	59.5	12.7
SD21B102-5	62.9	56.0	14.0	SD22D122-5	62.6	59.3	13.0
SD Vivian	62.7	57.7	14.3	LCSJulep	62.5	59.4	12.9
AP24AX	61.9	56.3	13.5	CP7017AX	62.1	59.1	12.7
CP7017AX	61.4	58.2	13.4	SD22B025-3	62.0	59.1	12.4
SD21B102-4	61.1	55.8	14.5	**SD21B102-4**	61.8	58.3	13.0
KivariAX	60.8	56.8	12.9	SDMidland	61.7	59.3	12.5
LCSJulep	60.7	59.6	14.4	LCSWarbirdAX	61.7	59.3	12.6
SD21B046-6	60.6	56.9	14.2	SD22D160-2	61.2	59.3	12.8
Winner	60.5	57.6	13.9	WB4422	61.2	59.3	12.5
SD22D160-2	60.3	58.4	14.3	CP7909	61.2	58.7	12.5
LCSHelixAX	60.1	59.0	13.6	APBigfoot	61.2	58.9	13.0
LCSAries	59.9	59.0	13.5	AP24AX	61.2	55.4	12.0
CO19D087R	59.5	55.9	13.3	CrescentAX	61.1	58.9	12.3
SD22B025-3	59.4	58.3	14.0	WB4540	61.0	58.2	12.9
SD22D122-8	59.3	58.8	14.0	CP7319AX	60.9	59.2	12.7
Ideal	59.3	57.7	14.2	CP7869	60.8	59.0	12.9
SD22D122-5	59.2	57.9	14.1	Draper	60.6	58.8	12.6
APBigfoot	59.0	57.2	14.0	LCSSteelAX	60.6	58.7	12.2
LCSMojo	58.8	57.0	13.9	SDAndes	60.6	59.6	12.5
SDMidland	58.4	58.1	13.9	SD Vivian	60.6	59.0	13.2
LCSWarbirdAX	58.4	58.3	13.9	SDPheasant	60.4	59.1	12.5
Draper	58.2	57.0	14.2	LCSAries	60.4	58.9	12.2
LCSRadar	58.2	57.3	14.5	CO19D087R	60.2	58.1	12.2
SDAndes	58.1	58.6	13.9	Winner	60.1	59.3	12.5
WB4422	57.5	58.0	14.6	SD21B021-2	60.1	58.3	12.6
MSMaverick	57.4	57.9	14.4	CP7462	59.9	58.0	13.1
APClair	57.2	57.6	14.2	LCSRadar	59.8	58.8	13.1
CrescentAX	56.3	57.7	13.8	APClair	59.7	58.7	13.0
LCSSteelAX	56.1	56.7	13.7	APSunbird	59.7	58.9	12.7
CP7909	55.9	57.7	14.0	SD21B046-6	59.7	58.7	12.9
CP7462	55.8	56.3	14.2	LCSMojo	59.6	58.9	12.2
CP7050AX	55.0	58.9	14.5	MSMaverick	59.3	59.0	12.8
WB4540	54.1	55.0	14.5	CP7050AX	58.9	59.4	13.2
CP7319AX	53.5	58.7	14.3	LCSHelixAX	58.6	59.2	12.4
CP7869	52.6	57.5	14.3	Expedition	57.8	58.8	13.3
CP7266AX	50.9	56.7	14.2	CP7266AX	57.6	58.7	12.5
Expedition	50.6	57.9	14.6	KivariAX	57.5	55.5	12.1
AACVortex	48.1	55.5	15.2	AACVortex	57.3	59.0	13.5
Trial Average#	58.6	57.6	14.0		60.7	58.8	12.7
LSD	4.0	0.9	0.4		4.7	2.1	0.5
CV	7.9	1.4	3.9		13.7	7.4	5.9

NEBRASKA by Katherine Frels

Growing Location and Conditions

The Lincoln, NE strip trial was not submitted for quality analysis due to poor yields and test weight from intermittent drought throughout the growing season. The 2026 trial was moved to the Stumpf International Wheat Research Center in Grant, NE.

NE20620

NE20620 is a medium maturity HRW with the pedigree LCH13NEDH-14-31/Ruth. NE20620 has been the top performing line in three-year yield trial averages with good test weight and protein and above average end-use quality. It is moderately resistant to leaf rust, stem rust, stripe rust, and FHB. NE20620 is on breeder seed increase for a likely 2027 release. It will be marketed statewide as a replacement for Ruth with improved yield, disease resistance and end-use quality.

NEB-148-42

NEB-148-42 is a medium maturity HRW developed through the LCS:UNL doubled haploid collaboration. Its pedigree is NW13493/LCH13NEDH-5-72. NEB-148-42 yields just under NE20620 in three-year yield trial averages with slightly better test weight. It is susceptible to stripe rust and moderately resistant to leaf rust, stem rust, and resistant to SBMV. It rated as MR/MS to FHB but has had high DON levels compared to most UNL wheat lines. End-use quality has been rated as acceptable to good.

BAYER (WESTBRED) by Adam Bray

WB4650

WB4650 is a medium maturity awnless hard red winter wheat with a strong virus package and excellent forage/grazing potential. It shows good resistance to both Wheat Streak Mosaic and Soilborne Mosaic viruses. It has good acid soils tolerance. It is moderately resistant to Stripe Rust and Leaf Rust. Internal quality testing indicates good protein, good test weight, and good end use functionality. WB4650 was released in 2025 targeting forage and dual-purpose growers in the northern and western central plains.

XH4027

XH4027 is a hard red winter wheat with medium late maturity, great straw strength, and excellent dryland yield. This line has improved yield, standability, and end use quality over Keldin in the Northern Plains. It is moderately resistant to FHB. Internal quality testing indicates above average protein and test weight with above average functionality. XH4027 will be released through an out-licensing partner in the Northern Plains.

Northern Growout: 2025 (Small-Scale) Samples

Test entry number	25-2414	25-2415	25-2416	25-2417
Sample identification	**23Nord-191_ND**	**SD20D009-9_SD**	**SD21B102-4_SD**	**SY Monument_CK**
Wheat Data				
GIPSA classification	1 HRW	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	60.1	60.7	60.6	60.1
Hectoliter weight (kg/hl)	79.1	79.8	79.7	79.1
1000 kernel weight (gm)	37.6	37.0	33.7	34.7
Wheat kernel size (Rotap)				
Over 7 wire (%)	89.8	86.4	78.4	83.6
Over 9 wire (%)	10.2	13.5	21.4	16.3
Through 9 wire (%)	0.0	0.1	0.2	0.2
Single kernel (skcs)[a]				
Hardness (avg /s.d)	52.5/17.7	55.3/17.1	61.9/15.6	67.1/17.9
Weight (mg) (avg/s.d)	37.6/8.9	37/9.4	33.7/8.8	34.7/10.1
Diameter (mm)(avg/s.d)	2.91/0.36	2.81/0.37	2.73/0.39	2.8/0.41
Moisture (%) (avg/s.d)	12.3/0.5	12.4/0.4	12.4/0.4	12.3/0.4
SKCS distribution	15-22-27-36-03	09-20-34-37-01	04-12-28-56-01	03-10-18-69-01
Classification	Mixed	Hard	Hard	Hard
Wheat protein (12% mb)	12.9	11.7	12.6	12.9
Wheat ash (12% mb)	1.75	1.70	1.74	1.61
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	76.6	77.3	77.4	77.0
Quadrumat Sr. Mill	69.8	71.0	71.4	70.3
Flour moisture (%)	13.6	12.7	12.3	11.9
Flour protein (14% mb)	11.5	10.5	11.3	11.4
Flour ash (14% mb)	0.56	0.52	0.53	0.55
Rapid Visco-Analyser				
Peak time (min)	6.0	6.0	6.0	5.9
Peak viscosity (RVU)	154.5	179.1	174.9	169.4
Breakdown (RVU)	57.3	70.9	66.4	69.0
Final viscosity at 13 min (RVU)	192.7	207.1	209.3	198.6
Minolta color meter				
L*	90.67	91.22	90.81	90.59
a*	-0.99	-0.81	-0.92	-0.87
b*	8.96	7.42	8.60	8.47
PPO	0.205	0.602	0.673	0.324
Falling number (sec)	392	330	363	370
Damaged Starch				
(AI%)	96.8	97.0	96.8	97.2
(AACC76-31)	8.8	9.1	8.9	9.3

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Northern Growout: 2025 (Small-Scale) Samples (continued)

Test entry number	25-2418	25-2419	25-2420	25-2421
Sample identification	NE20620_NE	NEB 148-42_NE	X4027_WB	WB4650_WB
Wheat Data				
GIPSA classification	1 HRW	3 HRW	1 HRW	1 HRW
Test weight (lb/bu)	62.9	62.0	61.5	60.0
Hectoliter weight (kg/hl)	82.7	81.5	80.9	78.9
1000 kernel weight (gm)	40.8	34.8	36.5	31.0
Wheat kernel size (Rotap)				
Over 7 wire (%)	86.5	81.1	80.9	84.0
Over 9 wire (%)	13.4	18.9	19.1	16.0
Through 9 wire (%)	0.1	0.1	0.1	0.0
Single kernel (skcs)[a]				
Hardness (avg /s.d)	63.8/14.8	59.8/16.2	66/14.7	59.7/16.5
Weight (mg) (avg/s.d)	40.8/10.7	34.8/8.5	36.5/10.7	31/8.3
Diameter (mm)(avg/s.d)	2.88/0.37	2.8/0.35	2.79/0.43	2.71/0.36
Moisture (%) (avg/s.d)	12.1/0.4	12.3/0.5	12.5/0.4	12.8/0.4
SKCS distribution	02-09-26-63-01	06-16-28-50-01	01-08-23-68-01	05-18-26-51-01
Classification	Hard	Hard	Hard	Hard
Wheat protein (12% mb)	13.1	12.2	13.0	12.8
Wheat ash (12% mb)	1.71	1.72	1.77	1.73
Milling and Flour Quality Data				
Flour yield (%, str. grade)				
Miag Multomat Mill	77.6	77.7	74.2	76.6
Quadrumat Sr. Mill	69.0	70.0	65.7	69.8
Flour moisture (%)	12.7	12.6	12.2	11.9
Flour protein (14% mb)	11.6	11.0	11.6	11.2
Flour ash (14% mb)	0.58	0.57	0.57	0.56
Rapid Visco-Analyser				
Peak time (min)	6.0	6.3	6.2	6.1
Peak viscosity (RVU)	153.2	218.0	212.8	203.1
Breakdown (RVU)	52.3	96.7	89.7	80.8
Final viscosity at 13 min (RVU)	199.3	214.2	213.9	227.2
Minolta color meter				
L*	90.50	91.08	90.82	90.85
a*	-0.71	-1.03	-0.94	-1.02
b*	7.83	8.42	8.45	8.96
PPO	0.578	0.557	0.563	0.411
Falling number (sec)	345	374	384	386
Damaged Starch				
(AI%)	97.3	96.6	97.0	96.7
(AACC76-31)	9.5	8.6	9.1	8.7

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Northern Growout: Physical Dough Tests and Gluten Analysis 2025 (Small-Scale) Samples

Test Entry Number	25-2414	25-2415	25-2416	25-2417
Sample Identification	23Nord-191_ND	SD20D009-9_SD	SD21B102-4_SD	SY Monument_CK
	MIXOGRAPH			
Flour Abs (% as-is)	67.8	68.8	67.6	68.7
Flour Abs (14% mb)	67.5	67.5	65.7	66.1
Mix Time (min)	3.25	8.63	4.5	8.5
Mix tolerance (0-6)	2	6	4	6
	FARINOGRAPH			
Flour Abs (% as-is)	75.0	67.2	66.5	67.7
Flour Abs (14% mb)	74.6	65.9	64.6	65.1
Peak time (min)	4.8	4.2	4.4	4.2
Mix stability (min)	5.0	6.8	7.8	6.0
Mix Tolerance Index (FU)	53	38	34	42
Breakdown time (min)	7.1	7.5	8.1	7.1
	ALVEOGRAPH			
P(mm): Tenacity	156	155	136	173
L(mm): Extensibility	46	42	60	31
G(mm): Swelling index	14.9	14.4	17.2	12.4
W(10^{-4} J): strength (curve area)	262	276	305	243
P/L: curve configuration ratio	3.4	3.69	2.28	5.58
Ie(P_{200}/P): elasticity index	39.8	49.3	52.9	0
	EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	170/229/340	630/857/990	330/354/332	711/1145/1128
Extensibility (mm at 45/90/135 min)	159/158.6/148.7	131.8/128.9/112.7	166.7/157.8/154.5	124.1/96.8/96.7
Energy (cm^2 at 45/90/135 min)	48.3/65.8/87.8	145.7/169.5/149.6	107.1/102.4/96.7	147/145.3/129.6
Resist $_{max}$ (BU at 45/90/135min)	221/309/462	905/1140/1183	486/486/478	984.2/1317/1212
Ratio (at 45/90/135 min)	1.07/1.44/2.29	4.78/6.65/8.78	1.98/2.24/2.15	5.73/11.82/11.67
	PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+9, 5+10	1, 7+9, 5+10	2*, 7+8, 2+12	2*, 7+9, 5+10
TPP/TMP	0.87	0.87	0.84	0.89
	SEDIMENTATION TEST			
Volume (ml)	50.8	64.2	56.9	63.3

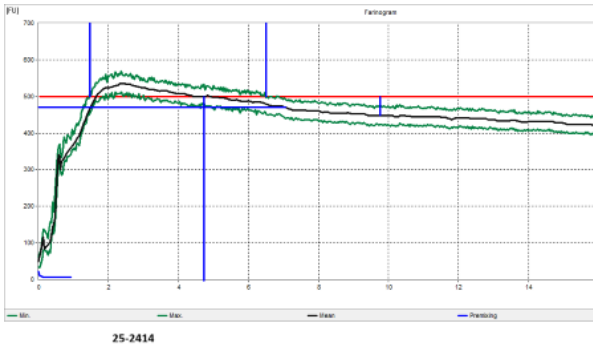
Northern Growout: Physical Dough Tests and Gluten Analysis 2025 (Small-Scale) Samples (continued)

Test Entry Number	25-2418	25-2419	25-2420	25-2421
Sample Identification	NE20620_NE	NEB 148-42_NE	X4027_WB	WB4650_WB
	MIXOGRAPH			
Flour Abs (% as-is)	69.5	68.4	70	67.3
Flour Abs (14% mb)	67.6	66.1	67.9	65.1
Mix Time (min)	7.9	6.0	5.1	5.6
Mix tolerance (0-6)	6	5	4	5
	FARINOGRAPH			
Flour Abs (% as-is)	68.9	68.0	70.7	64.8
Flour Abs (14% mb)	67.1	65.7	68.6	62.6
Peak time (min)	5.9	5.6	5.5	5.1
Mix stability (min)	11.0	9.7	9.0	11.0
Mix Tolerance Index (FU)	25	33	34	26
Breakdown time (min)	12.4	10.0	9.7	11.2
	ALVEOGRAPH			
P(mm): Tenacity	182	176	189	132
L(mm): Extensibility	33	30	29	45
G(mm): Swelling index	12.8	12.2	12	14.9
W(10^{-4} J): strength (curve area)	267	252	244	227
P/L: curve configuration ratio	5.52	5.87	6.52	2.93
Ie(P_{200}/P): elasticity index	0	0	0	50.3
	EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	559/675/775	435/599/709	433/504/480	480/634/732
Extensibility (mm at 45/90/135 min)	151.6/140.6/128.2	134.4/125.9/124.2	133.2/128.1/127.3	139.7/114/114.3
Energy (cm^2 at 45/90/135 min)	165.3/163.5/161.1	97.9/121.2/139.2	97.2/106.7/100.8	111.7/105.9/124.8
Resist $_{max}$ (BU at 45/90/135min)	879/953/1071	577/788/922	580/703/643	637/748/892
Ratio (at 45/90/135 min)	3.69/4.8/6.05	3.24/4.76/5.71	3.25/3.94/3.77	3.44/5.56/6.4
	PROTEIN ANALYSIS			
HMW-GS Composition	2*, 7+9, 5+10	2*, 7+8, 5+10	2*, 7+9, 5+10	1,17+18, 5+10
TPP/TMP	0.88	0.84	0.84	0.85
	SEDIMENTATION TEST			
Volume (ml)	61.8	54.7	53.9	52.8

Physical Dough Tests – Farino and Mixo

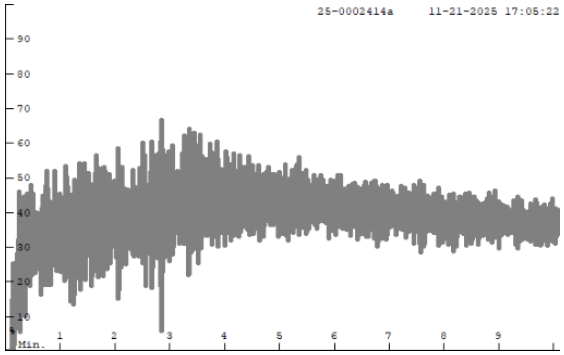
2025 (Small Scale) Samples – Northern Growout

Farinograms



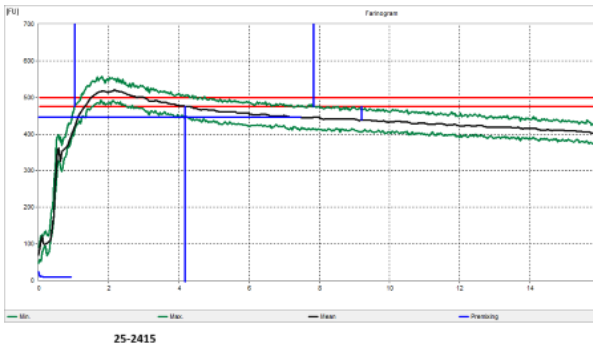
Water abs = 74.6%, Peak time = 4.8 min,
Mix stab = 5.0 min, MTI = 53 FU

Mixograms

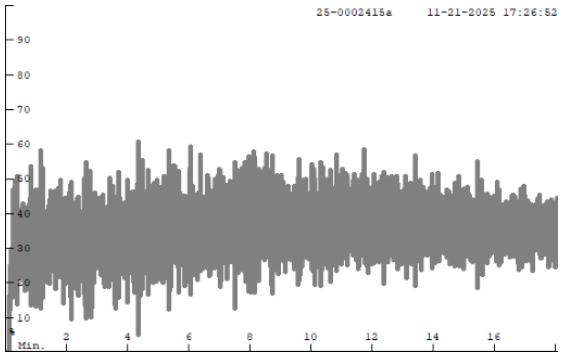


Water abs = 67.5%
Mix time = 3.3 min

25-2414, 23Nord-191_ND



Water abs = 65.9%, Peak time = 4.2 min,
Mix stab = 6.8 min, MTI = 38 FU



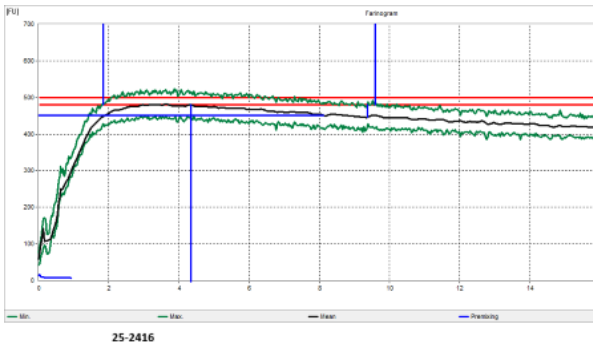
Water abs = 67.5%
Mix time = 8.6 min

25-2415, SD20D009-9_SD

Physical Dough Tests – Farino and Mixo

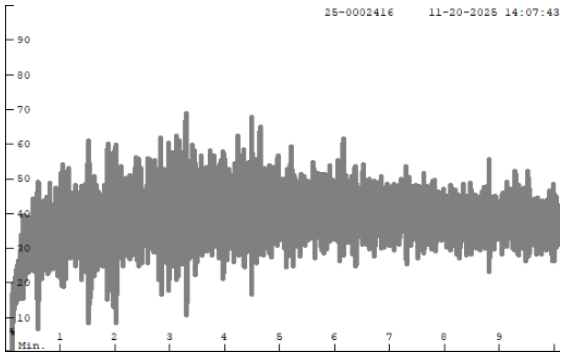
2025 (Small Scale) Samples – Northern Growout (Continued)

Farinograms



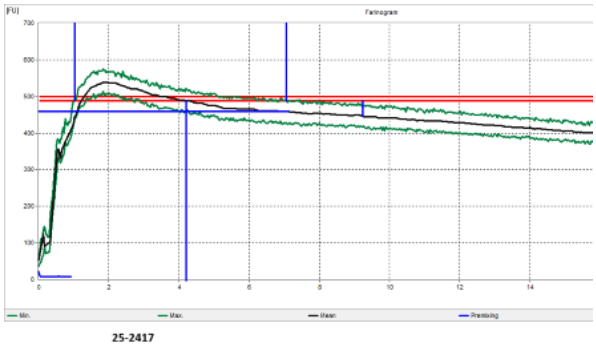
Water abs = 64.6%, Peak time = 4.4 min,
Mix stab = 7.8 min, MTI = 34 FU

Mixograms

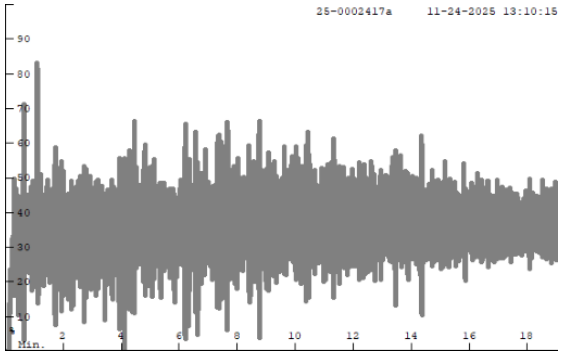


Water abs = 65.7%
Mix time = 4.5 min

25-2416, SD21B102-4_SD



Water abs = 65.1%, Peak time = 4.2 min,
Mix stab = 6.0 min, MTI = 42 FU



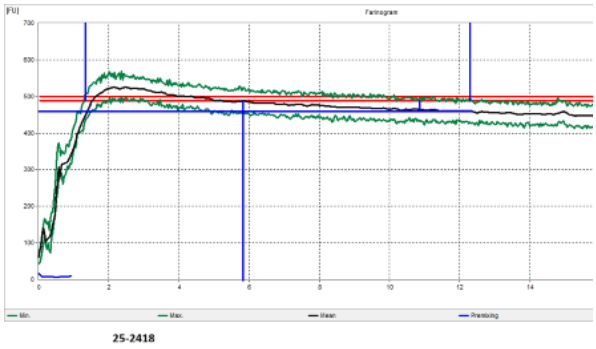
Water abs = 66.1%
Mix time = 8.5 min

25-2417, SY Monument_CK

Physical Dough Tests - Farino and Mixo

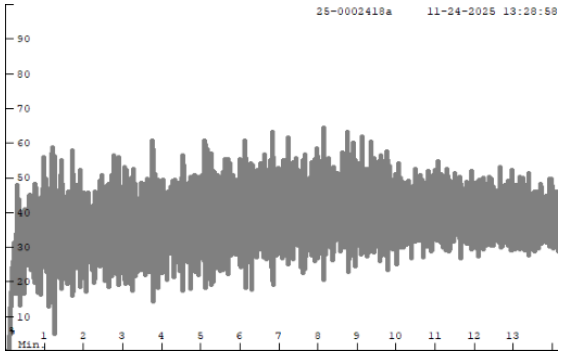
2025 (Small Scale) Samples – Northern Growout (Continued)

Farinograms



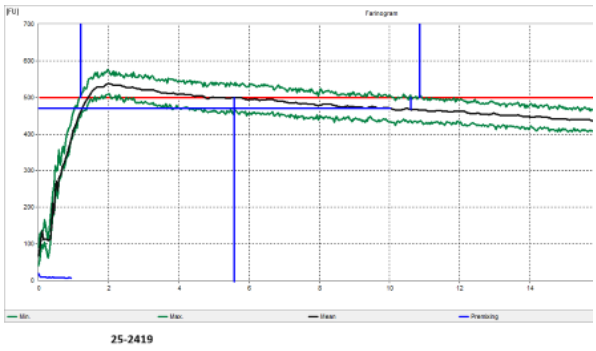
Water abs = 67.1%, Peak time = 5.9 min,
Mix stab = 11.0 min, MTI = 25 FU

Mixograms

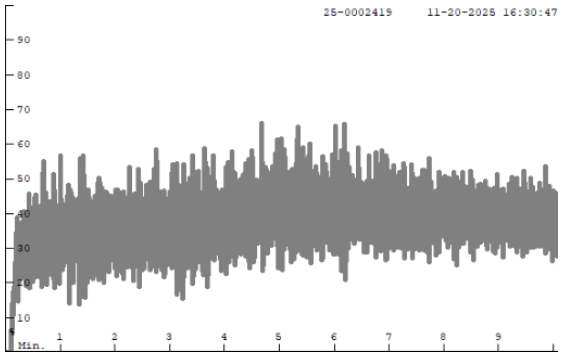


Water abs = 67.6%
Mix time = 7.9 min

25-2418, NE20620_NE



Water abs = 65.7%, Peak time = 5.6 min,
Mix stab = 9.7 min, MTI = 33 FU



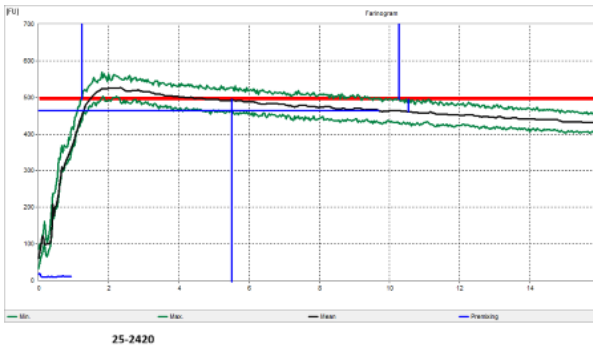
Water abs = 66.1%
Mix time = 6.0 min

25-2419, NEB 148-42_NE

Physical Dough Tests - Farino and Mixo

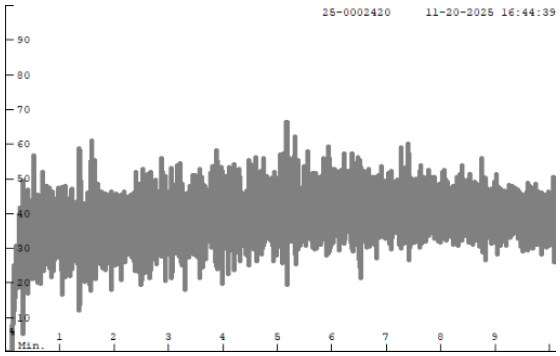
2025 (Small Scale) Samples – Northern Growout (Continued)

Farinograms



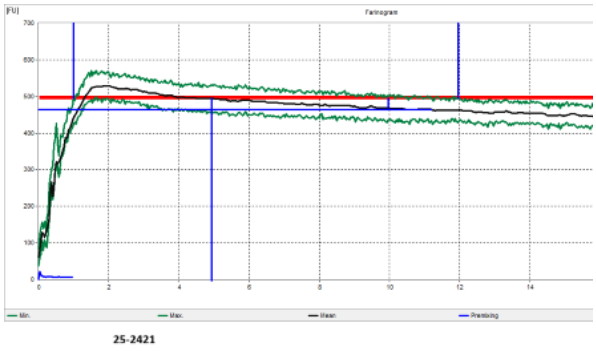
Water abs = 68.6%, Peak time = 5.5 min,
Mix stab = 9.0 min, MTI = 34 FU

Mixograms

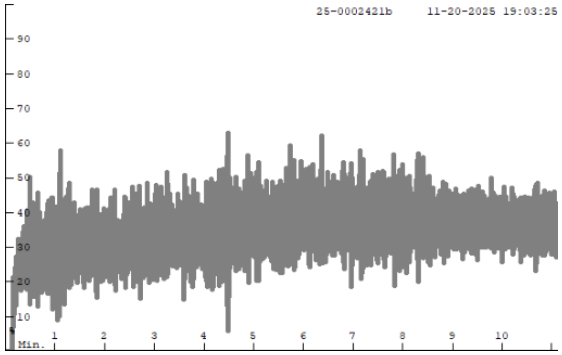


Water abs = 67.9%
Mix time = 5.1 min

25-2420, X4027_WB



Water abs = 62.6%, Peak time = 5.1 min,
Mix stab = 11.0 min, MTI = 26 FU

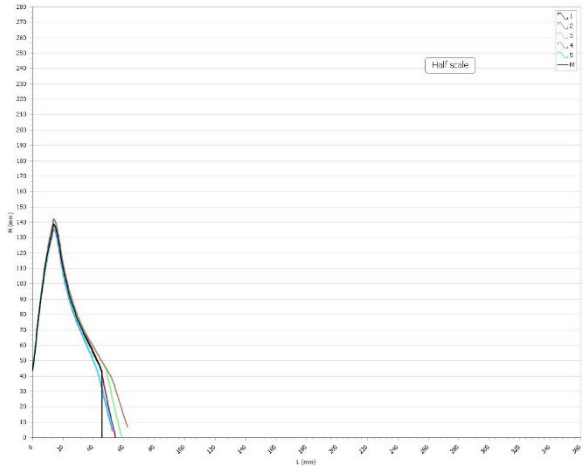


Water abs = 65.1%
Mix time = 5.6 min

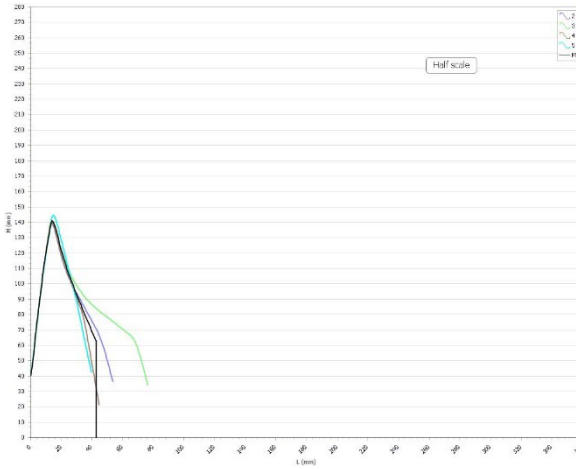
25-2421, WB4650_WB

Physical Dough Tests - Alveograms

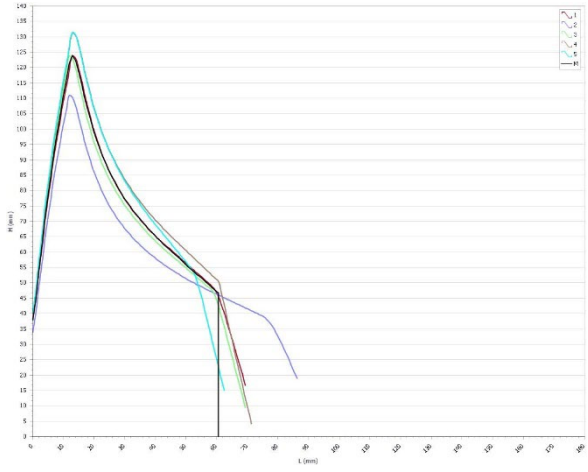
2025 (Small Scale) Samples – Northern Growout



25-2414, 23Nord-191_ND
P(mm H_20) =156, L(mm) = 46, W($10E^{-4}$ J) = 262



25-2415, SD20D009-9_SD
P(mm H_20) =155, L(mm) = 42, W($10E^{-4}$ J) = 276

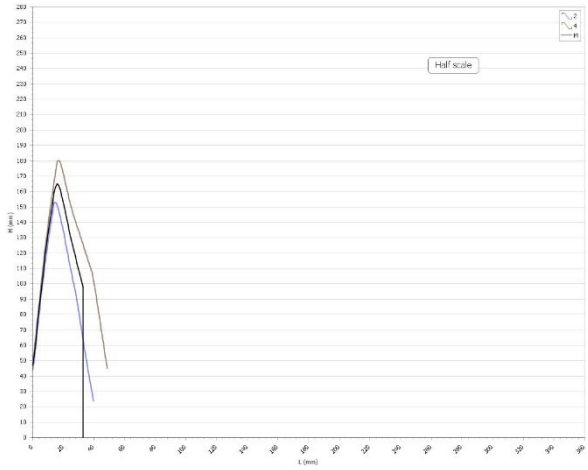


25-2416, SD21B102-4_SD
P(mm H_20) = 136, L(mm) = 60, W($10E^{-4}$ J) = 305

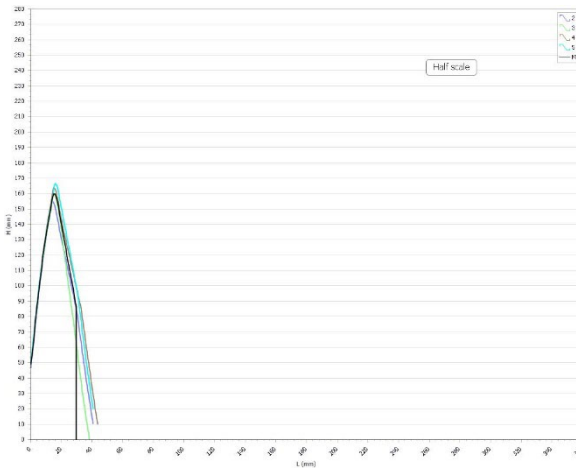
25-2417, SY Monument_CK
P(mm H_20) =173, L(mm) = 31, W($10E^{-4}$ J) = 243

Physical Dough Tests - Alveograms

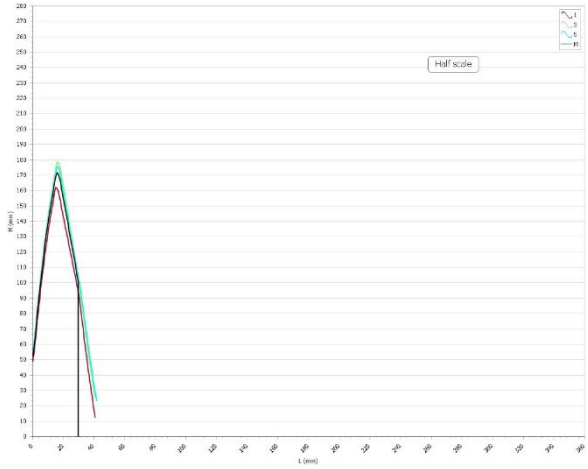
2025 (Small Scale) Samples – Northern Growout



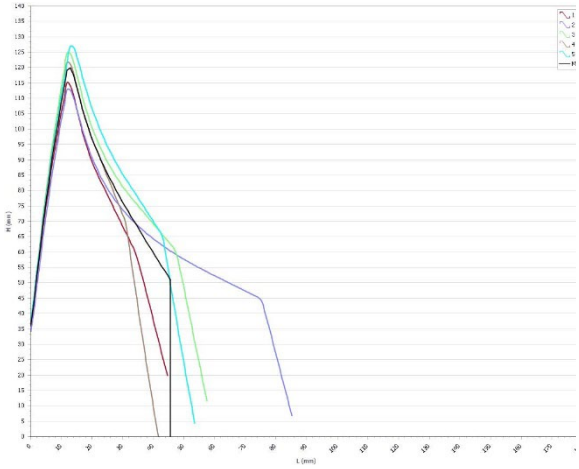
25-2418, NE20620_NE
P(mm H_20) =182, L(mm) = 33, W(10E^{-4} J) = 267



25-2419, NEB 148-42_NE
P(mm H_20) =176, L(mm) = 30, W(10E^{-4} J) = 252



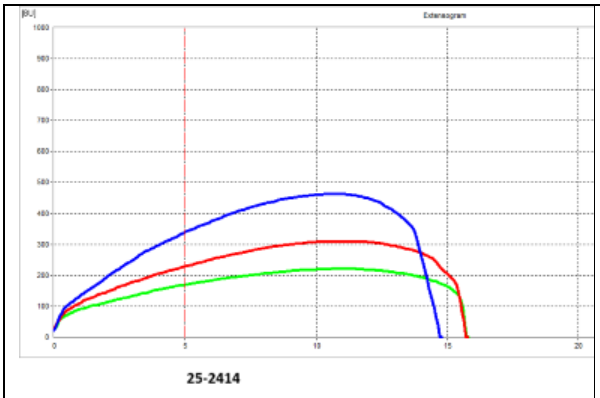
25-2420, X4027_WB
P(mm H_20) = 189, L(mm) = 29, W(10E^{-4} J) = 244



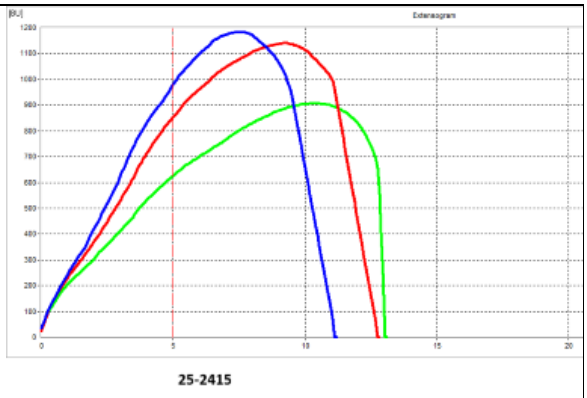
25-2421, WB4650_WB
P(mm H_20) =132, L(mm) = 45, W(10E^{-4} J) = 227

Physical Dough Tests - Extensigrams

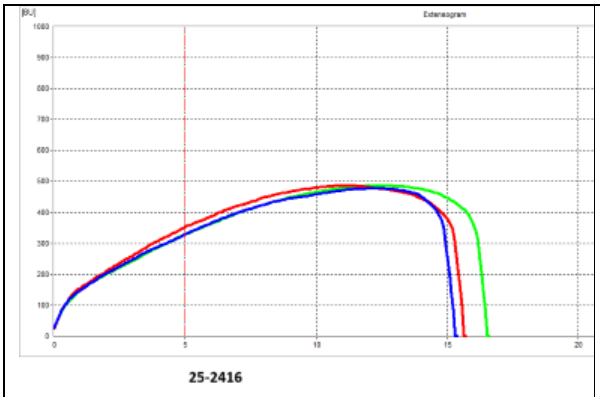
2025 (Small Scale) Samples – Northern Growout



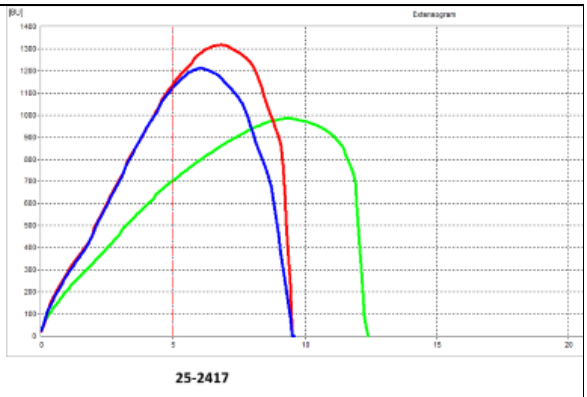
25-2414, 23Nord-191_ND
R (BU) = 229, E (mm) = 159, W (cm^2) = 66
Rmax (BU) = 309, Ratio = 1.4 at 90 min



25-2415, SD20D009-9_SD
R (BU) = 857, E (mm) = 129, W (cm^2) = 170
Rmax (BU) = 1140, Ratio = 6.7 at 90 min



25-2416, SD21B102-4_SD
R (BU) = 354, E (mm) = 158, W (cm^2) = 102
Rmax (BU) = 486, Ratio = 2.2 at 90 min

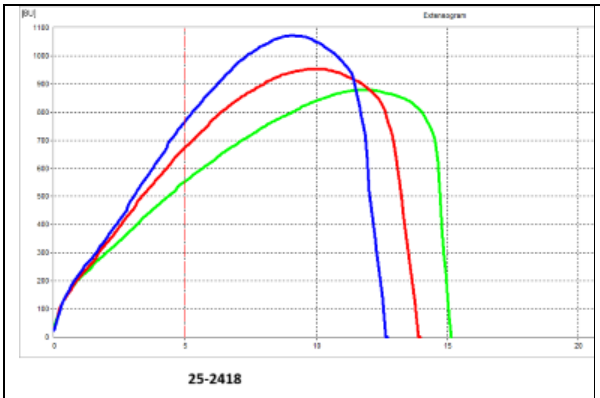


25-2417, SY Monument_CK
R (BU) = 1145, E (mm) = 97, W (cm^2) = 145
Rmax (BU) = 1317, Ratio = 11.8 at 90 min

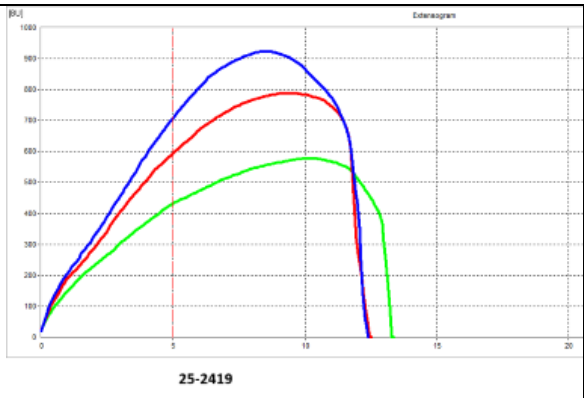
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Physical Dough Tests - Extensigrams

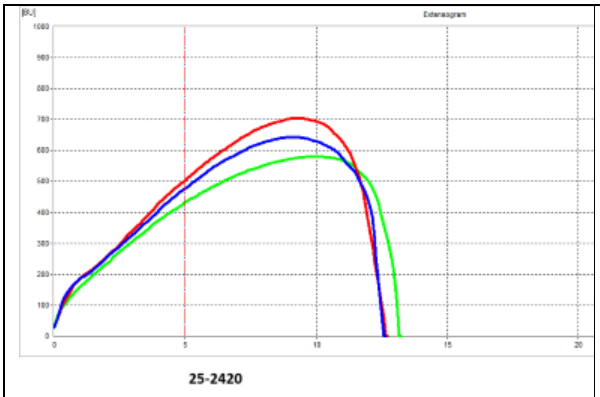
2025 (Small Scale) Samples – Northern Growout



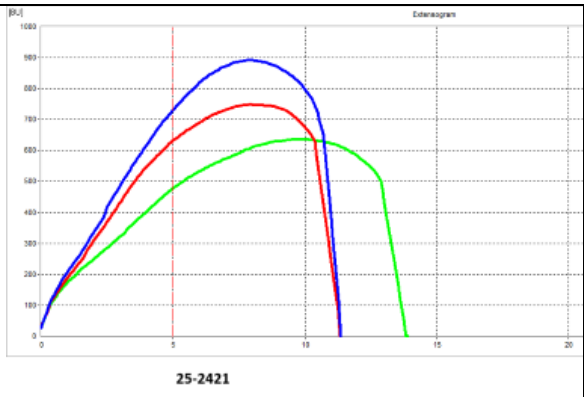
25-2418, NE20620_NE
R (BU) = 675, E (mm) = 141, W (cm^2) = 164
Rmax (BU) = 953, Ratio = 4.8 at 90 min



25-2419, NEB 148-42_NE
R (BU) = 599, E (mm) = 126, W (cm^2) = 121
Rmax (BU) = 788, Ratio = 4.8 at 90 min



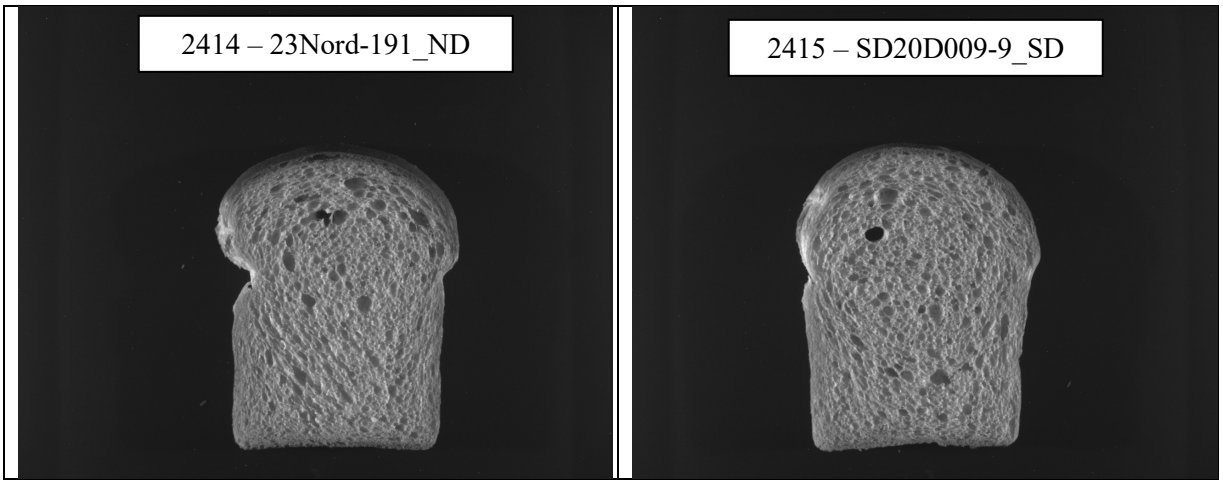
25-2420, X4027_WB
R (BU) = 504, E (mm) = 128, W (cm^2) = 107
Rmax (BU) = 703, Ratio = 3.9 at 90 min



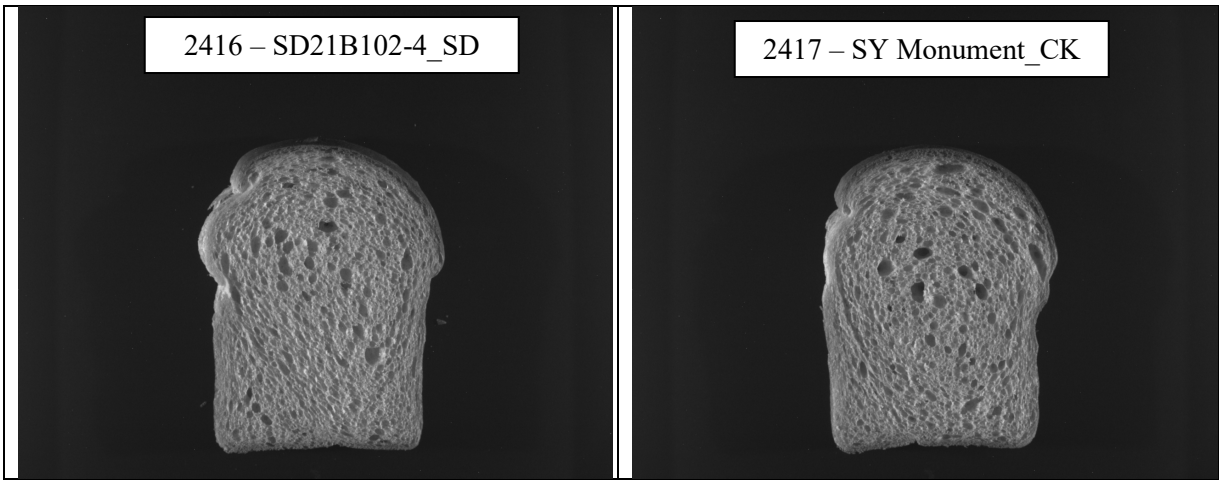
25-2421, WB4650_WB
R (BU) = 634, E (mm) = 114, W (cm^2) = 106
Rmax (BU) = 748, Ratio = 5.6 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Northern Growout: C-Cell Bread Images and Analysis
2025 (Small-Scale) Samples

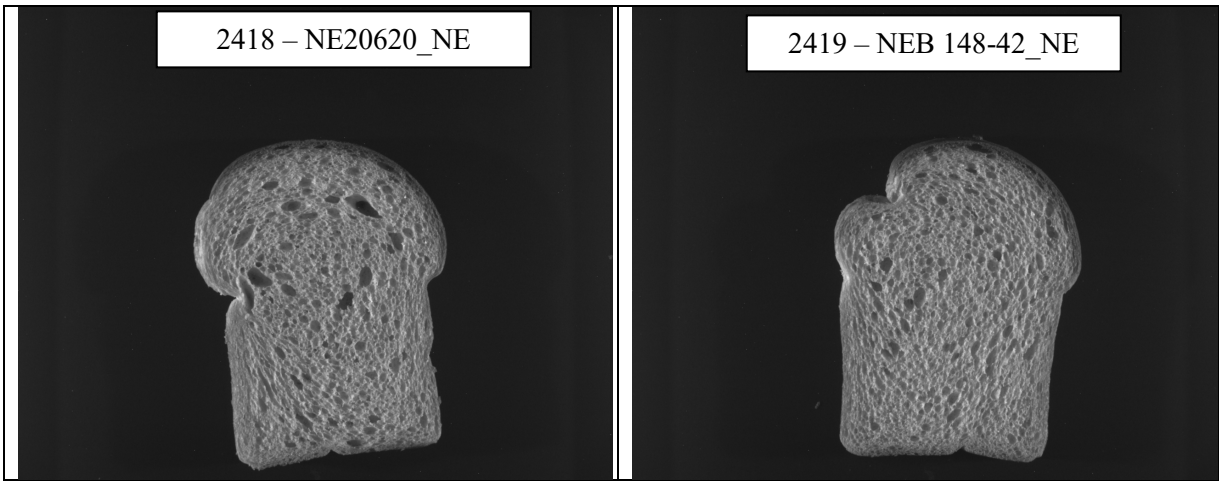


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2414	5882	114	3319	0.440	2.200	2.125	1.770	-6.45
2415	5899	117	3229	0.445	2.245	1.095	1.740	-5.00

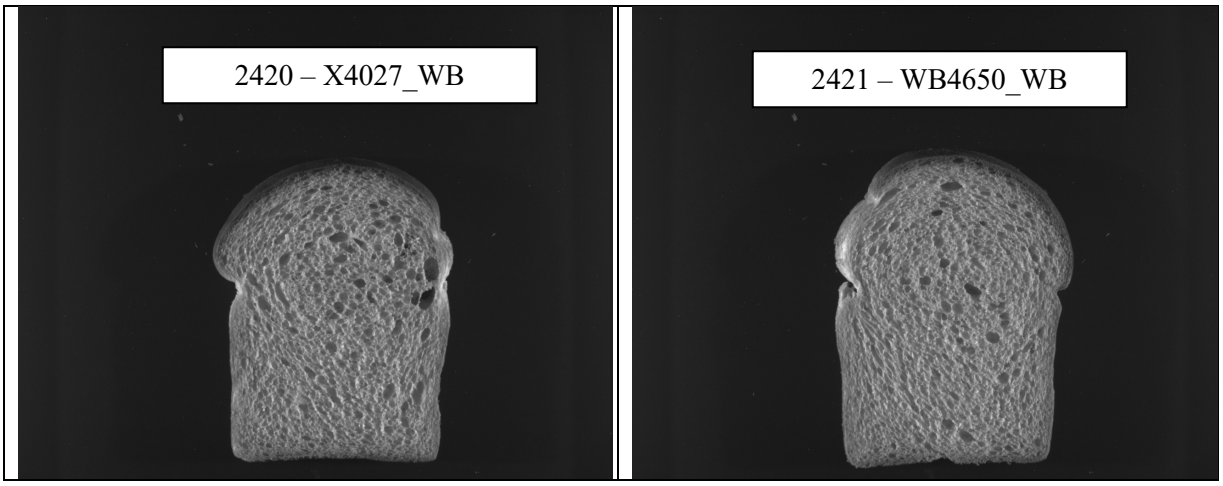


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2416	6037	116	3363	0.440	2.235	1.600	1.760	-8.40
2417	5792	112	3277	0.435	2.100	0.970	1.785	-6.15

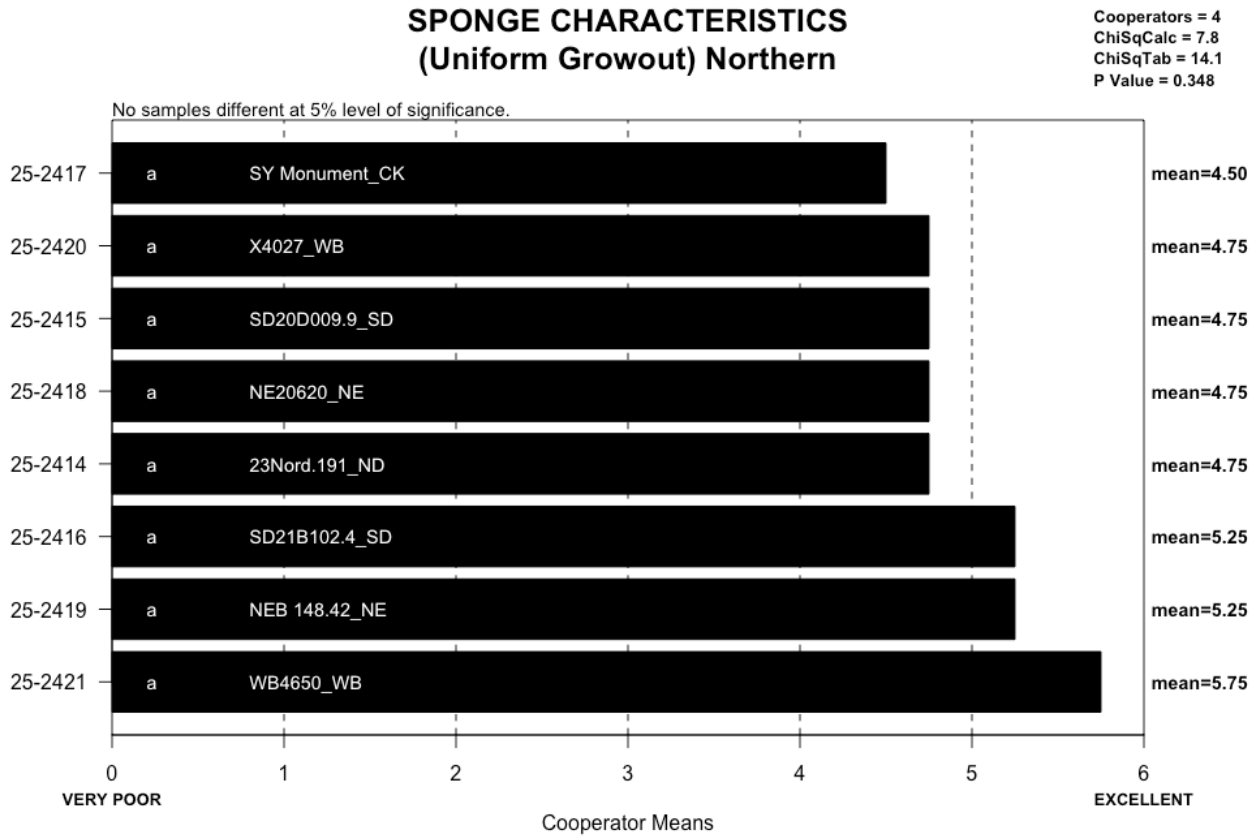
Northern Growout: C-Cell Bread Images and Analysis
2025 (Small-Scale) Samples

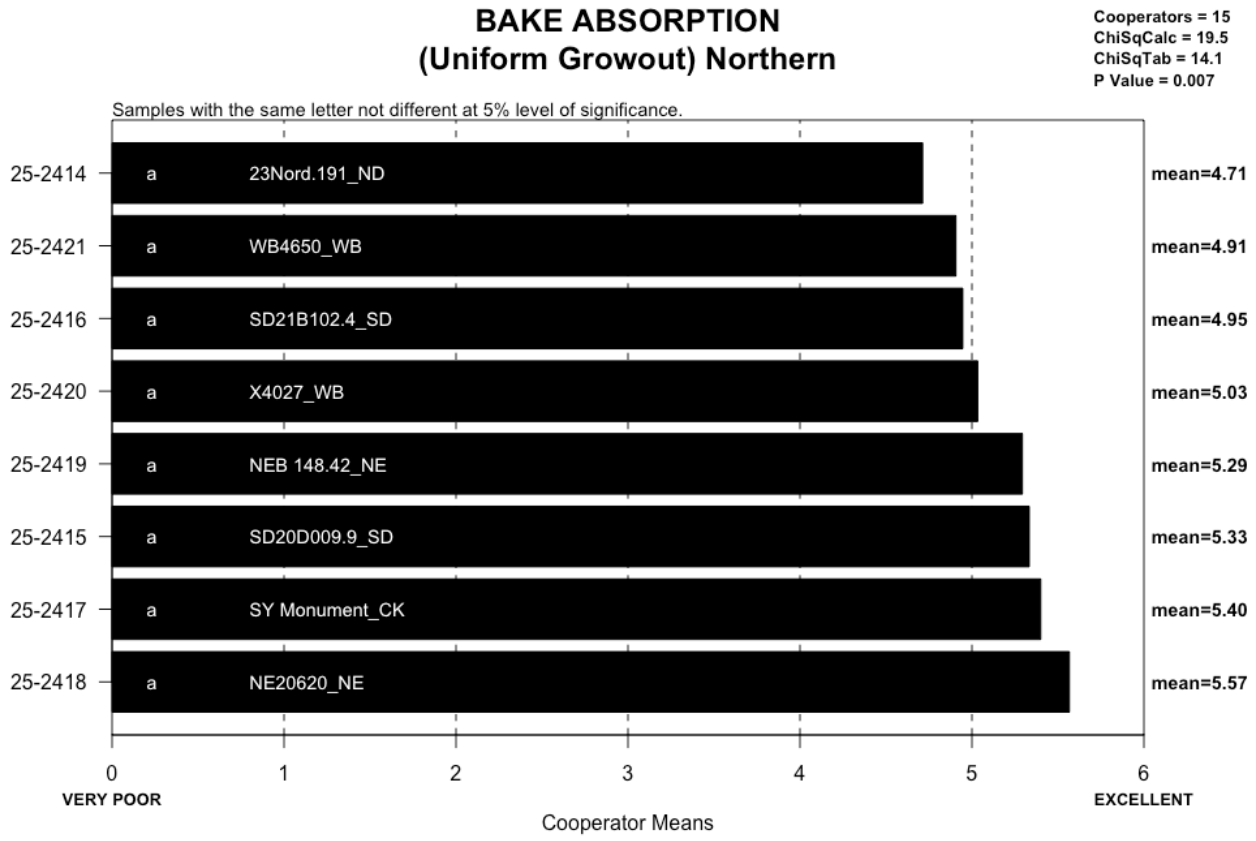


Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2418	6058	113	3304	0.435	2.210	3.465	1.750	-3.00
2419	6109	114	3080	0.450	2.350	1.725	1.850	-0.85



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2420	5848	111	3100	0.440	2.255	3.440	1.660	-2.85
2421	6087	115	3383	0.435	2.175	0.970	1.755	-7.85


SPONGE CHARACTERISTICS
(Uniform Growout) Northern
Cooperators = 4
ChiSqCalc = 7.8
ChiSqTab = 14.1
P Value = 0.348
No samples different at 5% level of significance.
25-2417 a SY Monument_CK mean=4.50
25-2420 a X4027_WB mean=4.75
25-2415 a SD20D009.9_SD mean=4.75
25-2418 a NE20620_NE mean=4.75
25-2414 a 23Nord.191_ND mean=4.75
25-2416 a SD21B102.4_SD mean=5.25
25-2419 a NEB 148.42_NE mean=5.25
25-2421 a WB4650_WB mean=5.75
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

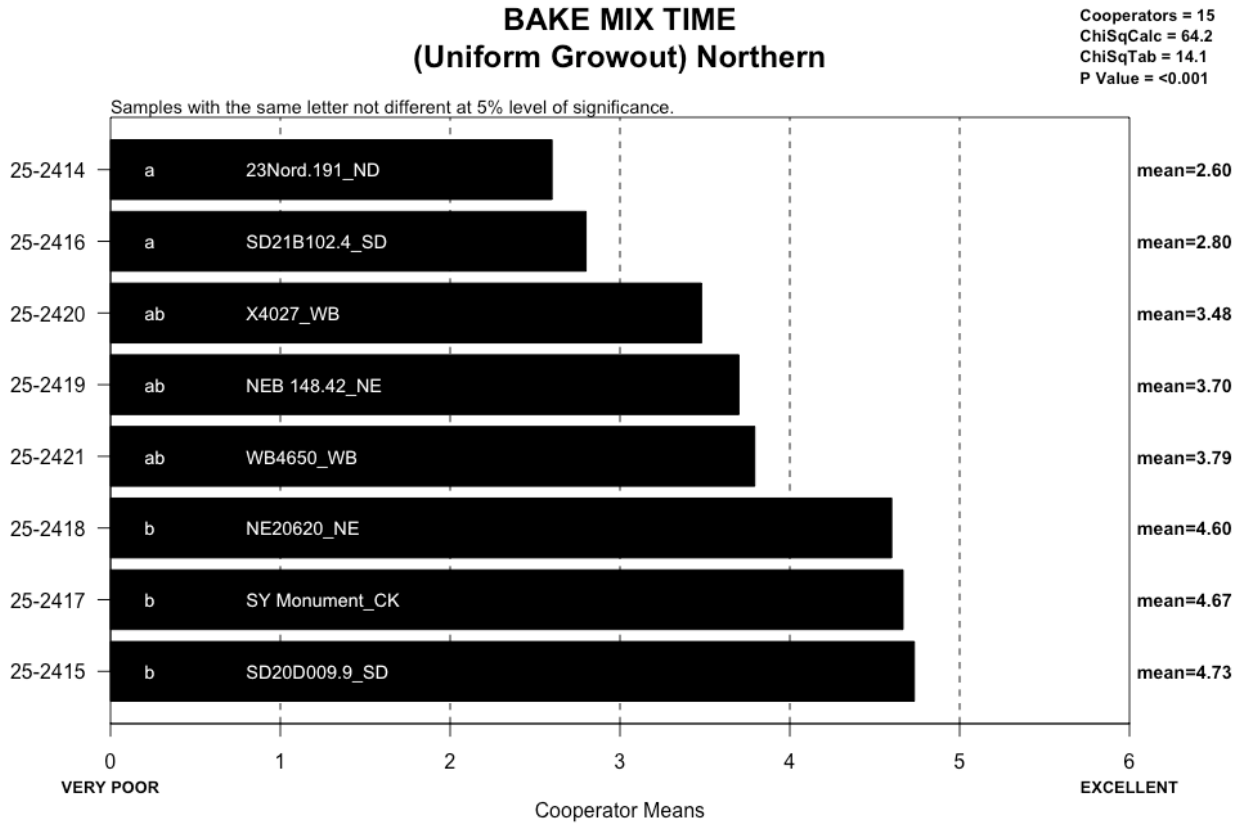

BAKE ABSORPTION
(Uniform Growout) Northern
Cooperators = 15
ChiSqCalc = 19.5
ChiSqTab = 14.1
P Value = 0.007
Samples with the same letter not different at 5% level of significance.
25-2414 a 23Nord.191_ND mean=4.71
25-2421 a WB4650_WB mean=4.91
25-2416 a SD21B102.4_SD mean=4.95
25-2420 a X4027_WB mean=5.03
25-2419 a NEB 148.42_NE mean=5.29
25-2415 a SD20D009.9_SD mean=5.33
25-2417 a SY Monument_CK mean=5.40
25-2418 a NE20620_NE mean=5.57
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

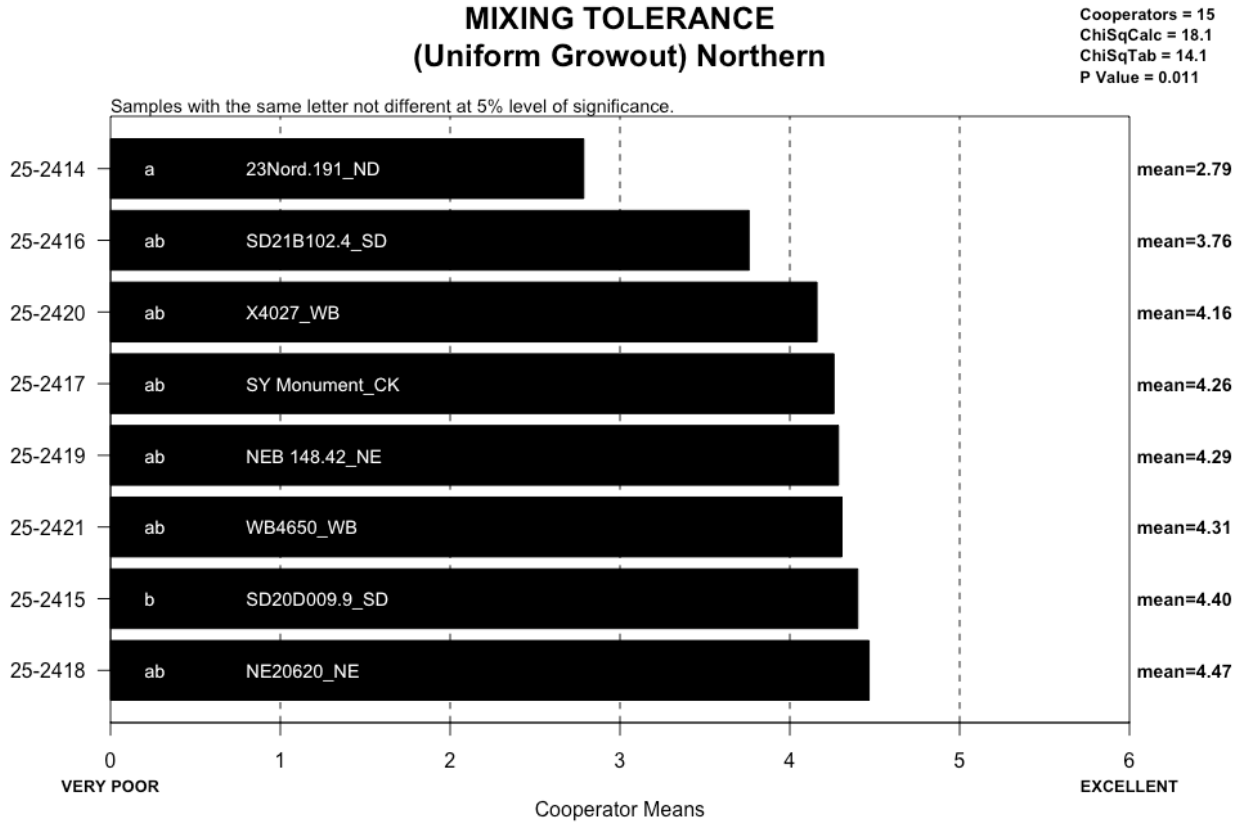
BAKE ABSORPTION, ACTUAL (14% MB)
(Uniform Growout) Northern
Cooperators A – O

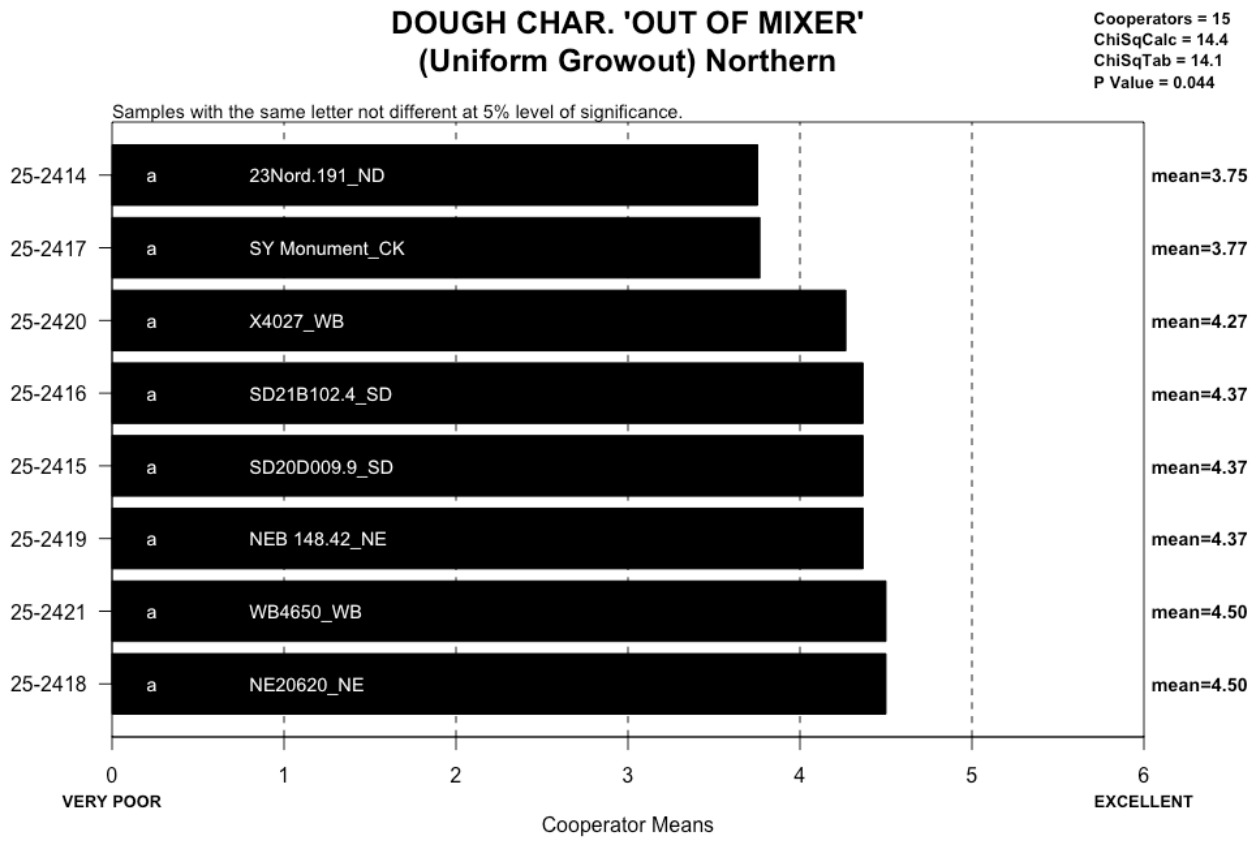
IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
25-2414	23Nord.191_ND	68.3	70	65.5	64.7	67.4	63	58	61.4	73.8	76.6	76.1	67.3	78.0	67.8	68.5
25-2415	SD20D009.9_SD	70.3	65	68.2	64.0	67.4	60	57	63.5	68.6	67.9	69.0	67.5	70.2	68.8	65.6
25-2416	SD21B102.4_SD	69.1	65	66.1	63.2	65.8	62	57	62.8	67.7	66.6	69.0	65.8	69.5	67.6	64.5
25-2417	SY Monument_CK	69.9	66	70.3	64.0	67.1	61	57	64.5	69.8	67.1	68.3	66.1	70.7	68.7	65.1
25-2418	NE20620_NE	70.7	69	69.9	65.9	68.8	64	58	66.7	69.8	69.1	70.5	67.5	71.9	69.5	67.6
25-2419	NEB 148.42_NE	69.2	68	70.5	64.9	66.4	61	57	63.9	69.5	67.7	70.0	66.0	71.0	68.4	66.4
25-2420	X4027_WB	70.6	71	67.2	65.0	67.6	64	58	64.5	72.1	70.6	71.6	67.9	73.7	70.0	66.9
25-2421	WB4650_WB	68.2	65	65.5	62.6	65.5	61	57	64.2	65.8	64.6	66.3	65.0	67.8	67.3	62.6

BAKE MIX TIME, ACTUAL
(Uniform Growout) Northern
Cooperators A – O

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
25-2414	23Nord.191_ND	3.6	7	3.8	5.0	4.0	2.4	10	4.0	3.8	6	6.0	4.3	5	3.3	11
25-2415	SD20D009.9_SD	9.3	16	8.5	9.8	10.0	6.4	19	7.0	5.0	12	8.0	9.5	5	8.6	14
25-2416	SD21B102.4_SD	3.8	10	4.0	5.0	5.0	2.8	13	3.3	4.3	8	6.0	5.0	5	4.5	13
25-2417	SY Monument_CK	9.1	12	8.8	10.8	12.4	7.4	16	8.7	5.0	4	8.0	9.5	5	14.0	18
25-2418	NE20620_NE	6.9	14	6.3	7.5	8.8	6.0	19	6.0	4.5	20	7.0	7.8	6	7.9	16
25-2419	NEB 148.42_NE	5.4	12	5.5	6.5	6.8	3.5	11	4.0	4.8	14	6.5	6.5	6	6.0	13
25-2420	X4027_WB	4.9	7	4.8	5.2	6.8	3.0	11	4.3	4.5	12	6.5	6.5	6	6.5	15
25-2421	WB4650_WB	5.6	13	5.5	5.9	7.0	4.6	11	4.8	4.8	11	7.0	6.0	5	7.5	15

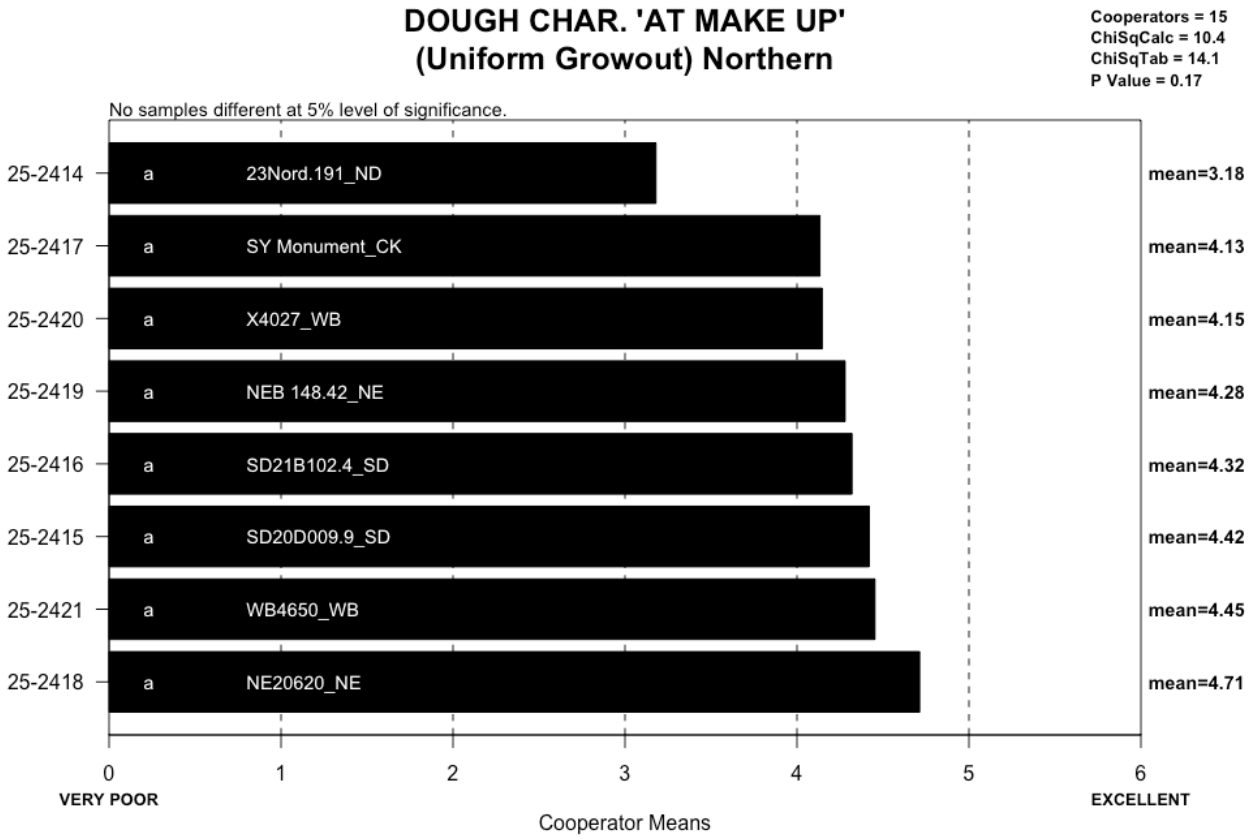

BAKE MIX TIME
(Uniform Growout) Northern
Cooperators = 15
ChiSqCalc = 64.2
ChiSqTab = 14.1
P Value = <0.001
Samples with the same letter not different at 5% level of significance.
25-2414 a 23Nord.191_ND mean=2.60
25-2416 a SD21B102.4_SD mean=2.80
25-2420 ab X4027_WB mean=3.48
25-2419 ab NEB 148.42_NE mean=3.70
25-2421 ab WB4650_WB mean=3.79
25-2418 b NE20620_NE mean=4.60
25-2417 b SY Monument_CK mean=4.67
25-2415 b SD20D009.9_SD mean=4.73
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means


MIXING TOLERANCE
(Uniform Growout) Northern
Cooperators = 15
ChiSqCalc = 18.1
ChiSqTab = 14.1
P Value = 0.011
Samples with the same letter not different at 5% level of significance.
25-2414 a 23Nord.191_ND mean=2.79
25-2416 ab SD21B102.4_SD mean=3.76
25-2420 ab X4027_WB mean=4.16
25-2417 ab SY Monument_CK mean=4.26
25-2419 ab NEB 148.42_NE mean=4.29
25-2421 ab WB4650_WB mean=4.31
25-2415 b SD20D009.9_SD mean=4.40
25-2418 ab NE20620_NE mean=4.47
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means



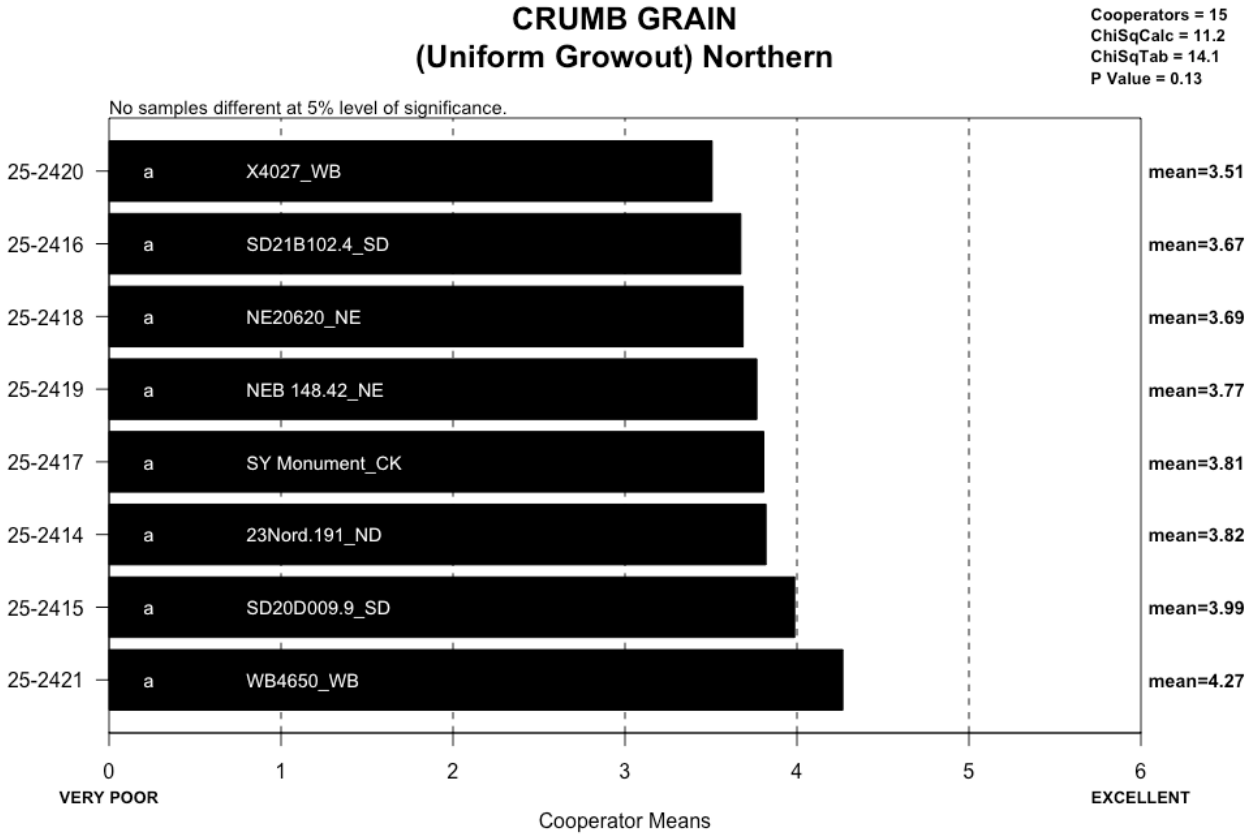
DOUGH CHAR. 'OUT OF MIXER', DESCRIBED
(Uniform Growout) Northern

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
25-2414	23Nord.191_ND	6	3	0	4	2
25-2415	SD20D009.9_SD	1	1	2	7	4
25-2416	SD21B102.4_SD	2	0	1	9	3
25-2417	SY Monument_CK	5	1	0	8	1
25-2418	NE20620_NE	2	0	6	4	3
25-2419	NEB 148.42_NE	1	0	2	11	1
25-2420	X4027_WB	1	2	3	7	2
25-2421	WB4650_WB	0	0	0	13	2



DOUGH CHAR. 'AT MAKE UP', DESCRIBED
(Uniform Growout) Northern

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
25-2414	23Nord.191_ND	5	4	1	4	1
25-2415	SD20D009.9_SD	0	1	3	9	2
25-2416	SD21B102.4_SD	2	2	0	9	2
25-2417	SY Monument_CK	1	0	5	8	1
25-2418	NE20620_NE	0	0	3	9	3
25-2419	NEB 148.42_NE	0	2	2	10	1
25-2420	X4027_WB	2	2	1	10	0
25-2421	WB4650_WB	2	0	1	9	3

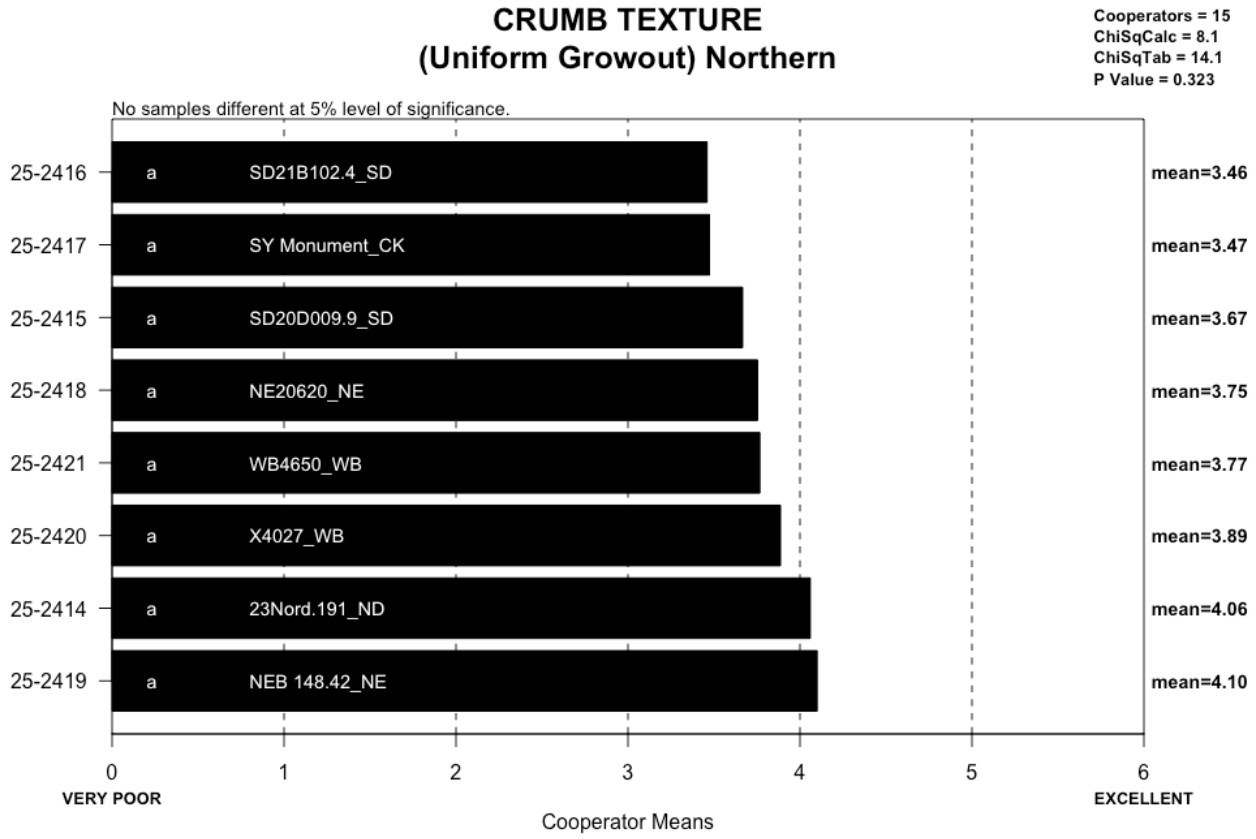


CRUMB GRAIN, DESCRIBED
(Uniform Growout) Northern

IDCODE	ID	Open	Fine	Dense
25-2414	23Nord.191_ND	3	9	3
25-2415	SD20D009.9_SD	7	6	2
25-2416	SD21B102.4_SD	6	5	4
25-2417	SY Monument_CK	5	9	1
25-2418	NE20620_NE	7	6	2
25-2419	NEB 148.42_NE	8	6	1
25-2420	X4027_WB	9	3	3
25-2421	WB4650_WB	5	9	1

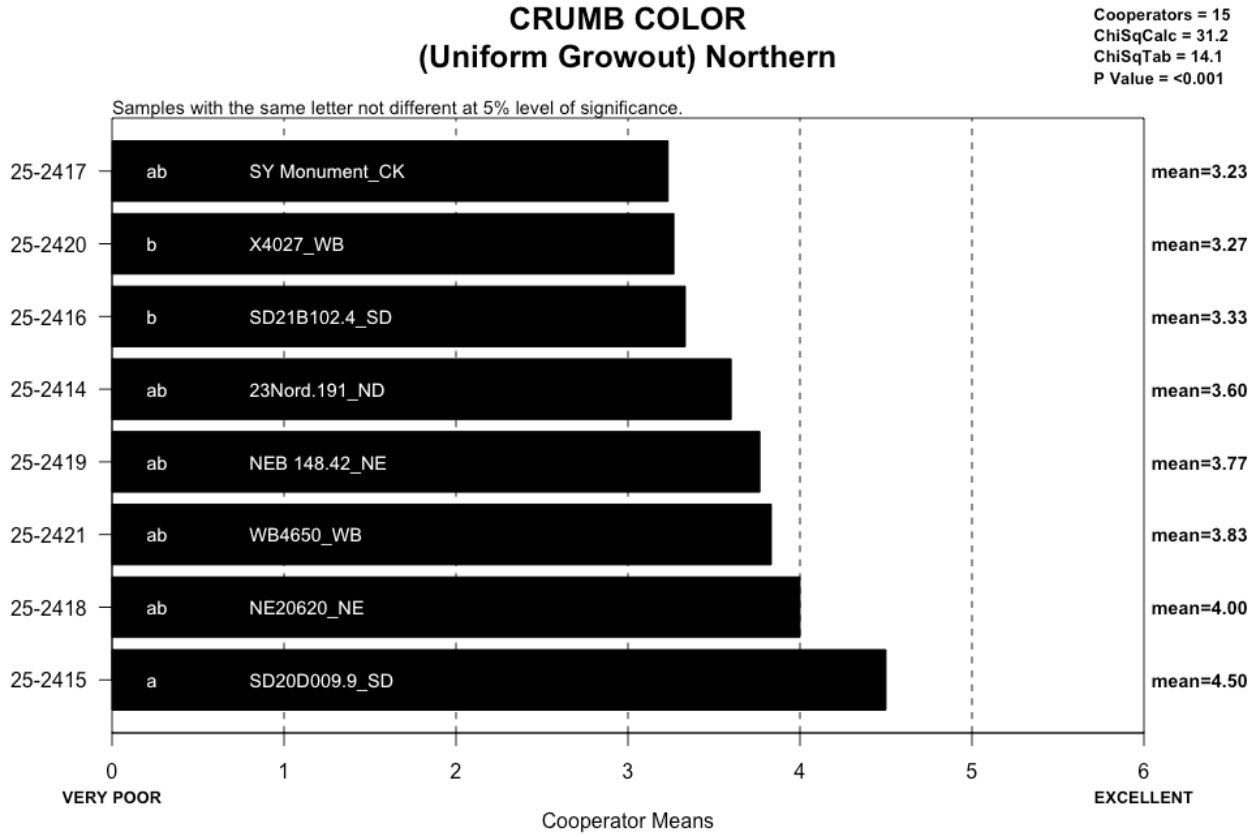
CELL SHAPE, DESCRIBED
(Uniform Growout) Northern

IDCODE	ID	Round	Irregular	Elongated
25-2414	23Nord.191_ND	5	6	4
25-2415	SD20D009.9_SD	5	5	5
25-2416	SD21B102.4_SD	8	4	3
25-2417	SY Monument_CK	5	7	3
25-2418	NE20620_NE	5	8	2
25-2419	NEB 148.42_NE	6	7	2
25-2420	X4027_WB	8	3	4
25-2421	WB4650_WB	3	8	4



CRUMB TEXTURE, DESCRIBED
(Uniform Growout) Northern

IDCODE	ID	Harsh	Smooth	Silky
25-2414	23Nord.191_ND	3	9	3
25-2415	SD20D009.9_SD	3	11	1
25-2416	SD21B102.4_SD	6	7	2
25-2417	SY Monument_CK	6	8	1
25-2418	NE20620_NE	6	4	5
25-2419	NEB 148.42_NE	3	8	4
25-2420	X4027_WB	3	9	3
25-2421	WB4650_WB	4	8	3



CRUMB COLOR, DESCRIBED
(Uniform Growout) Northern

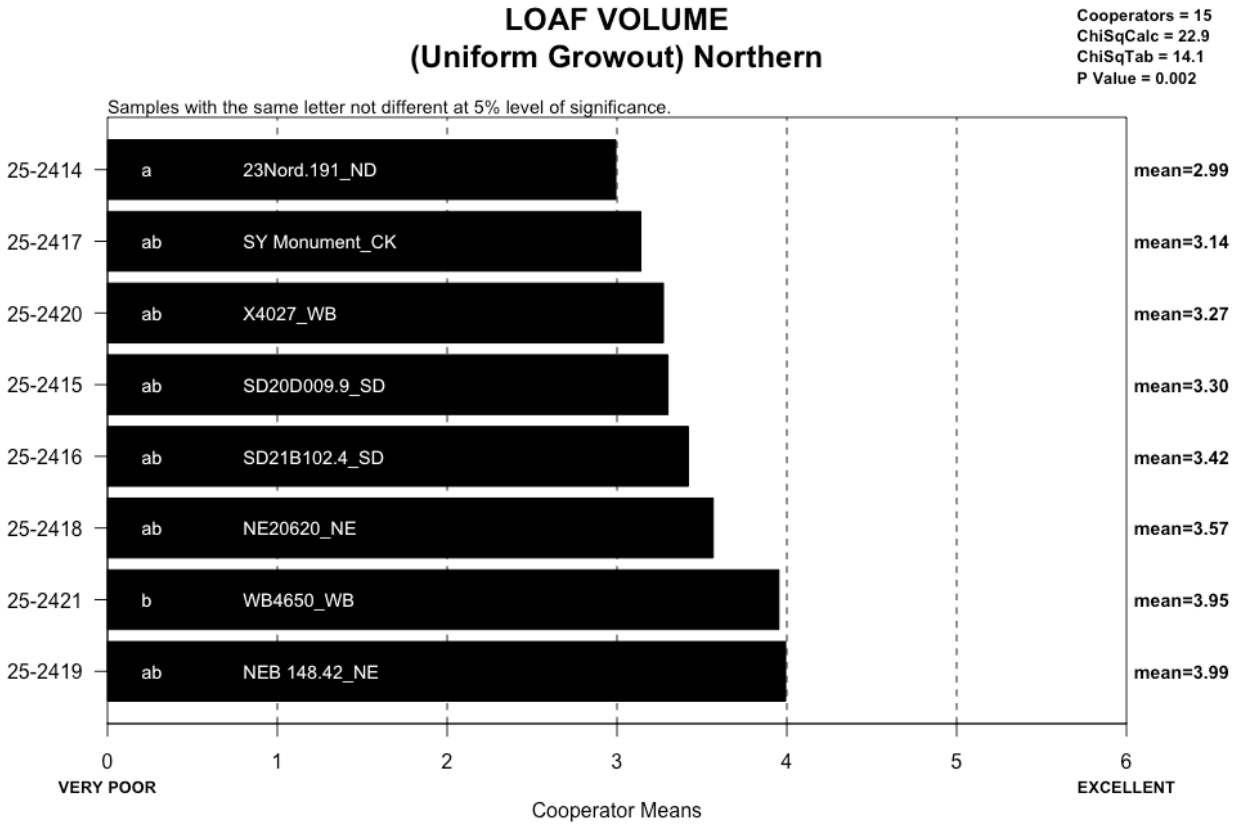
IDCODE	ID	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
25-2414	23Nord.191_ND	1	0	1	3	7	3	0
25-2415	SD20D009.9_SD	0	0	0	3	5	6	1
25-2416	SD21B102.4_SD	1	0	1	5	7	1	0
25-2417	SY Monument_CK	2	1	0	4	7	1	0
25-2418	NE20620_NE	1	0	0	5	3	5	1
25-2419	NEB 148.42_NE	0	0	2	3	7	3	0
25-2420	X4027_WB	0	2	1	4	7	1	0
25-2421	WB4650_WB	1	0	1	4	3	6	0

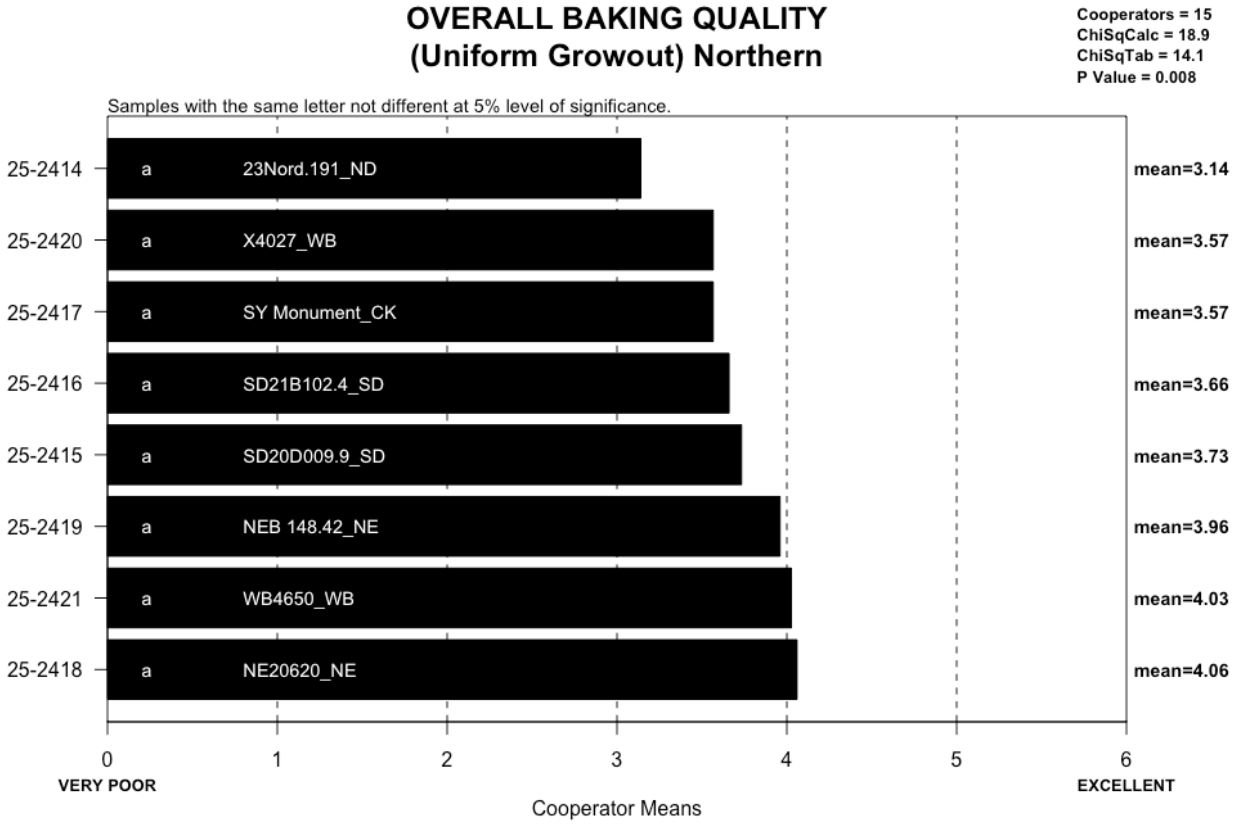
LOAF WEIGHT, ACTUAL
(Uniform Growout) Northern
Cooperators A – O

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
25-2414	23Nord.191_ND	142.4	470.3	144.2	143.3	156.8	148.8	409.5	150.7	137.0	420.1	435	137.5	435	144.1	439.1
25-2415	SD20D009.9_SD	143.9	469.9	144.6	140.7	154.1	145.7	401.3	152.3	135.6	432.3	435	138.3	447	138.8	447.5
25-2416	SD21B102.4_SD	143.6	470.1	147.3	149.8	154.1	145.6	408.7	154.5	132.6	417.3	434	139.2	448	135.6	450.5
25-2417	SY Monument_CK	143.0	471.4	147.4	140.4	152.1	145.1	417.6	151.4	137.1	416.8	438	140.5	450	138.7	448.9
25-2418	NE20620_NE	143.1	471.5	144.7	143.5	156.1	145.4	406.1	152.7	137.6	421.1	435	140.1	446	139.7	445.5
25-2419	NEB 148.42_NE	142.2	469.9	144.8	141.9	153.7	148.5	410.3	150.7	133.8	416.2	430	140.2	450	138.4	449.3
25-2420	X4027_WB	143.2	466.4	144.6	143.5	154.0	145.2	410.5	154.9	135.3	413.6	433	139.4	452	141.3	453.8
25-2421	WB4650_WB	141.9	467.6	145.2	143.2	153.9	143.3	407.3	151.3	132.0	419.8	432	139.6	150	140.2	445.4

LOAF VOLUME, ACTUAL
(Uniform Growout) Northern
Cooperators A – O

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
25-2414	23Nord.191_ND	795	2757	910	841	780	675	2575	738	915	2450	2119	805	2062	853	1900
25-2415	SD20D009.9_SD	890	2997	980	748	760	800	2525	777	835	2625	2127	817	2058	790	1976
25-2416	SD21B102.4_SD	835	2922	775	831	820	725	2725	814	890	2550	2193	847	2116	930	1862
25-2417	SY Monument_CK	880	3012	940	823	755	775	2575	784	780	2050	2087	759	2076	755	1925
25-2418	NE20620_NE	860	2922	1010	853	805	750	2475	799	835	2625	2240	762	2301	758	1928
25-2419	NEB 148.42_NE	860	2952	955	935	820	775	2725	800	870	2700	2300	768	2277	830	1974
25-2420	X4027_WB	820	2772	900	805	770	700	2600	791	860	2500	2142	754	2061	943	1941
25-2421	WB4650_WB	845	3087	940	880	800	750	2650	823	865	2600	2266	812	2275	868	1950


LOAF VOLUME
(Uniform Growout) Northern
Cooperators = 15
ChiSqCalc = 22.9
ChiSqTab = 14.1
P Value = 0.002
Samples with the same letter not different at 5% level of significance.
25-2414 a 23Nord.191_ND mean=2.99
25-2417 ab SY Monument_CK mean=3.14
25-2420 ab X4027_WB mean=3.27
25-2415 ab SD20D009.9_SD mean=3.30
25-2416 ab SD21B102.4_SD mean=3.42
25-2418 ab NE20620_NE mean=3.57
25-2421 b WB4650_WB mean=3.95
25-2419 ab NEB 148.42_NE mean=3.99
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means


OVERALL BAKING QUALITY
(Uniform Growout) Northern
Cooperators = 15
ChiSqCalc = 18.9
ChiSqTab = 14.1
P Value = 0.008
Samples with the same letter not different at 5% level of significance.
25-2414 a 23Nord.191_ND mean=3.14
25-2420 a X4027_WB mean=3.57
25-2417 a SY Monument_CK mean=3.57
25-2416 a SD21B102.4_SD mean=3.66
25-2415 a SD20D009.9_SD mean=3.73
25-2419 a NEB 148.42_NE mean=3.96
25-2421 a WB4650_WB mean=4.03
25-2418 a NE20620_NE mean=4.06
0 1 2 3 4 5 6
VERY POOR
EXCELLENT
Cooperator Means

COOPERATOR'S COMMENTS
(Uniform Growout) Northern
Cooperators A – O

25-2414	23Nord-191_ND
A	Weak mixograph, very good dough feel, poorer crumb grain, and poorer loaf volume than predicted with protein. Overall poorer quality.
B	Overhydrated, low mix time. Slack, sticky dough. Cut back on absorption by 5%.
C	slight cap
D	High Water Abs, Normal MT, Slightly Sticky & Strong Dough, Medium Loaf Volume, Yellow Crumb Grain, Fine Elongated Cells, Good Resilient & Smooth Texture
E	Shorter mix time. Good dough at make up. Avg open dull colored grain. Very low volume. Lowest mix toler.
F	No comment.
G	Lower volume, good mix time, sticy dough
H	No comment.
I	No comment.
J	High protein and very high absorption. Low stability and mix time. Fair volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	No comment.
25-2415	SD20D009-9_SD
A	Very long mix time. Overall acceptable quality.
B	Excellent absorption, good mix time. Optimum dough handling. Good loaf volume.
C	white dough
D	High Water Abs, Long MT, Slightly Sticky & Strong Dough, Fair Loaf Volume, Creamy Crumb Grain, Fine Elongated Cells, Good Resilient & Smooth Texture
E	Longer mix time, high absorp. Tough dough at make up. Avg open creamy colored grain. Very low volume.
F	No comment.
G	Lower volume, long mix time, good dough
H	No comment.
I	No comment.
J	Good protein, high absorption, and mix time. Low stability. Fair volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	No comment.
25-2416	SD21B102-4_SD
A	Good dough feel out of mixer, but dough feel rating declined to wet at make up after fermentation. Slightly poorer loaf volume than predicted with protein. Overall poorer quality.
B	Excellent absorption with slightly low mix time. Optimum dough handling. Good loaf volume.
C	poor volume
D	High Water Abs, Normal MT, Slightly Sticky & Strong Dough, Fair Loaf Volume, Dull Crumb Grain, Open Round Cells, Good Resilient & Slightly Harsh Texture
E	Good mix time, avg absorp. Good dough at make up. Avg open harsh texture crum grain. Low volume. Avg Mtol.
F	No comment.
G	Good volume, good mix time, sticky dough
H	No comment.
I	No comment.
J	High protein and absorption. Good stability and mix time. Fair volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	No comment.

COOPERATOR'S COMMENTS
(Uniform Growout) Northern
Cooperators A – O

25-2417	SY Monument_CK
A	Very long mix time. Overall aceptable quality.
B	Excellent absorption with average mix time. Optimum dough handling. Excellent loaf volume.
C	excellent loaf externals
D	High Water Abs, Very Long MT, Slightly Sticky & Strong Dough, Medium Loaf Volume, Dark Yellow Crumb Grain, Fine Elongated Cells, Good Resilient & Smooth Texture
E	Very long mix time, high absorp. Avg harsh texture dull colored crumb grain. Very low volume. Excellent mix tol.
F	No comment.
G	Lower volume, long mix time, good dough
H	No comment.
I	No comment.
J	High protein and absorption. Low stability, mix time and volume. Negative bench comments. Gray color.
K	No comment.
L	No comment.
M	No comment.
N	The dough developed well when the mixing time was extended to 14 minutes
O	No comment.
25-2418	NE20620_NE
A	Long mix time, tough dough feel out of mixer, but improved at make up. Slightly poorer loaf volume than predicted with protein. Overall acceptable quality.
B	Excellent absorption with average mix time. Optimum dough handling. Excellent loaf volume.
C	tough, slight cap
D	High Water Abs, Long MT, Slightly Sticky & Strong Dough, High Loaf Volume, Dull Crumb Grain, Fine Elongated Cells, Good Resilient & Silky Texture
E	Long mix time, high absorp. Tough dough. Avg harsh texture dull colored crumb grain. Low volume.
F	No comment.
G	Lower volume, long mix time, good dough
H	No comment.
I	No comment.
J	High protein, absorption, and mix time. Good stability. Fair volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	Very Crumbly
25-2419	NEB 148-42_NE
A	Overall acceptable quality.
B	Slightly soft dough handling with average mix time. Excellent loaf volume.
C	cap
D	High Water Abs, Normal MT, Slightly Sticky & Strong Dough, High Loaf Volume, Creamy Crumb Grain, Fine Elongated Cells, Good Resilient & Silky Texture
E	Long mix time, avg absorp. Tough dough at make up. Avg open harsh texture crumb grain. Low volume.
F	No comment.
G	Good volume, good mix time, good dough
H	No comment.
I	No comment.
J	Good protein, stability, mix time, and volume. High absorption
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	No comment.

COOPERATOR'S COMMENTS
(Uniform Growout) Northern
Cooperators A – O

25-2420	X4027_WB
A	Tough dough out of mixer, but improved at make up. Slightly poorer loaf volume than predicted with protein. Overall acceptable quality.
B	Overhydrated, low mix time. Slack, sticky dough. Cut back on absorption by 5%.
C	tough, left and right break
D	High Water Abs, Normal MT, Slightly Sticky & Strong Dough, Fair Loaf Volume, Dark Yellow Crumb Grain, Fine Elongated Cells, Good Resilient & Smooth Texture
E	Long mix time, high absorp. Sticky dough at make up. Dense harsh texture crumb grain. Very low volume.
F	No comment.
G	Lower volume, good mix time, good dough
H	No comment.
I	No comment.
J	High protein and absorption. Good stability and mix time. Fair volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	Very Crumbly
25-2421	WB4650_WB
A	Overall acceptable quality.
B	Excellent absorption with average mix time. Optimum dough handling. Excellent loaf volume.
C	nice loaf externals
D	High Water Abs, Normal MT, Slightly Sticky & Strong Dough, High Loaf Volume, Yellow Crumb Grain, Fine Elongated Cells, Good Resilient & Silky Texture
E	Long mix time, avg absorp. Sticky dough at make up. Avg dull colored crumb grain. Low volume. Good mix tol.
F	No comment.
G	Lower volume, good mix time, good dough
H	No comment.
I	No comment.
J	High protein and absorption. Good stability and mix time. Fair volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	No comment.

NORTHERN MICRO-QUALITY ANALYSIS

Entry_Code	Entry_ID	Entry_No	Breeding Program	Locations*
25-UM2414	23Nord-191	2414	NDSU	UM
25-UM2415	SD20D009-9	2415	SDSU	UM
25-UM2416	SD21B102-4	2416	SDSU	UM
25-UM2417	SY Monument	2417	Check	UM
25-UM2418	NE20620	2418	UNL	UM
25-UM2419	NEB 148-42	2419	UNL	UM
25-UM2420	XH4027	2420	Bayer/Westbred	UM
25-UM2421	WB4650	2421	Bayer/Westbred	UM
25-SD2414	23Nord-191	2414	NDSU	SD
25-SD2415	SD20D009-9	2415	SDSU	SD
25-SD2416	SD21B102-4	2416	SDSU	SD
25-SD2417	SY Monument	2417	Check	SD
25-SD2418	NE20620	2418	UNL	SD
25-SD2419	NEB 148-42	2419	UNL	SD
25-SD2420	XH4027	2420	Bayer/Westbred	SD
25-SD2421	WB4650	2421	Bayer/Westbred	SD

*SD=South Dakota State Univeristy; UM=USDA Manhattan;

1. LOCATIONS AND ENTRIES

C. There are 2 locations:

USDA Manhattan = UM;

South Dakota = SD;

D. There are 8 entries grown in each of the locations:

23Nord-191 (NDSU) = 2414

SD20D009-9 (SDSU) = 2415

SD21B102-4 (SDSU) = 2416

SY Monument (Check) = 2417

NE20620 (UNL) = 2418

NEB 148-42 (UNL) = 2419

XH4027 (Westbred) = 2420

WB 4650 (Westbred) = 2421

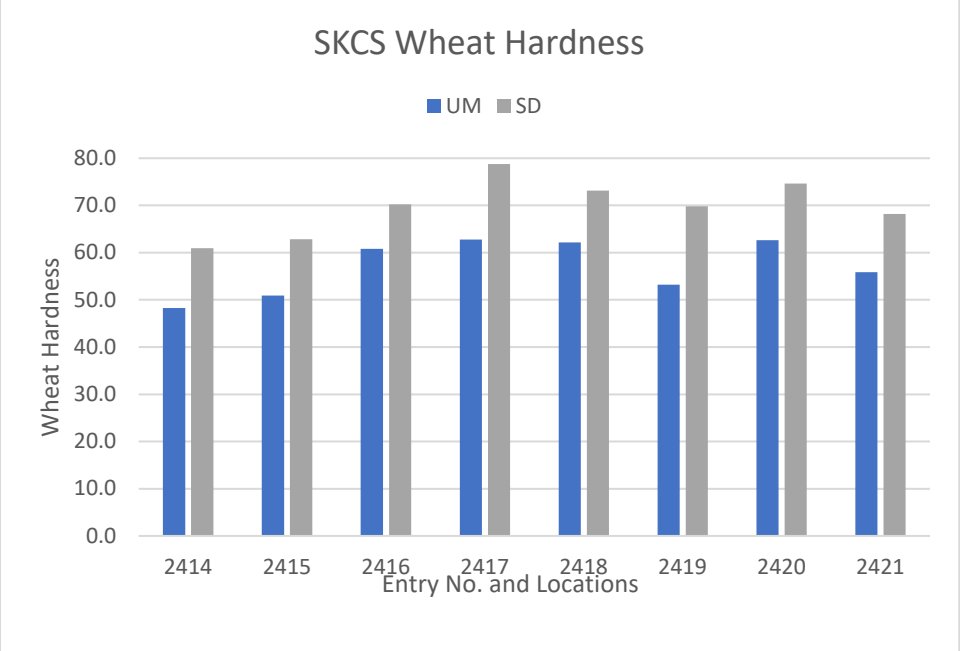
2. SKCS SINGLE KERNEL INFORMATION

D. Kernel Hardness

SKCS Wheat Kernel Hardness

	LOCATIONS*			
Entry No.	UM	SD	Avg	StDev
2414	48.3	61.0	54.6	8.98
2415	50.9	62.8	56.9	8.40
2416	60.8	70.2	65.5	6.62
2417	62.8	78.8	70.8	11.29
2418	62.2	73.2	67.7	7.76
2419	53.2	69.8	61.5	11.76
2420	62.6	74.6	68.6	8.48
2421	55.9	68.2	62.0	8.69
Avg.	57.1	69.8		
StDev	5.80	5.91		

*SD=South Dakota State University; UM=USDA Manhattan;

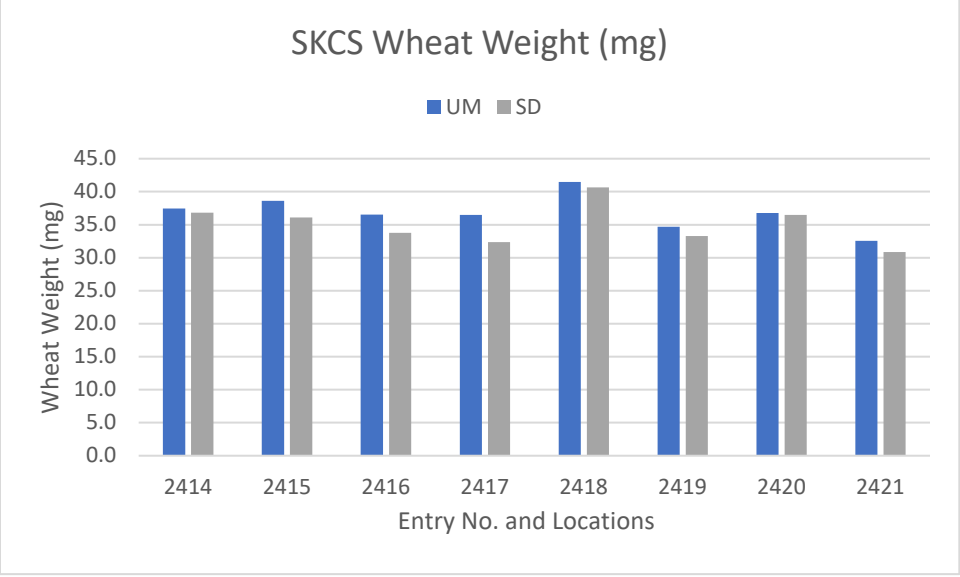


E. Kernel Weight (mg)

SKCS Wheat Kernel Weight (mg)

	LOCATIONS*			
Entry No.	UM	SD	Avg	StDev
2414	37.4	36.8	37.1	0.45
2415	38.6	36.1	37.4	1.79
2416	36.5	33.8	35.2	1.96
2417	36.5	32.4	34.4	2.90
2418	41.5	40.6	41.1	0.60
2419	34.7	33.3	34.0	0.97
2420	36.8	36.5	36.6	0.19
2421	32.5	30.9	31.7	1.19
Avg.	36.8	35.0		
StDev	2.63	3.09		

*SD=South Dakota State University; UM=USDA Manhattan;

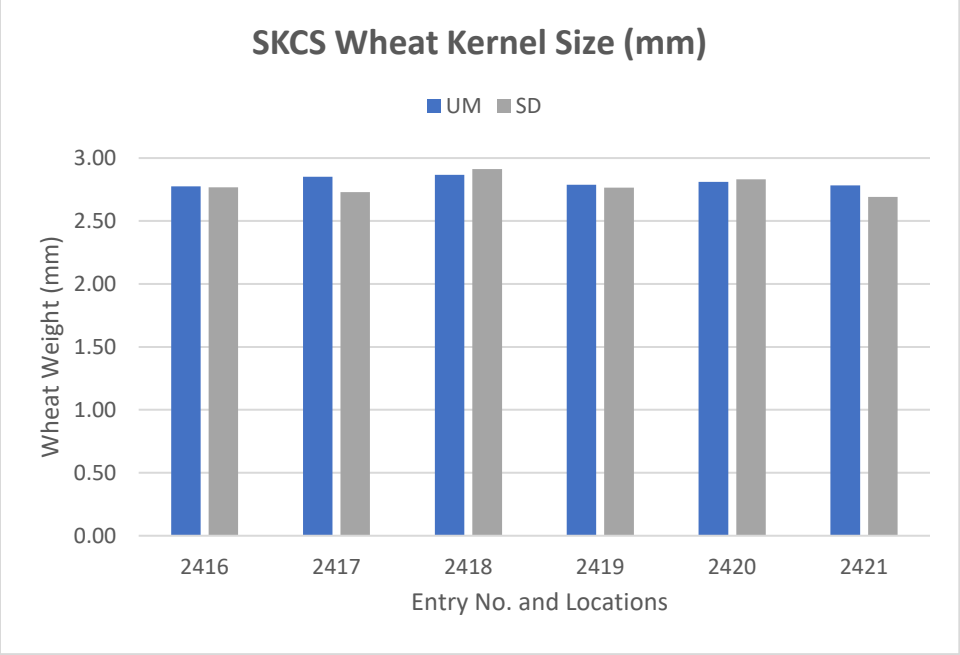


F. Kernel Size

SKCS Wheat Kernel Size (mm)

Entry No.	LOCATIONS* UM	SD	Avg	StDev
2414	2.88	2.90	2.89	0.01
2415	2.85	2.84	2.84	0.00
2416	2.78	2.77	2.77	0.01
2417	2.85	2.73	2.79	0.09
2418	2.87	2.91	2.89	0.03
2419	2.79	2.77	2.78	0.02
2420	2.81	2.83	2.82	0.01
2421	2.78	2.69	2.74	0.07
Avg.	2.81	2.78		
StDev	0.04	0.08		

*SD=South Dakota State University; UM=USDA Manhattan;



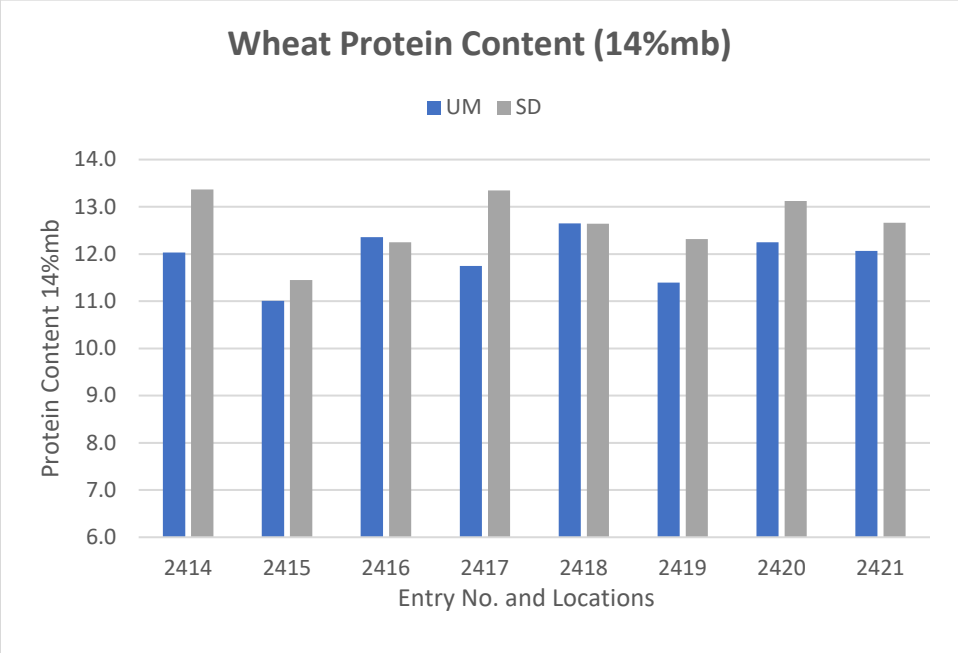
3. PROTEN CONTENT

C. Wheat Protein

Wheat Protein Content (14%mb)

Entry No.	LOCATIONS* UM	SD	Avg	StDev
2414	12.0	13.4	12.7	0.94
2415	11.0	11.4	11.2	0.31
2416	12.4	12.2	12.3	0.08
2417	11.8	13.3	12.5	1.13
2418	12.7	12.6	12.6	0.01
2419	11.4	12.3	11.9	0.65
2420	12.2	13.1	12.7	0.62
2421	12.1	12.7	12.4	0.42
Avg.	11.9	12.6		
StDev	0.5	0.6		

*SD=South Dakota State University; UM=USDA Manhattan;

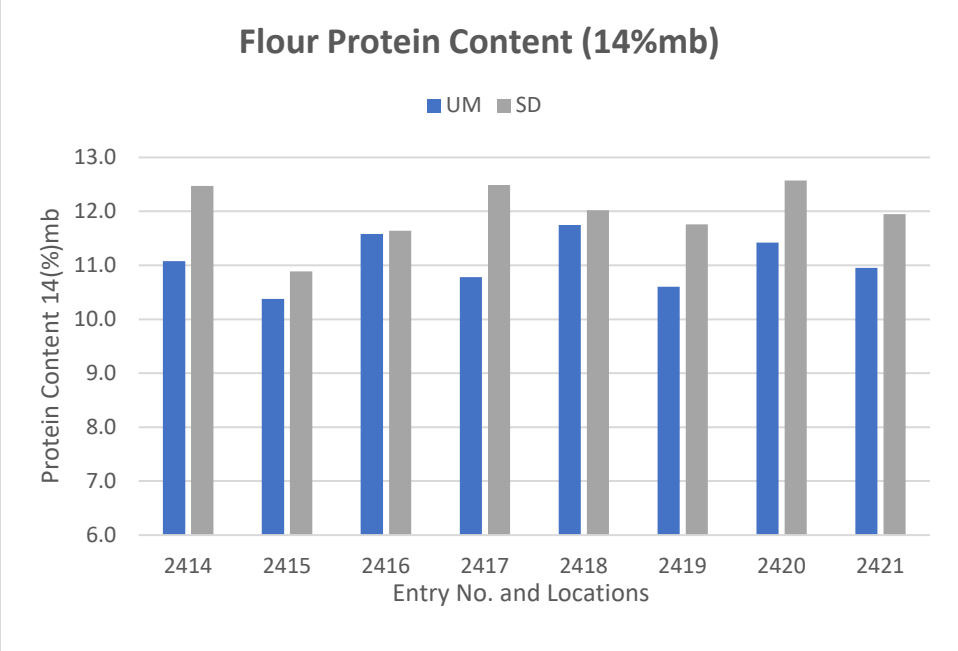


D. Flour Protein

Flour Protein Content (14%)

Entry No.	LOCATIONS* UM	SD	Avg	StDev
2414	11.1	12.5	11.8	0.98
2415	10.4	10.9	10.6	0.36
2416	11.6	11.6	11.6	0.04
2417	10.8	12.5	11.6	1.21
2418	11.8	12.0	11.9	0.19
2419	10.6	11.8	11.2	0.82
2420	11.4	12.6	12.0	0.81
2421	11.0	12.0	11.5	0.71
Avg.	11.1	12.0		
StDev	0.48	0.56		

*SD=South Dakota State University; UM=USDA Manhattan;

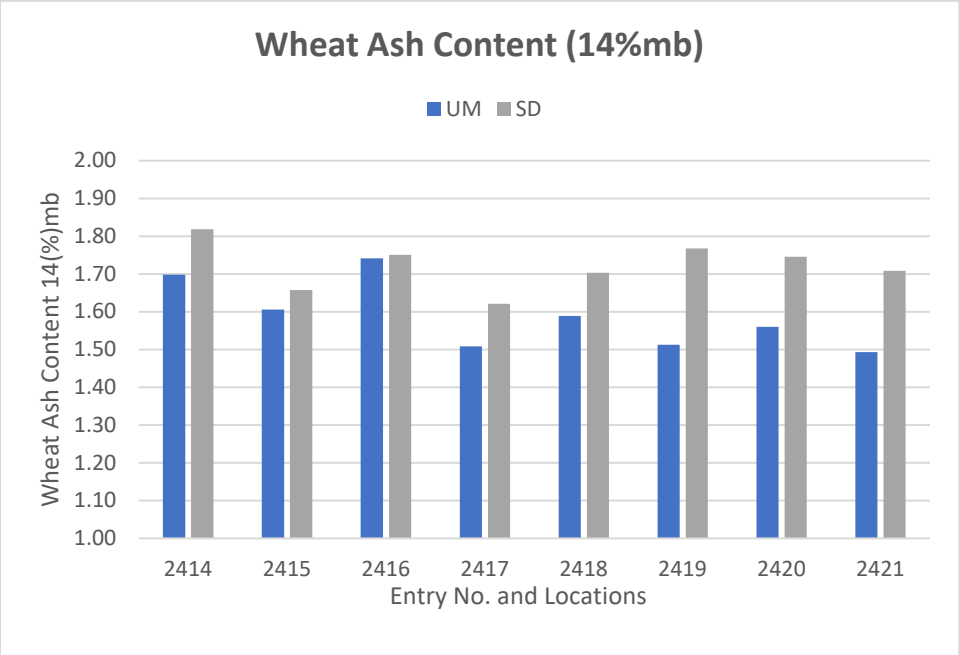


4. WHEAT ASH

Wheat Ash Content (14%)

	LOCATIONS*			
Entry No.	UM	SD	Avg	StDev
2414	1.70	1.82	1.76	0.08
2415	1.61	1.66	1.63	0.04
2416	1.74	1.75	1.75	0.01
2417	1.51	1.62	1.56	0.08
2418	1.59	1.70	1.65	0.08
2419	1.51	1.77	1.64	0.18
2420	1.56	1.75	1.65	0.13
2421	1.49	1.71	1.60	0.15
Avg.	1.59	1.72		
StDev	0.09	0.06		

*SD=South Dakota State University; UM=USDA Manhattan;



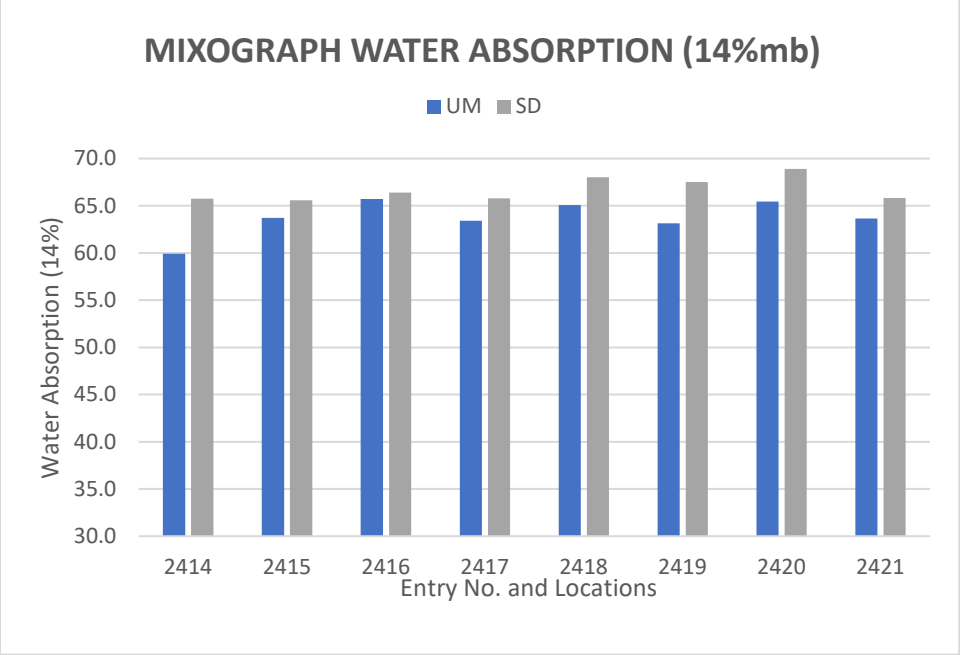
5. MIXOGRAPH TEST RESULTS

D. Mixograph Water Absorption

Mixograph Water Absorption (14%mb)

	LOCATIONS*			
Entry No.	UM	SD	Avg	StDev
2414	59.9	65.7	62.8	4.12
2415	63.7	65.6	64.7	1.31
2416	65.7	66.4	66.0	0.48
2417	63.4	65.8	64.6	1.68
2418	65.1	68.0	66.5	2.09
2419	63.1	67.5	65.3	3.09
2420	65.4	68.9	67.2	2.43
2421	63.6	65.8	64.7	1.53
Avg.	63.8	66.7		
StDev	1.84	1.26		

*SD=South Dakota State University; UM=USDA Manhattan;

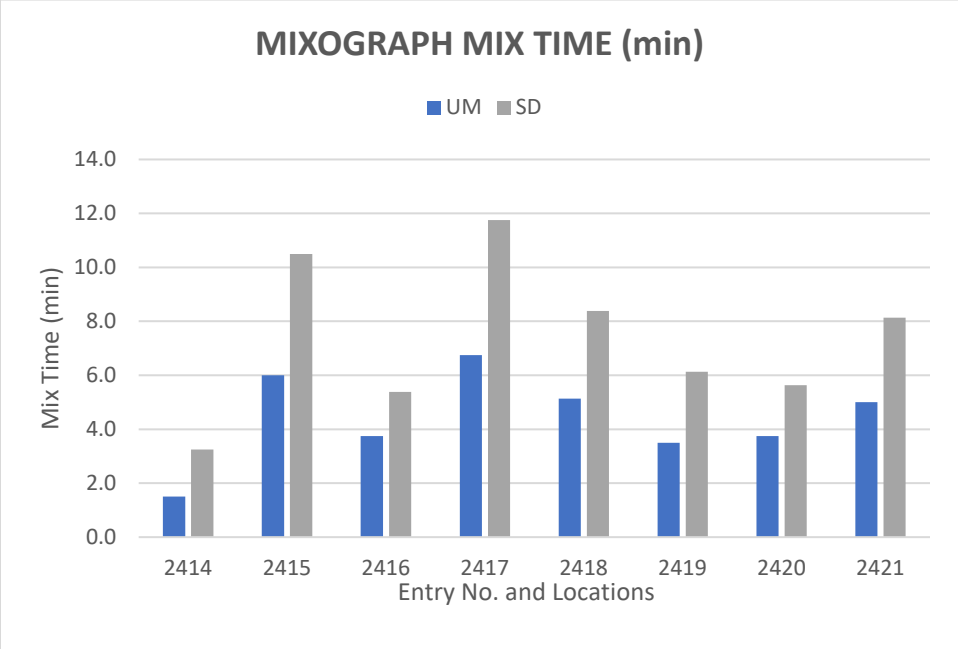


E. Mixograph Mix Time

Mixograph Mix Time (min)

	LOCATIONS*			
Entry No.	**UM**	**SD**	**Avg**	**StDev**
2414	1.5	3.3	2.4	1.24
2415	6.0	10.5	8.3	3.18
2416	3.8	5.4	4.6	1.15
2417	6.8	11.8	9.3	3.54
2418	5.1	8.4	6.8	2.30
2419	3.5	6.1	4.8	1.86
2420	3.8	5.6	4.7	1.33
2421	5.0	8.1	6.6	2.21
Avg.	4.4	7.4		
StDev	1.65	2.83		

*SD=South Dakota State University; UM=USDA Manhattan;

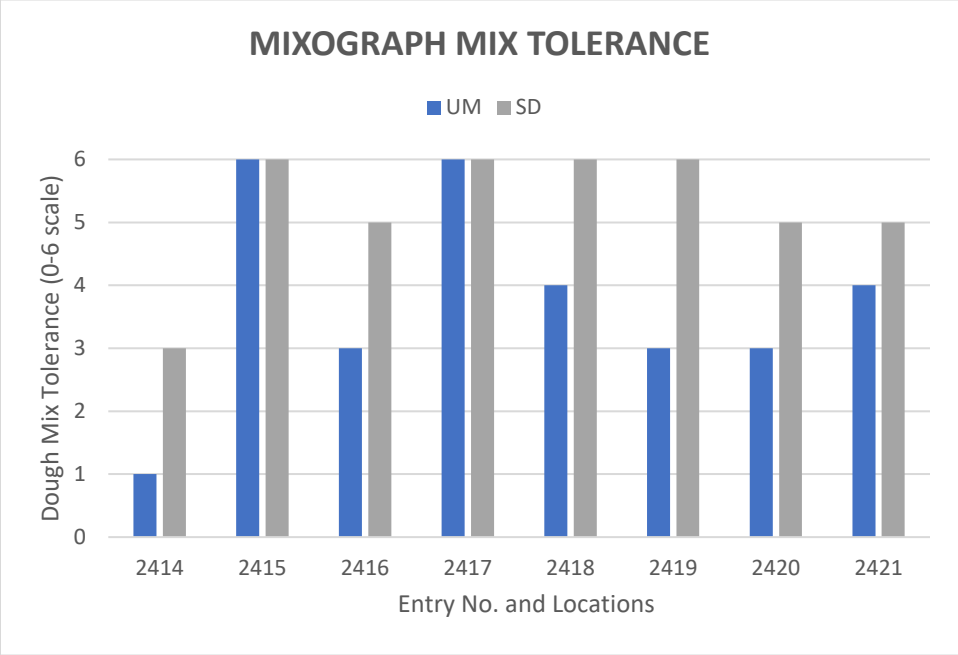


F. Mixograph Mix Tolerance

Mixograph Mix Tolerance

Entry No.	LOCATIONS* UM	SD	Avg	StDev
2414	1	3	2.0	1.41
2415	6	6	6.0	0.00
2416	3	5	4.0	1.41
2417	6	6	6.0	0.00
2418	4	6	5.0	1.41
2419	3	6	4.5	2.12
2420	3	5	4.0	1.41
2421	4	5	4.5	0.71
Avg.	3.8	5.3		
StDev	1.67	1.04		

*SD=South Dakota State University; UM=USDA Manhattan;

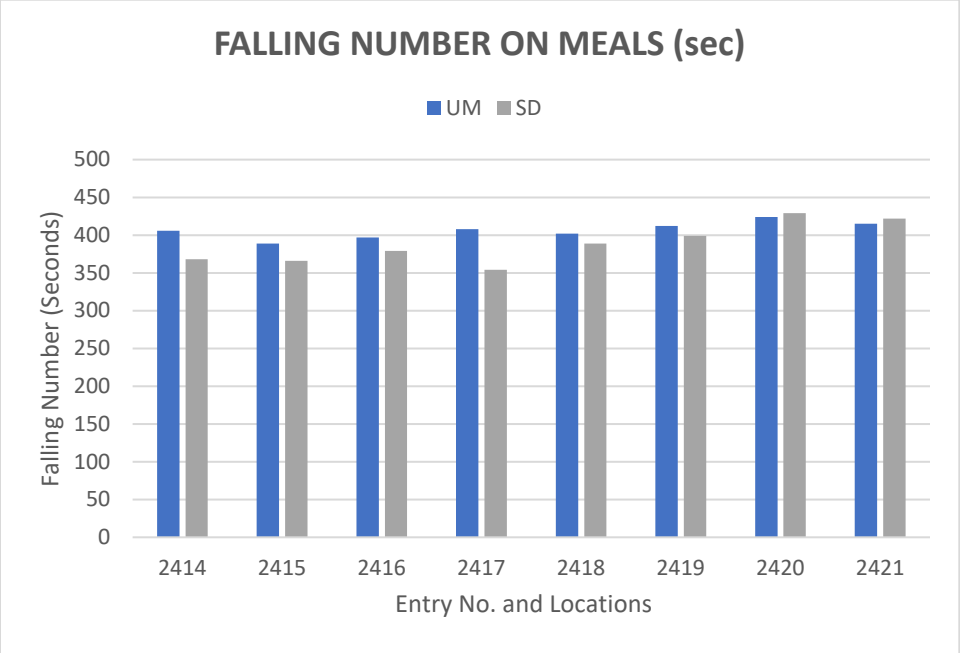


6. FALLING NUMBER TEST

Falling Number on Meals (sec)

	LOCATIONS*			
Entry No.	**UM**	**SD**	**Avg**	**StDev**
2414	406	368	387	27
2415	389	366	378	16
2416	397	379	388	13
2417	408	354	381	38
2418	402	389	396	9
2419	412	399	406	9
2420	424	429	427	4
2421	415	422	419	5
Avg.	407	388		
StDev	11	27		

*SD=South Dakota State University; UM=USDA Manhattan;

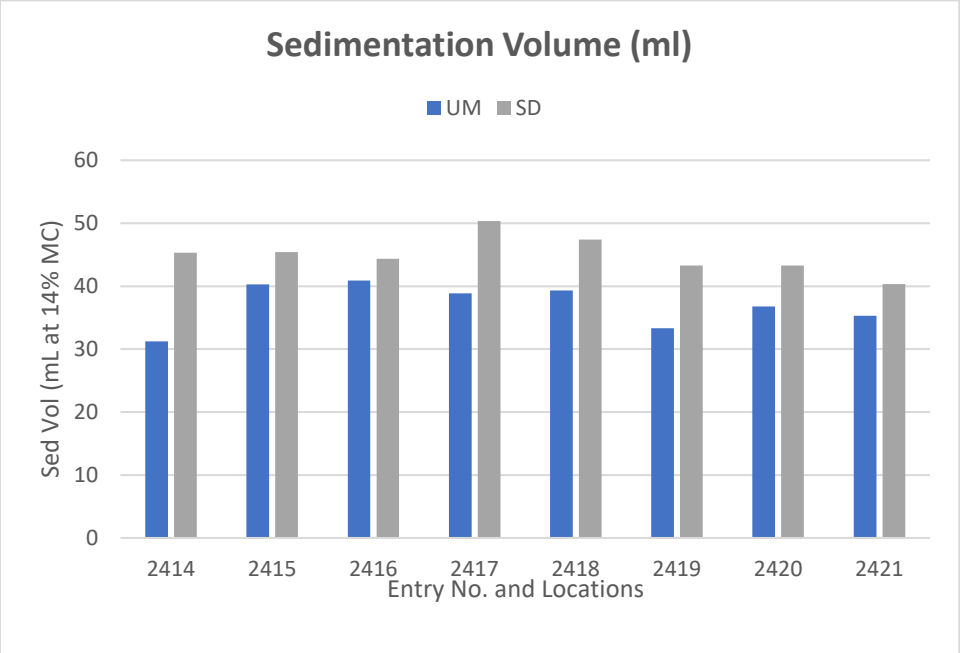


7. SEDIMENTATION TEST

Sedimentation Volume (ml)

	LOCATIONS*			
Entry No.	UM	SD	Avg	StDev
2414	31.2	45.3	38.3	9.98
2415	40.3	45.4	42.8	3.61
2416	40.9	44.3	42.6	2.46
2417	38.8	50.3	44.6	8.13
2418	39.3	47.4	43.3	5.72
2419	33.3	43.3	38.3	7.07
2420	36.8	43.3	40.0	4.61
2421	35.3	40.3	37.8	3.56
Avg.	37.0	45.0		
StDev	3.47	2.99		

*SD=South Dakota State University; UM=USDA Manhattan;



MONTANA

25-2422	Yellowstone_CK
25-2423	SY Monument_CK
25-2424	MTS2270_MT
25-2425	MTS2286_MT
25-2426	MTAX22120_MT

Description of Test Plots and Breeder Entries

Montana – Suchismita (Sue) Mondal

MT2270

It has exceptional yield stability and winter hardiness across tested locations in Montana. It has good stripe rust and stem rust resistance. It is a hollow stemmed line and is susceptible to Wheat stem sawfly.

MTS2286

This is a sister lines of MT2270, however it is solid stemmed, It has higher yields than the solid stem variety Bobcat. The sawfly cutting scores are also low. While it has very good resistance to stem rust, it is moderately susceptible to stripe rust.

MTAX22120

This is a Co-Axium line. Has been performing well across testing locations in Montana. It has cmc4 and Wsm2, shows good resistance to WSMV. It is a hollow stem line and susceptible to Wheat stem sawfly. It has good stripe rust resistance and moderate stem rust resistance.

Montana: 2025 (Small-Scale) Samples

Test entry number	25-2422	25-2423	25-2424
Sample identification	**Yellowstone_CK**	**SY Monument_CK**	**MT2270_MT**
Wheat Data			
GIPSA classification	1 HRW	1 HRW	1 HRW
Test weight (lb/bu)	62.2	62.1	62.0
Hectoliter weight (kg/hl)	81.8	81.8	81.5
1000 kernel weight (gm)	35.7	33.3	38.5
Wheat kernel size (Rotap)			
Over 7 wire (%)	83.9	78.9	87.5
Over 9 wire (%)	16.0	20.7	12.2
Through 9 wire (%)	0.1	0.4	0.3
Single kernel (skcs)[a]			
Hardness (avg /s.d)	60.1/14.8	58.9/14.8	51.9/13.6
Weight (mg) (avg/s.d)	35.7/9.1	33.3/9.7	38.5/9.0
Diameter (mm)(avg/s.d)	2.74/0.42	2.66/0.41	2.83/0.36
Moisture (%) (avg/s.d)	10.7/0.6	10.5/0.6	10.4/0.6
SKCS distribution	03-15-31-51-01	05-14-31-50-01	06-28-41-25-01
Classification	Hard	Hard	Hard
Wheat protein (12% mb)	12.0	12.4	12.8
Wheat ash (12% mb)	1.41	1.34	1.20
Milling and Flour Quality Data			
Flour yield (%, str. grade)			
Miag Multomat Mill	76.2	76.5	76.4
Quadrumat Sr. Mill	69.3	69.7	69.9
Flour moisture (%)	12.0	12.0	12.7
Flour protein (14% mb)	11.1	11.1	11.1
Flour ash (14% mb)	0.45	0.45	0.42
Rapid Visco-Analyser			
Peak Time (min)	6.2	6.0	6.0
Peak Viscosity (RVU)	191.7	165.4	179.5
Breakdown (RVU)	63.9	54.8	64.7
Final Viscosity at 13 min (RVU)	232.3	210.6	218.0
Minolta color meter			
L*	91.57	90.91	91.83
a*	-1.10	-0.97	-1.36
b*	8.59	8.75	9.18
PPO	0.234	0.401	0.397
Falling number (sec)	349	341	373
Damaged Starch			
(AI%)	97.5	97.5	97.5
(AACC76-31)	9.7	9.7	9.7

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Montana: 2025 (Small-Scale) Samples

Test entry number	25-2425	25-2426
Sample identification	**MTS2286_MT**	**MTAX22120_MT**
Wheat Data		
GIPSA classification	1 HRW	1 HRW
Test weight (lb/bu)	60.5	61.5
Hectoliter weight (kg/hl)	79.5	70.9
1000 kernel weight (gm)	32.3	31.4
Wheat kernel size (Rotap)		
Over 7 wire (%)	74.5	72.0
Over 9 wire (%)	25.1	27.7
Through 9 wire (%)	0.4	0.3
Single kernel (skcs)[a]		
Hardness (avg /s.d)	52.0/16.9	58.9/14.2
Weight (mg) (avg/s.d)	32.3/11.0	31.4/9.3
Diameter (mm)(avg/s.d)	2.57/0.43	2.65/0.4
Moisture (%) (avg/s.d)	10.3/0.8	10.5/0.7
SKCS distribution	11-28-30-31-03	04-17-32-47-01
Classification	Mixed	Hard
Wheat protein (12% mb)	13.6	13.5
Wheat ash (12% mb)	1.29	1.29
Milling and Flour Quality Data		
Flour yield (%, str. grade)		
Miag Multomat Mill	76.7	77.6
Quadrumat Sr. Mill	69.2	70.0
Flour moisture (%)	11.7	12.0
Flour protein (14% mb)	11.8	12.0
Flour ash (14% mb)	0.41	0.39
Rapid Visco-Analyser		
Peak Time (min)	6.1	6.1
Peak Viscosity (RVU)	208.7	182.5
Breakdown (RVU)	72.7	56.4
Final Viscosity at 13 min (RVU)	247.4	235.3
Minolta color meter		
L*	91.48	90.85
a*	-1.32	-1.16
b*	9.08	8.96
PPO	0.489	0.365
Falling number (sec)	359	386
Damaged Starch		
(AI%)	97.3	97.2
(AACC76-31)	9.5	9.3

[a]s.d. = standard deviation; skcs = Single Kernel Characterization System 4100.

Montana: Physical Dough Tests and Gluten Analysis
2025 (Small-Scale) Samples

Test Entry Number	25-2422	25-2423	25-2424
Sample Identification	Yellowstone_CK	SY Monument_CK	MT2270_MT
MIXOGRAPH			
Flour Abs (% as-is)	69.1	69.4	68.6
Flour Abs (14% mb)	66.8	67.2	67.4
Mix Time (min)	8.25	7.38	4.63
Mix tolerance (0-6)	5	5	4
FARINOGRAPH			
Flour Abs (% as-is)	69.6	67.3	69.3
Flour Abs (14% mb)	67.3	65.1	68.1
Peak time (min)	3.6	4.9	6.8
Mix stability (min)	6.5	9.9	15.9
Mix Tolerance Index (FU)	40	26	14
Breakdown time (min)	7.6	10.5	17.9
ALVEOGRAPH			
P(mm): Tenacity	152	158	174
L(mm): Extensibility	35	47	50
G(mm): Swelling index	13.1	15.2	13.7
W(10^{-4} J): strength (curve area)	322	356	421
P/L: curve configuration ratio	4.34	3.36	3.48
Ie(P_{200}/P): elasticity index	0	61.2	55.6
EXTENSIGRAPH			
Resist (BU at 45/90/135 min)	541/725/600	503/654/663	426/592/588
Extensibility (mm at 45/90/135 min)	135.5/131.5/135	145.6/139.7/123.1	152.4/130.6/144.7
Energy (cm^2 at 45/90/135 min)	128.8/149/127.2	135.3/164.1/130	121.6/137.2/154
Resist $_{max}$ (BU at 45/90/135 min)	777/991/794	760/997/938	635/850/887
Ratio (at 45/90/135 min)	3.99/5.51/4.45	3.45/4.68/5.39	2.8/4.53/4.06
PROTEIN ANALYSIS			
HMW-GS Composition	1, 7+9, 5+10	2*, 7+9, 5+10	2*, 7+9, 5+10
TPP/TMP	0.78	0.81	0.86
SEDIMENTATION TEST			
Volume (ml)	69.4	68.5	70.1

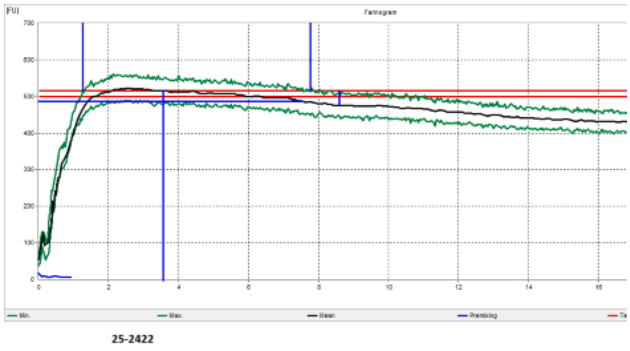
Montana: Physical Dough Tests and Gluten Analysis
2025 (Small-Scale) Samples

Test Entry Number	**25-2425**	**25-2426**
Sample Identification	**MTS2286_MT**	**MTAX22120_MT**
MIXOGRAPH		
Flour Abs (% as-is)	69.2	69.3
Flour Abs (14% mb)	67.0	67.4
Mix Time (min)	6.25	4.75
Mix tolerance (0-6)	6	5
FARINOGRAPH		
Flour Abs (% as-is)	67.4	67.3
Flour Abs (14% mb)	65.1	65.4
Peak time (min)	5.7	5.2
Mix stability (min)	18	8
Mix Tolerance Index (FU)	9	29
Breakdown time (min)	17.9	9.9
ALVEOGRAPH		
P(mm): Tenacity	154	149
L(mm): Extensibility	65	50
G(mm): Swelling index	17.9	15.7
W(10^{-4} J): strength (curve area)	319	267
P/L: curve configuration ratio	2.37	2.96
Ie(P_{200}/P): elasticity index	66.7	62.4
EXTENSIGRAPH		
Resist (BU at 45/90/135 min)	535/754/946	393/478/506
Extensibility (mm at 45/90/135 min)	140.7/139.2/122.8	154/151.5/157.8
Energy (cm^2 at 45/90/135 min)	135.7/200.5/176.8	117.5/142.5/155.3
Resist $_{max}$ (BU at 45/90/135 min)	790/1229/1225	611/759/781
Ratio (at 45/90/135 min)	3.8/5.42/7.71	2.55/3.15/3.21
PROTEIN ANALYSIS		
HMW-GS Composition	1, 7+8, 5+10	2*, 7+8, 5+10
TPP/TMP	0.74	0.77
SEDIMENTATION TEST		
Volume (ml)	69.4	71.6

Physical Dough Tests

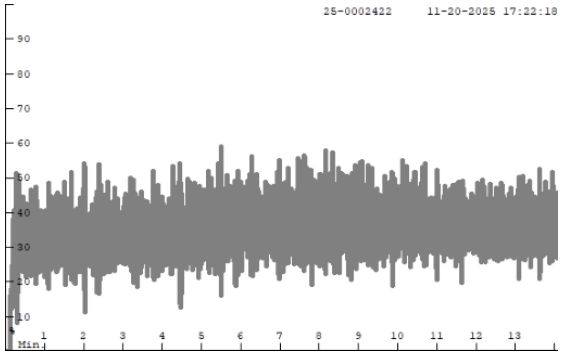
2025 (Small Scale) Samples – Montana

Farinograms



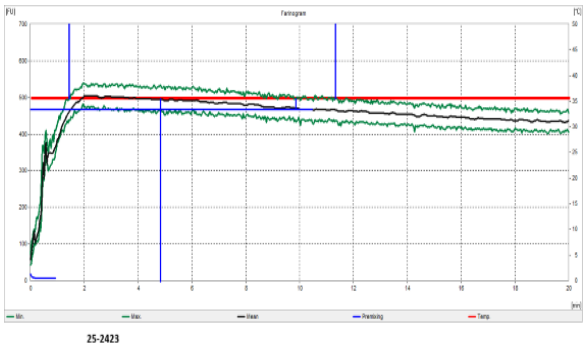
Water abs = 67.3%, Peak time = 3.6 min
Mix stab = 6.5 min, MTI = 40 FU

Mixograms

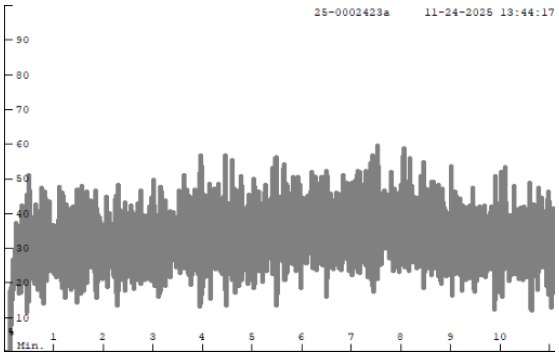


Water abs = 66.8%
Mix time = 8.3 min

25-2422, Yellowstone_CK



Water abs = 65.1%, Peak time = 4.9 min,
Mix stab = 9.9 min, MTI = 26 FU



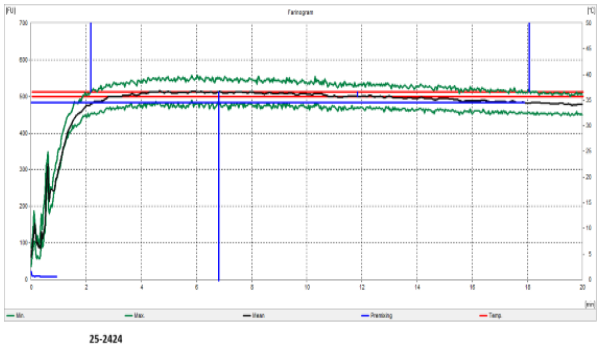
Water abs = 67.2%
Mix time = 7.4 min

25-2423, SY Monument_CK

Physical Dough Tests

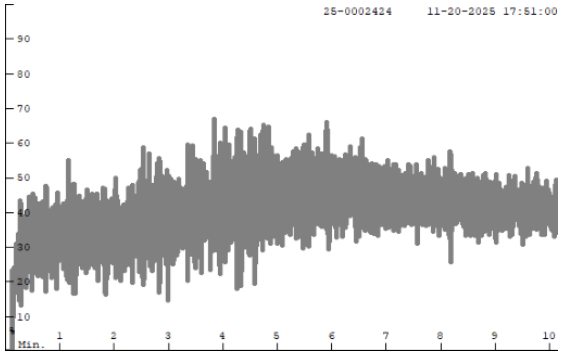
2025 (Small Scale) Samples – Montana (continued)

Farinograms



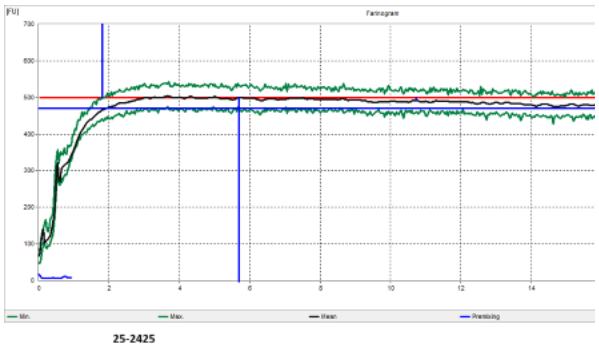
Water abs. = 68.1%, Peak time = 6.8 min,
Mix stab = 15.9 min, MTI = 14 FU

Mixograms

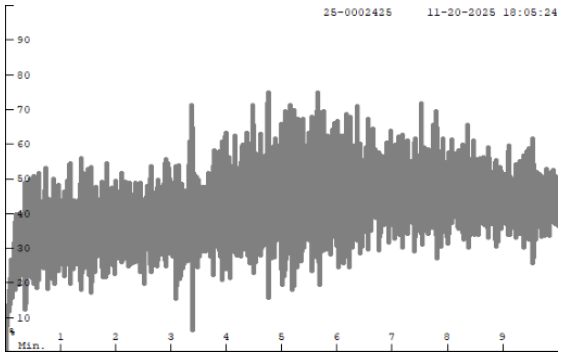


Water abs = 67.4%
Mix time = 4.6 min

25-2424, MT2270_MT



Water abs. = 65.1%, Peak time = 5.7 min,
Mix stab = 18 min, MTI = 9 FU



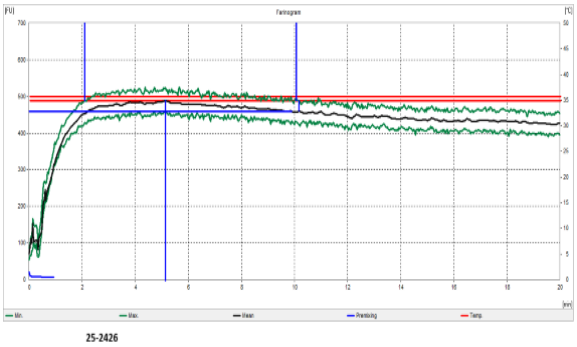
Water abs = 67.0%
Mix time = 6.3 min

25-2425, MTS2286_MT

Physical Dough Tests

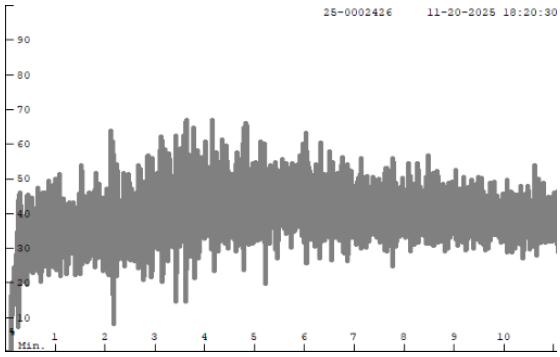
2025 (Small Scale) Samples – Montana (continued)

Farinograms



Water abs. = 65.4%, Peak time = 5.2 min,
Mix stab = 8.0 min, MTI = 29 FU

Mixograms

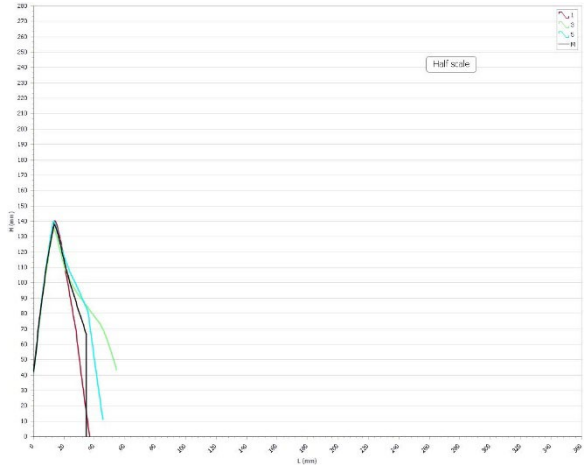


Water abs = 67.4%
Mix time = 4.8 min

25-2426, MTAX22120_MT

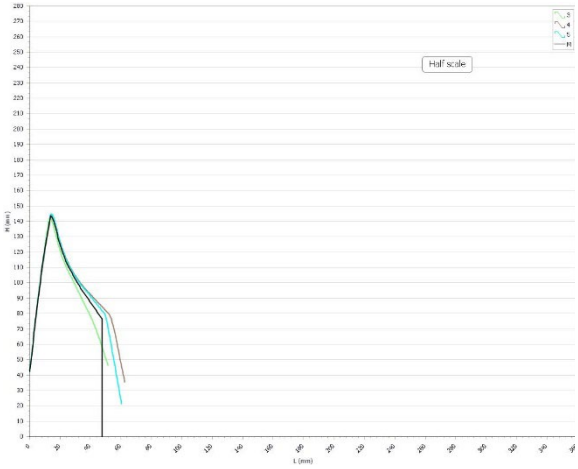
Physical Dough Tests - Alveograph

2025 (Small Scale) Samples – Montana



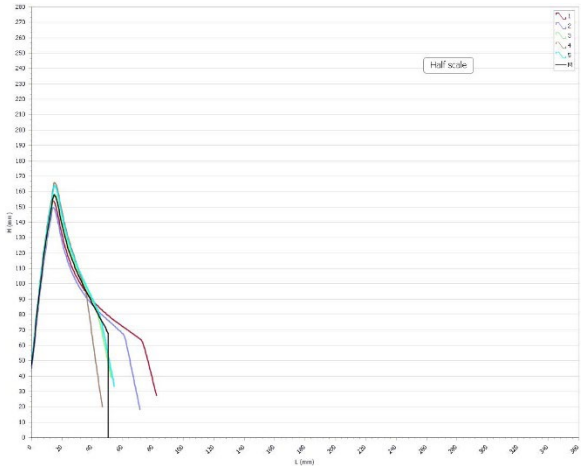
25-2422, Yellowstone_CK

P (mm H_20) = 152, L (mm) = 35, W ($10E^{-4}J$) = 322



25-2423, SY Monument_CK

P (mm H_20) = 158, L (mm) = 47, W ($10E^{-4}J$) = 356

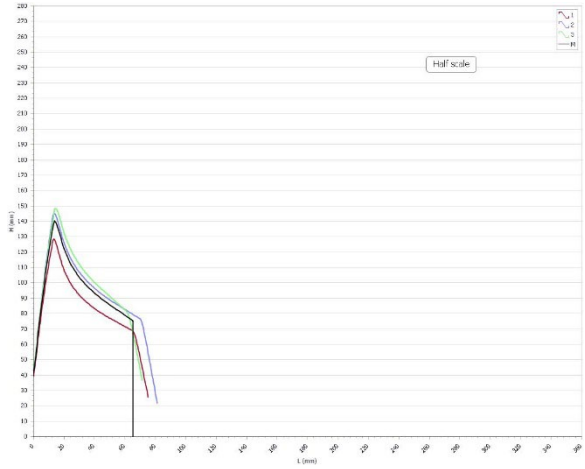


25-2424, MT2270_MT

P (mm H_20) = 174, L (mm) = 50, W ($10E^{-4}J$) = 421

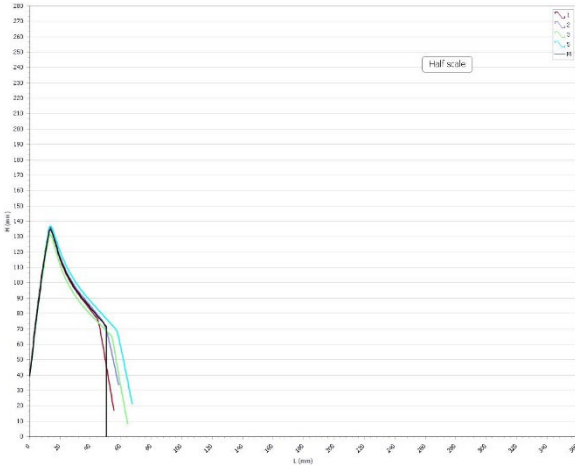
Physical Dough Tests - Alveograph

2025 (Small Scale) Samples – Montana



25-2425, MTS2286_MT

P (mm H_20) = 154, L (mm) = 65, W ($10E^{-4}J$) = 319

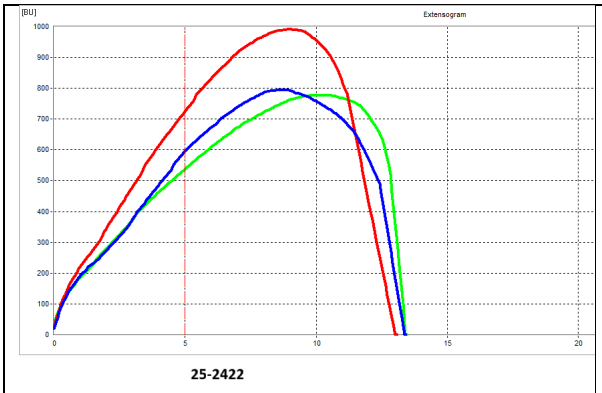


25-2426, MTAX22120_MT

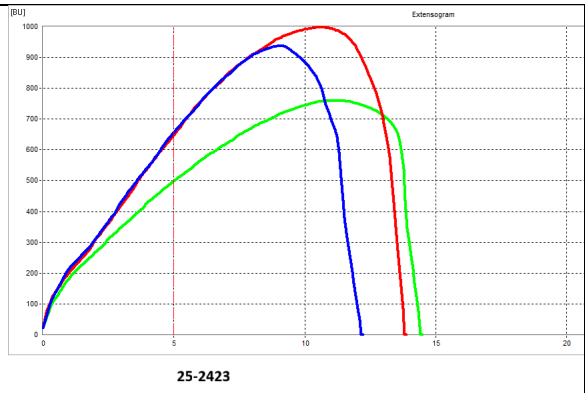
P (mm H_20) = 149, L (mm) = 50, W ($10E^{-4}J$) = 267

Physical Dough Tests - Extensigraph

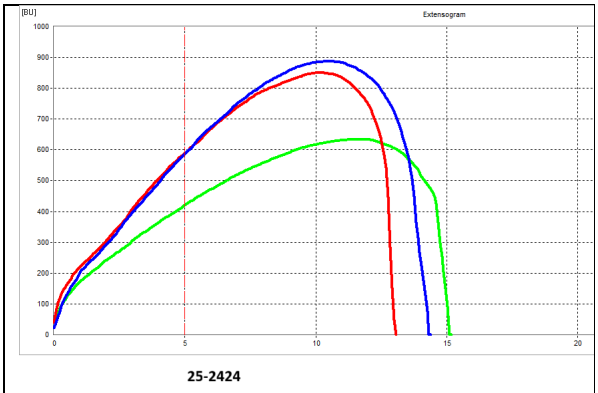
2025 (Small Scale) Samples – Montana



25-2422, Yellowstone_CK
R (BU) = 725, E (mm) = 132, W (cm^2) = 149
Rmax (BU) = 991, Ratio = 5.5 at 90 min



25-2423, SY Monument_CK
R (BU) = 654, E (mm) = 140, W (cm^2) = 164
Rmax (BU) = 997, Ratio = 4.7 at 90 min

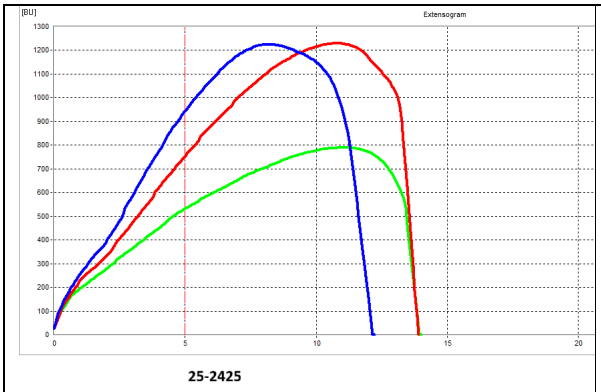


25-2424, MT2270_MT
R (BU) = 592, E (mm) = 131, W (cm^2) = 137
Rmax (BU) = 850, Ratio = 4.5 at 90 min

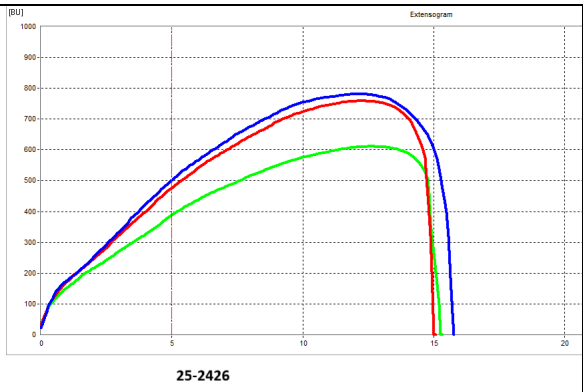
Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

Physical Dough Tests - Extensigraph

2025 (Small Scale) Samples – Montana



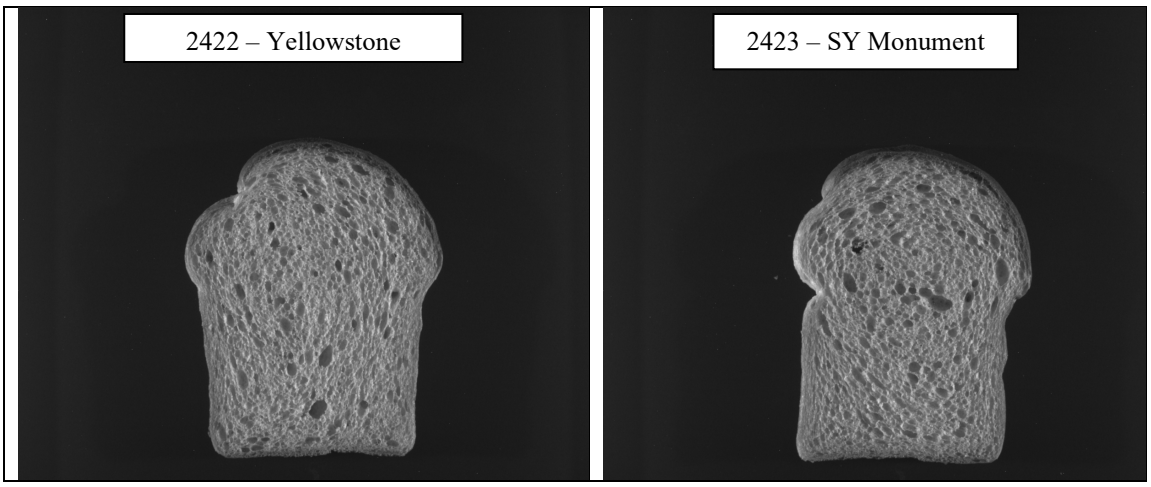
25-2425, MTS2286_MT
R (BU) = 754, E (mm) = 139, W (cm^2) = 201
Rmax (BU) = 1229, Ratio = 5.4 at 90 min



25-2426, MTAX22120_MT
R (BU) = 478, E (mm) = 151, W (cm^2) = 143
Rmax (BU) = 759, Ratio = 3.2 at 90 min

Notes: R (BU) = Resistance; E (mm) = Extensibility; W (cm^2) = Energy; Rmax (BU) = Maximum resistance. Green = 45 min, Red = 90 min, and Blue = 135 min.

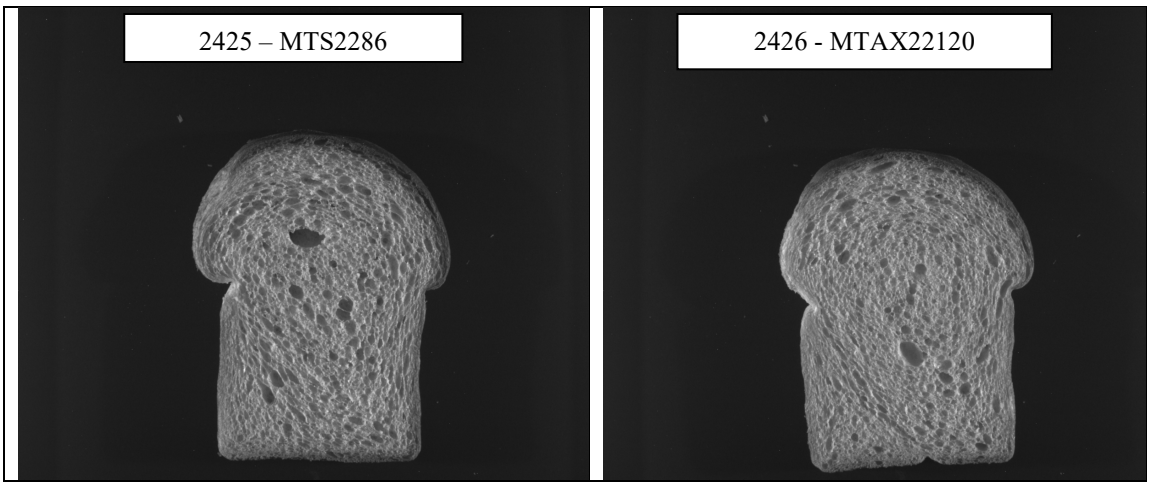
Montana: C-Cell Bread Images and Analysis
2025 (Small-Scale) Samples



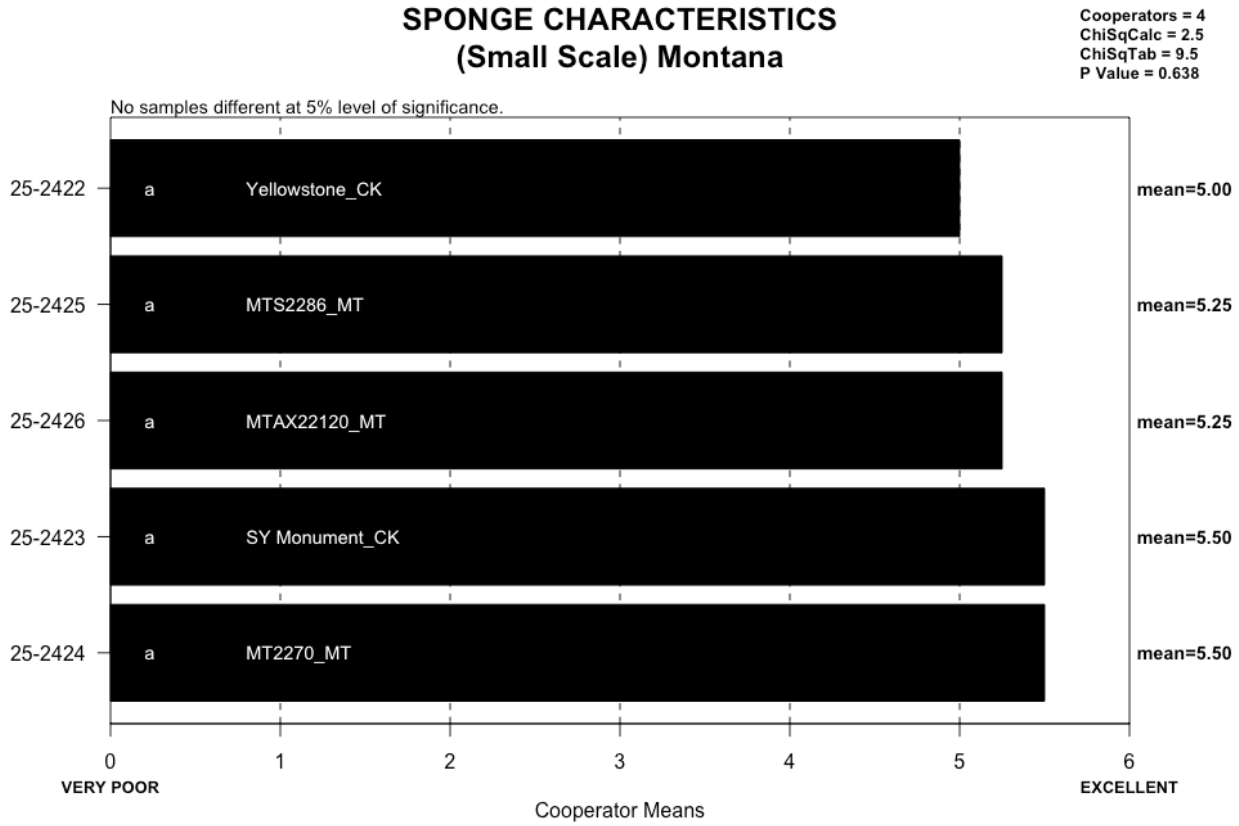
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2422	6143	117	3271	0.435	2.190	1.410	1.910	-1.00
2423	5938	113	3174	0.445	2.245	1.200	1.770	-8.05

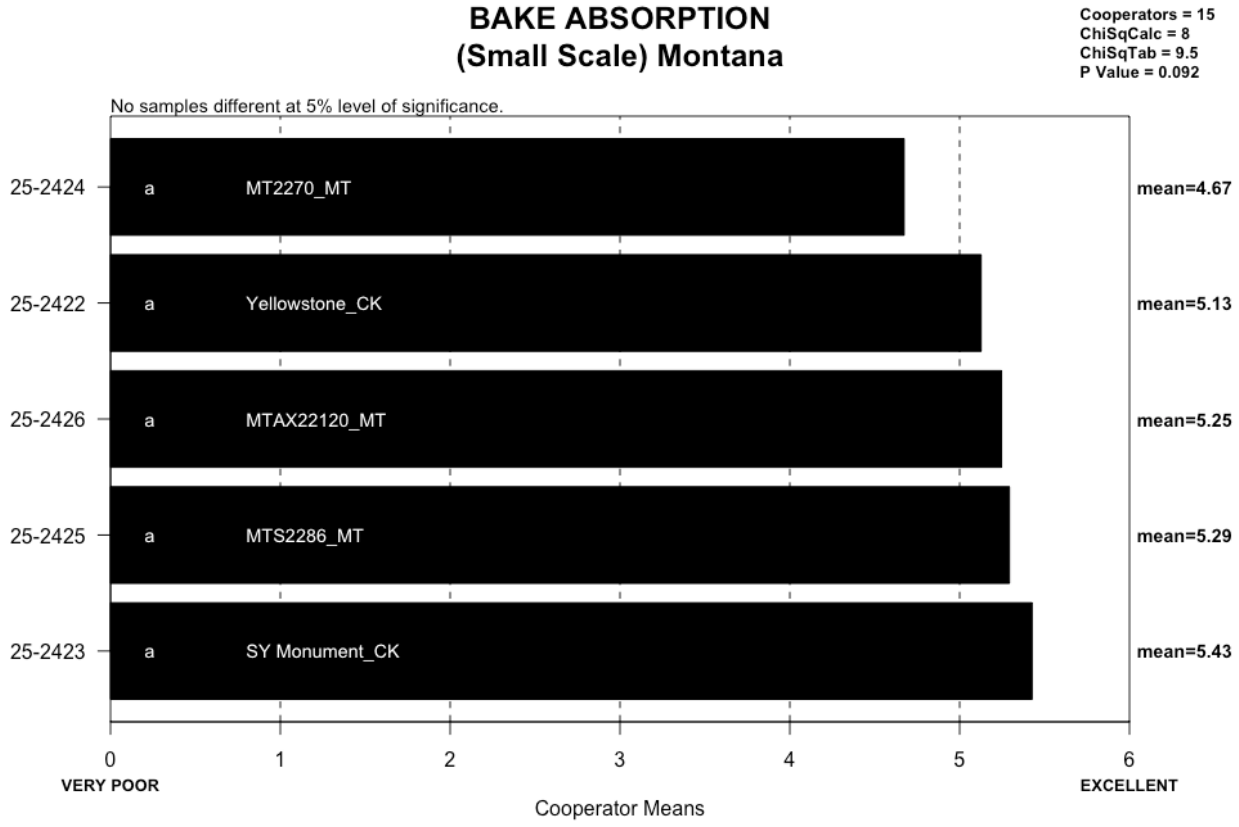
Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2424	6501	118	3479	0.440	2.260	1.420	1.750	-7.60

Montana: C-Cell Bread Images and Analysis
2025 (Small-Scale) Samples



Entry #	Slice Area (mm^2)	Slice Brightness	Number Cells	Wall Thick (mm)	Cell Diameter (mm)	Non-uniformity	Avg. Cell Elongation	Cell Angle to Vertical (^{0})
2425	6446	112	3336	0.440	2.355	0.730	1.800	-9.85
2426	6268	118	3588	0.425	2.090	1.120	1.810	-3.90


SPONGE CHARACTERISTICS
(Small Scale) Montana
Cooperators = 4
ChiSqCalc = 2.5
ChiSqTab = 9.5
P Value = 0.638
No samples different at 5% level of significance.
25-2422
a
Yellowstone_CK
mean=5.00
25-2425
a
MTS2286_MT
mean=5.25
25-2426
a
MTAX22120_MT
mean=5.25
25-2423
a
SY Monument_CK
mean=5.50
25-2424
a
MT2270_MT
mean=5.50
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

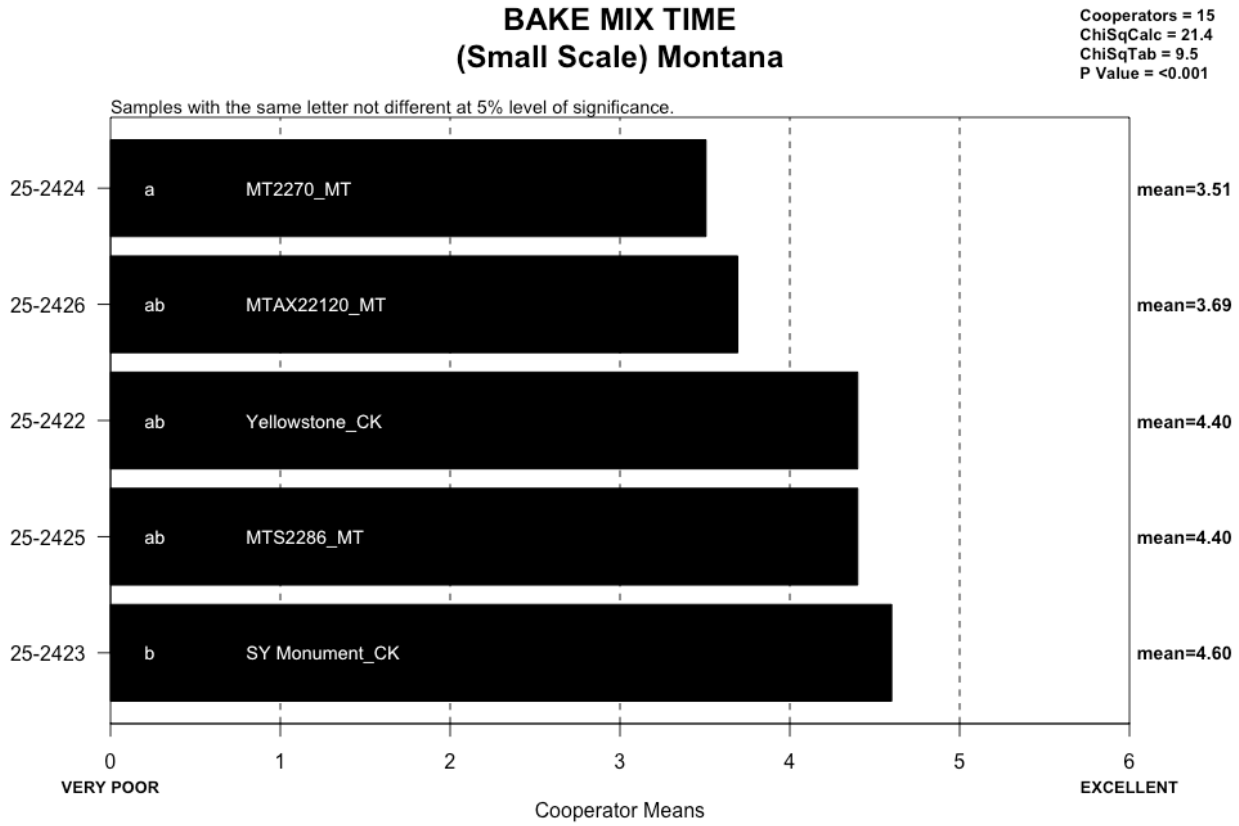

BAKE ABSORPTION
(Small Scale) Montana
Cooperators = 15
ChiSqCalc = 8
ChiSqTab = 9.5
P Value = 0.092
No samples different at 5% level of significance.
25-2424
a
MT2270_MT
mean=4.67
25-2422
a
Yellowstone_CK
mean=5.13
25-2426
a
MTAX22120_MT
mean=5.25
25-2425
a
MTS2286_MT
mean=5.29
25-2423
a
SY Monument_CK
mean=5.43
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

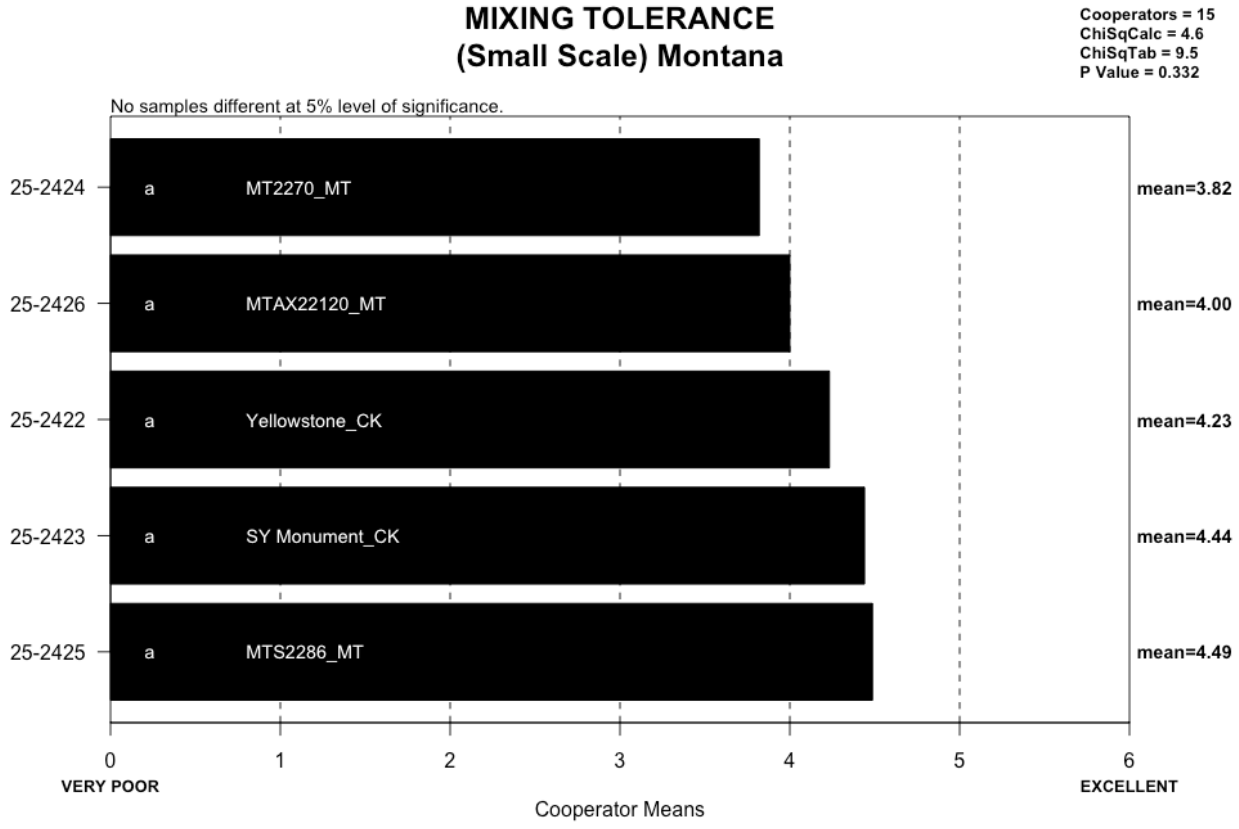
BAKE ABSORPTION, ACTUAL (14% MB)
(Small Scale) Montana
Cooperators A – O

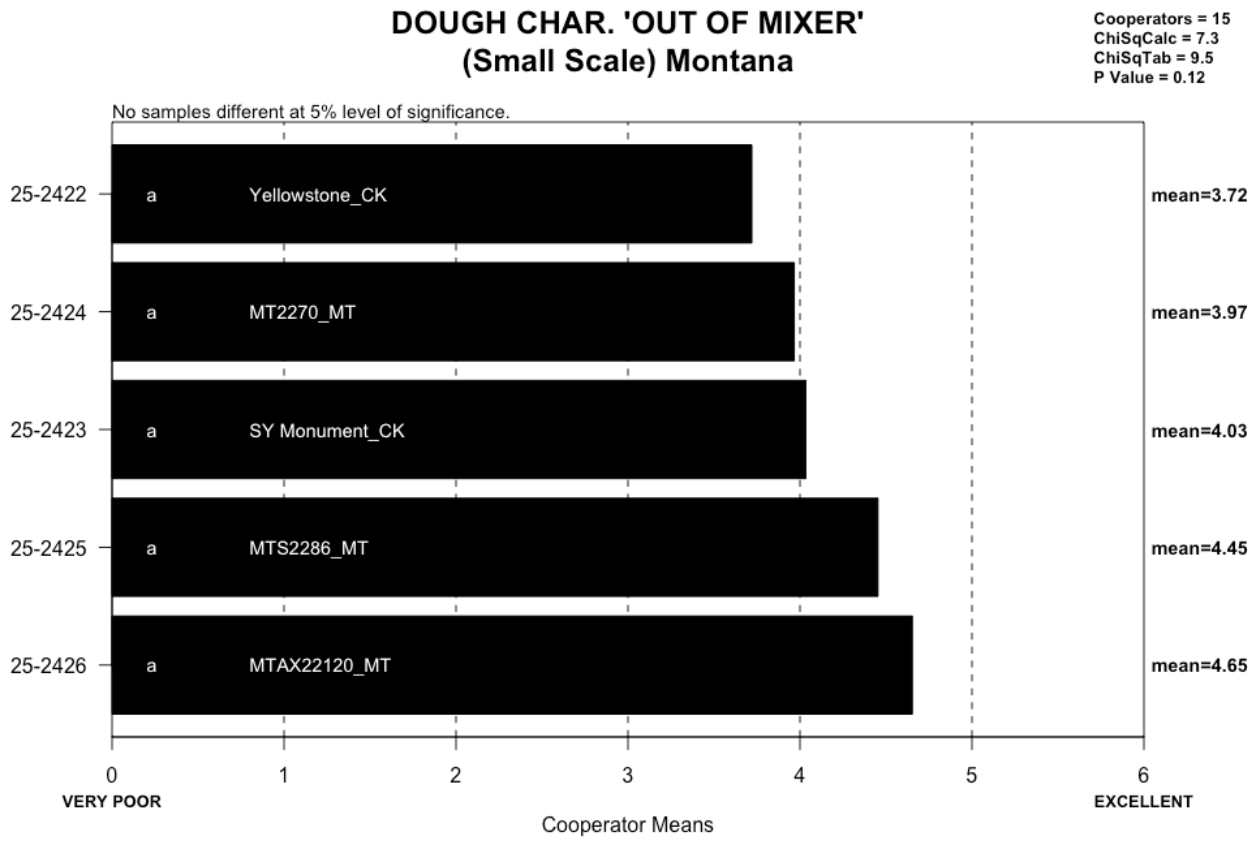
IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
25-2422	Yellowstone_CK	68.9	67	65.7	64.4	66.4	63	57	63.6	69.6	69.3	71.0	66.5	72.6	69.1	66.7
25-2423	SY Monument_CK	69.5	68	66.7	64.9	67.5	61	57	63.8	69.3	67.1	69.1	67.0	70.3	69.4	65.2
25-2424	MT2270_MT	68.6	70	63.4	63.6	67.5	63	57	63.1	69.7	70.1	71.3	67.5	72.3	68.6	67.5
25-2425	MTS2286_MT	69.0	67	66.5	63.4	67.0	63	58	65.4	68.6	67.1	69.0	66.7	70.4	69.2	64.9
25-2426	MTAX22120_MT	69.4	67	65.3	64.2	67.8	64	58	64.9	67.2	67.4	69.6	67.5	70.3	69.2	65.3

BAKE MIX TIME, ACTUAL
(Small Scale) Montana
Cooperators A – O

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
25-2422	Yellowstone_CK	6.9	15	6.0	10.0	9.8	6.7	10	5.6	4.8	18	7.0	7.5	5	10.5	13
25-2423	SY Monument_CK	7.3	20	6.0	11.0	9.8	5.8	11	6.1	5.0	20	8.0	7.8	5	11.0	12
25-2424	MT2270_MT	5.4	12	4.0	6.6	7.0	4.6	8	4.5	4.3	13	8.0	5.5	7	6.5	11
25-2425	MTS2286_MT	6.2	25	5.3	8.2	8.8	7.0	8	6.3	4.8	18	8.0	6.5	6	9.0	11
25-2426	MTAX22120_MT	4.4	11	4.0	6.4	6.8	5.0	8	4.3	4.5	15	7.5	5.8	6	6.0	14

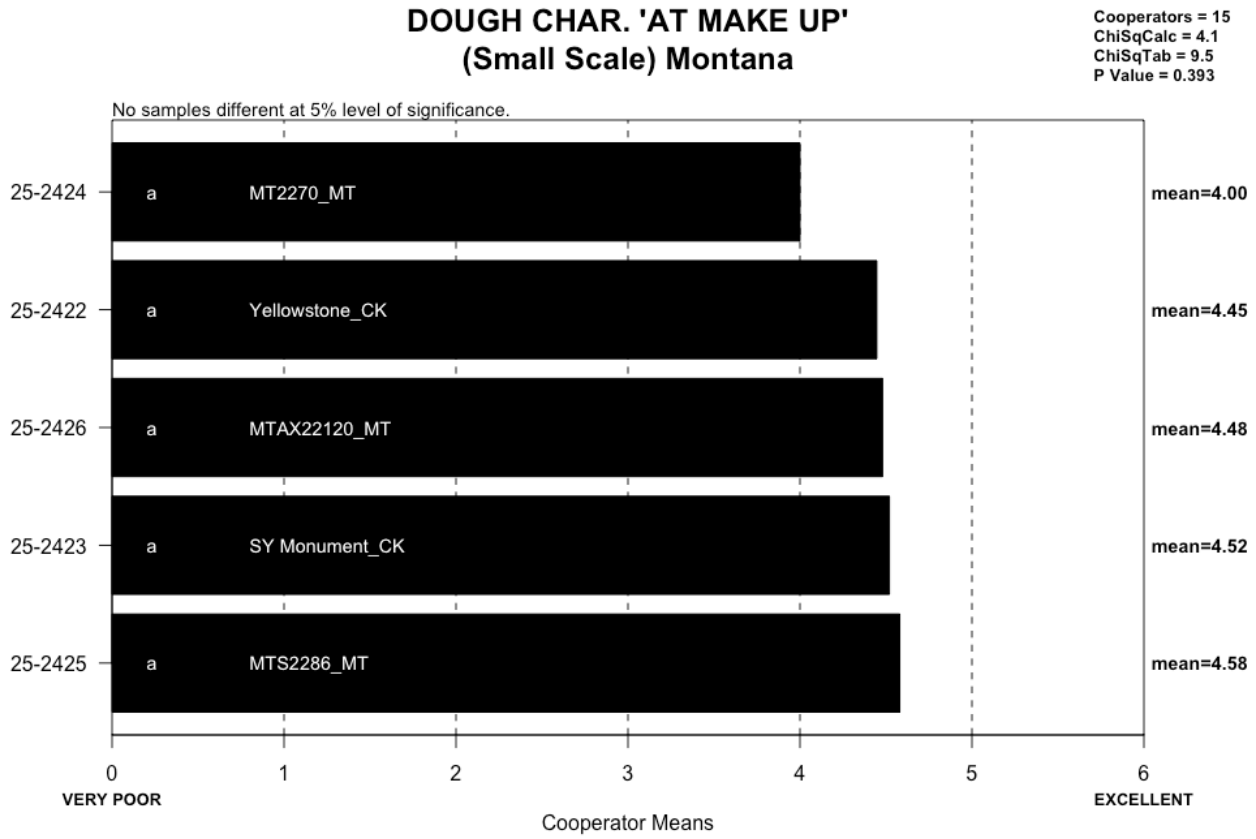

BAKE MIX TIME
(Small Scale) Montana
Cooperators = 15
ChiSqCalc = 21.4
ChiSqTab = 9.5
P Value = <0.001
Samples with the same letter not different at 5% level of significance.
25-2424
a
MT2270_MT
mean=3.51
25-2426
ab
MTAX22120_MT
mean=3.69
25-2422
ab
Yellowstone_CK
mean=4.40
25-2425
ab
MTS2286_MT
mean=4.40
25-2423
b
SY Monument_CK
mean=4.60
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


MIXING TOLERANCE
(Small Scale) Montana
Cooperators = 15
ChiSqCalc = 4.6
ChiSqTab = 9.5
P Value = 0.332
No samples different at 5% level of significance.
25-2424
a
MT2270_MT
mean=3.82
25-2426
a
MTAX22120_MT
mean=4.00
25-2422
a
Yellowstone_CK
mean=4.23
25-2423
a
SY Monument_CK
mean=4.44
25-2425
a
MTS2286_MT
mean=4.49
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means



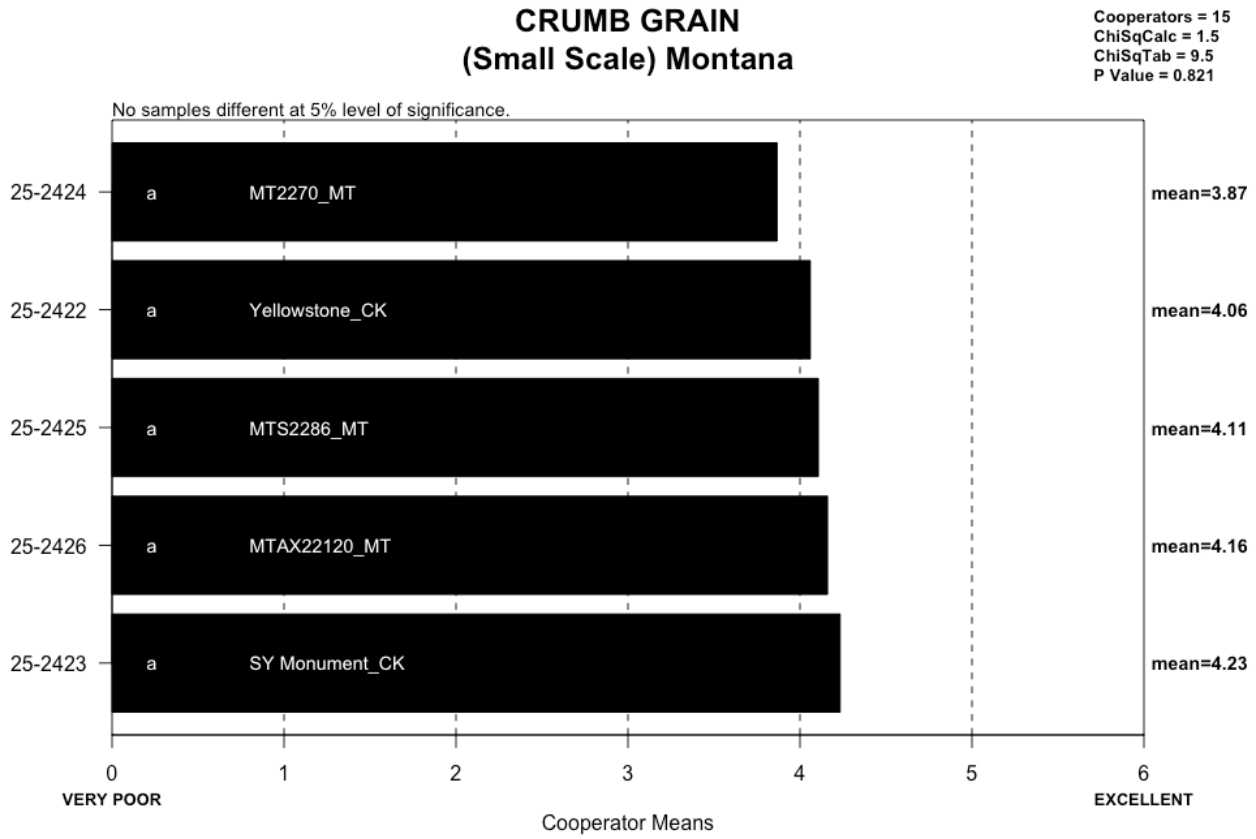
DOUGH CHAR. 'OUT OF MIXER', DESCRIBED
(Small Scale) Montana

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
25-2422	Yellowstone_CK	3	1	2	7	2
25-2423	SY Monument_CK	3	1	3	6	2
25-2424	MT2270_MT	3	2	1	7	2
25-2425	MTS2286_MT	3	1	1	6	4
25-2426	MTAX22120_MT	3	1	1	8	2



DOUGH CHAR. 'AT MAKE UP', DESCRIBED
(Small Scale) Montana

IDCODE	ID	Sticky	Wet	Tough	Good	Excellent
25-2422	Yellowstone_CK	1	0	1	12	1
25-2423	SY Monument_CK	1	1	0	11	2
25-2424	MT2270_MT	2	2	1	8	2
25-2425	MTS2286_MT	1	0	2	10	2
25-2426	MTAX22120_MT	1	1	1	11	1

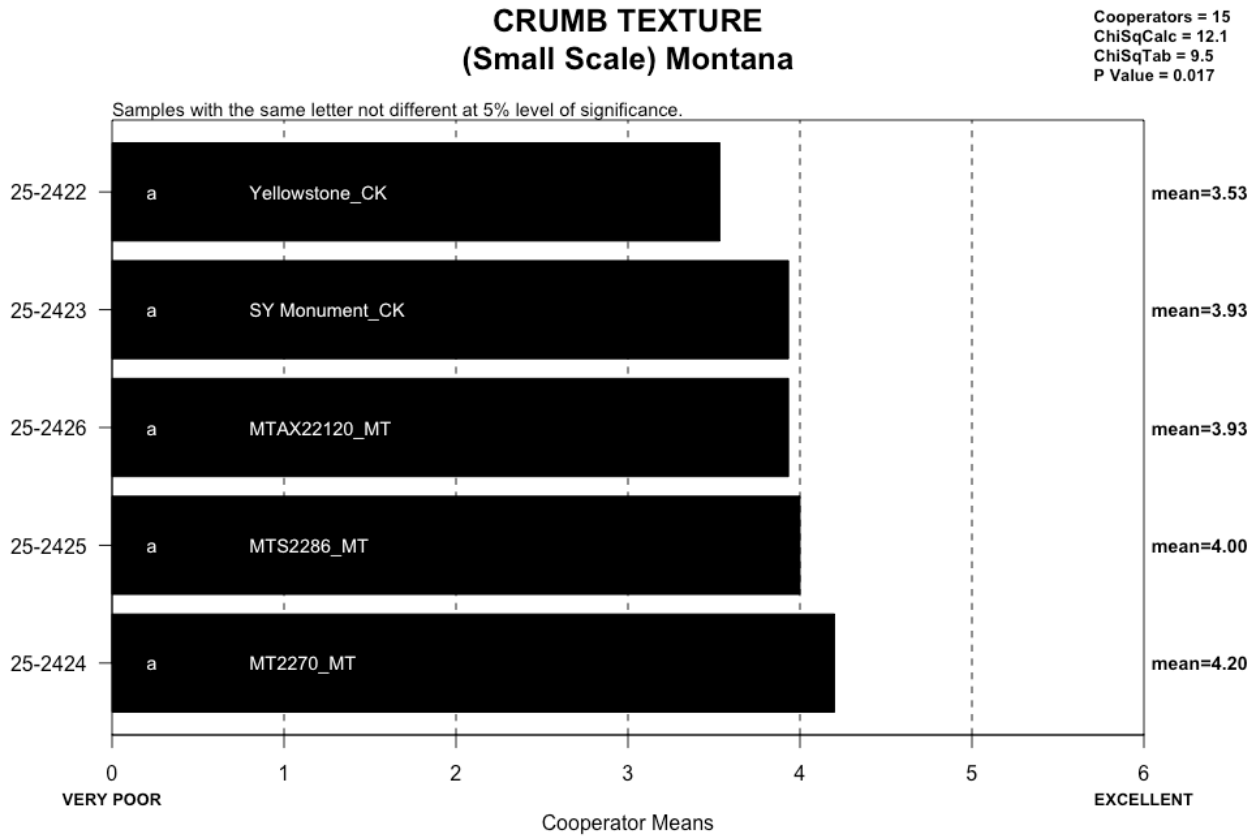


CRUMB GRAIN, DESCRIBED
(Small Scale) Montana

IDCODE	ID	Open	Fine	Dense
25-2422	Yellowstone_CK	6	7	2
25-2423	SY Monument_CK	5	8	2
25-2424	MT2270_MT	10	4	1
25-2425	MTS2286_MT	11	4	0
25-2426	MTAX22120_MT	11	4	0

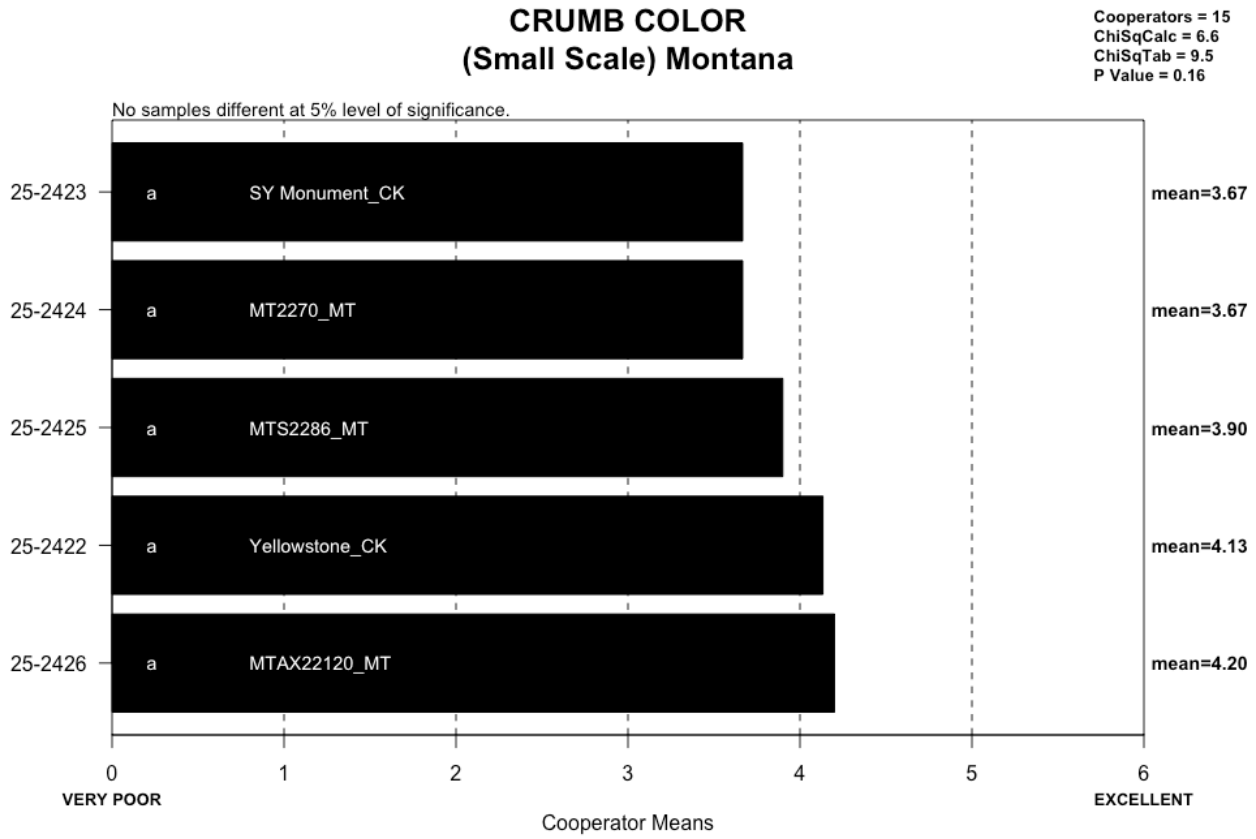
CELL SHAPE, DESCRIBED
(Small Scale) Montana

IDCODE	ID	Round	Irregular	Elongated
25-2422	Yellowstone_CK	7	4	4
25-2423	SY Monument_CK	7	4	4
25-2424	MT2270_MT	4	7	4
25-2425	MTS2286_MT	5	5	5
25-2426	MTAX22120_MT	4	7	4



CRUMB TEXTURE, DESCRIBED
(Small Scale) Montana

IDCODE	ID	Harsh	Smooth	Silky
25-2422	Yellowstone_CK	4	8	3
25-2423	SY Monument_CK	2	9	4
25-2424	MT2270_MT	0	12	3
25-2425	MTS2286_MT	2	9	4
25-2426	MTAX22120_MT	3	9	3



CRUMB COLOR, DESCRIBED
(Small Scale) Montana

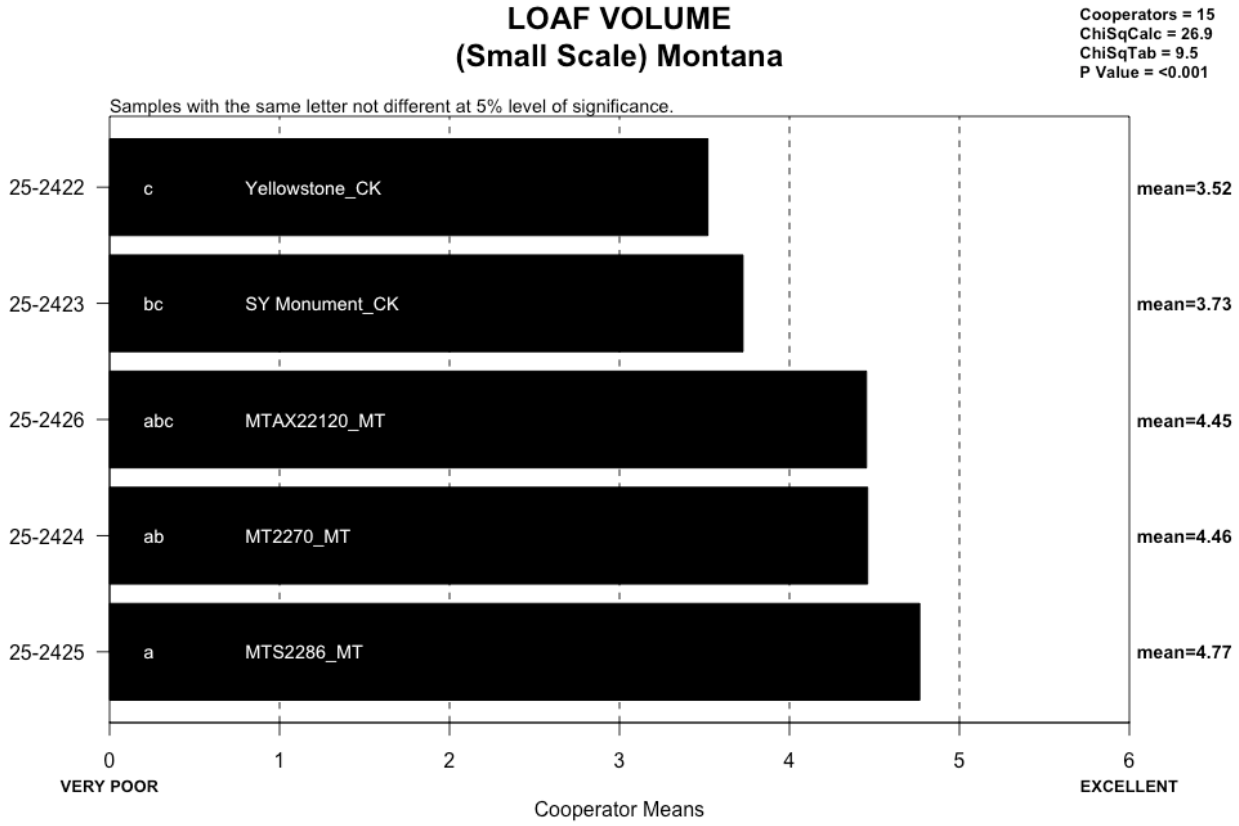
IDCODE	ID	Gray	Dark Yellow	Yellow	Dull	Creamy	White	Bright White
25-2422	Yellowstone_CK	0	1	0	2	8	3	1
25-2423	SY Monument_CK	1	0	2	2	6	4	0
25-2424	MT2270_MT	0	0	5	2	5	2	1
25-2425	MTS2286_MT	0	0	3	3	6	3	0
25-2426	MTAX22120_MT	0	0	1	3	7	3	1

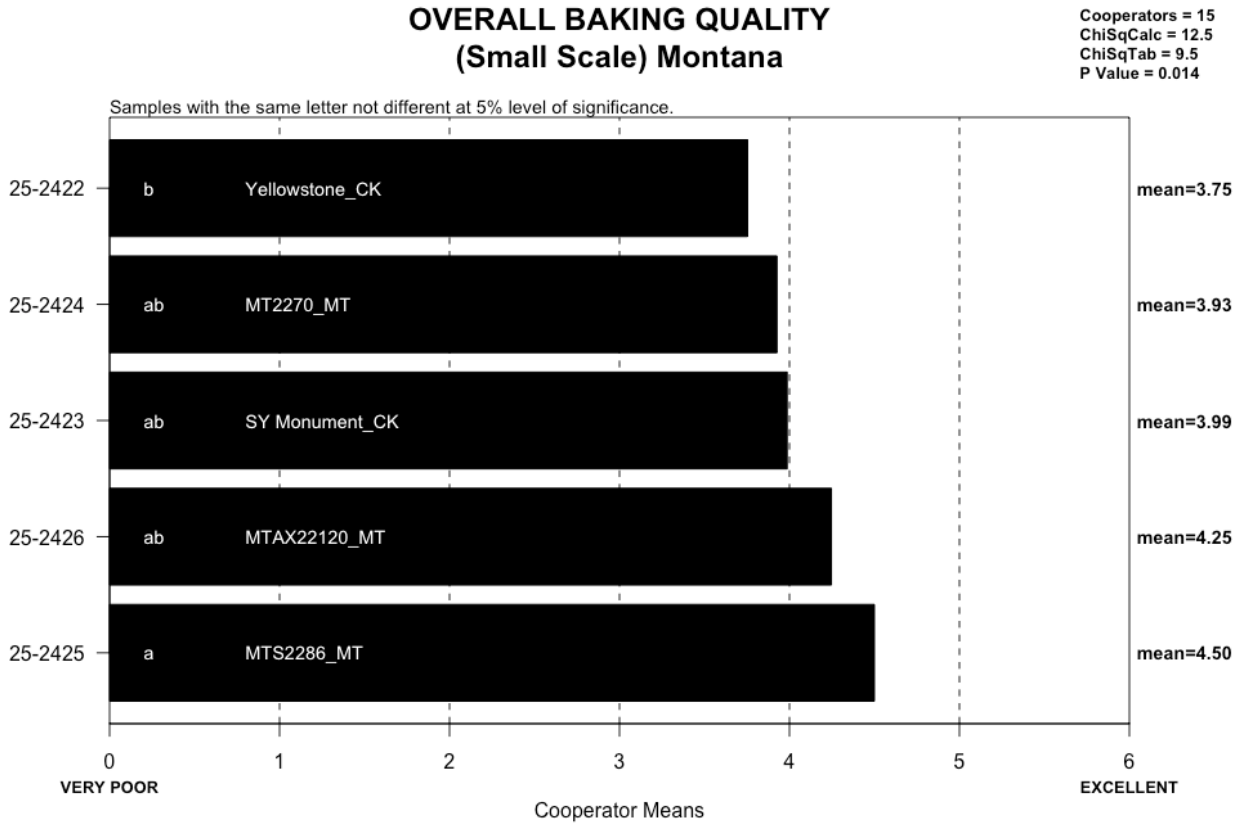
LOAF WEIGHT, ACTUAL
(Small Scale) Montana
Cooperators A – O

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
25-2422	Yellowstone_CK	143.6	472.3	145.7	140.1	153.1	143.0	410.6	155.2	135.1	418.8	434	133.3	452	143.0	432.0
25-2423	SY Monument_CK	139.3	441.8	143.6	141.6	154.9	144.0	404.7	157.7	137.9	422.3	437	138.0	455	142.2	452.0
25-2424	MT2270_MT	142.0	464.2	141.2	139.1	155.4	145.6	404.8	153.1	136.7	418.1	436	137.1	455	142.0	450.1
25-2425	MTS2286_MT	142.1	466.1	145.7	139.8	152.2	144.0	405.4	151.3	134.5	419.1	439	140.0	450	138.8	454.4
25-2426	MTAX22120_MT	142.5	471.0	145.9	142.8	155.7	144.0	403.9	155.0	135.1	415.9	437	139.8	450	141.6	458.4

LOAF VOLUME, ACTUAL
(Small Scale) Montana
Cooperators A – O

IDCODE	ID	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
25-2422	Yellowstone_CK	845	2892	945	830	805	825	2725	831	845	2650	2185	720	2086	945	1776
25-2423	SY Monument_CK	855	2952	955	888	835	750	2525	790	850	2800	2208	739	2059	885	1872
25-2424	MT2270_MT	875	2952	990	988	895	850	2825	885	940	2850	2227	792	2214	973	2001
25-2425	MTS2286_MT	965	3057	1020	903	920	925	2775	932	955	2650	2378	846	2318	990	1978
25-2426	MTAX22120_MT	890	2982	965	884	880	900	2800	936	910	2700	2313	847	2291	1015	1968


LOAF VOLUME
(Small Scale) Montana
Cooperators = 15
ChiSqCalc = 26.9
ChiSqTab = 9.5
P Value = <0.001
Samples with the same letter not different at 5% level of significance.
25-2422
c
Yellowstone_CK
mean=3.52
25-2423
bc
SY Monument_CK
mean=3.73
25-2426
abc
MTAX22120_MT
mean=4.45
25-2424
ab
MT2270_MT
mean=4.46
25-2425
a
MTS2286_MT
mean=4.77
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means


OVERALL BAKING QUALITY
(Small Scale) Montana
Cooperators = 15
ChiSqCalc = 12.5
ChiSqTab = 9.5
P Value = 0.014
Samples with the same letter not different at 5% level of significance.
25-2422
b
Yellowstone_CK
mean=3.75
25-2424
ab
MT2270_MT
mean=3.93
25-2423
ab
SY Monument_CK
mean=3.99
25-2426
ab
MTAX22120_MT
mean=4.25
25-2425
a
MTS2286_MT
mean=4.50
0
1
2
3
4
5
6
VERY POOR
EXCELLENT
Cooperator Means

COOPERATOR'S COMMENTS
(Small Scale) Montana
Cooperators A – O

25-2422	Yellowstone_CK
A	Long mix time, tough dough out of mixer but improved at make up. Overall acceptable quality.
B	Excellent absorption with good mix time. Goood dough handling. Average volume.
C	slow pick up, tough, excellent loaf externals
D	High Water Abs, Long MT, Slightly Sticky & Strong Dough, Medium Loaf Volume, Dark Yellow Crumb Grain, Open Elongated Cells, Good Resilient & Smooth Texture
E	Long mix time, avg absorp. Good dough at make up. Avg creamy colored crumb grain. Low volume. Good Mtol.
F	No comment.
G	Good volume, good mix time, good dough
H	No comment.
I	No comment.
J	High protein, absorption, and mix time. Low stability. Fair volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	No comment.
25-2423	SY Monument_CK
A	Long mix time, tough dough feel out of mixer but improved at make up. Overall acceptable quality.
B	Optimum dough handling with excellent absorption rating, mix time and volume.
C	nice loaf externals
D	Very High Water Abs, Very Long MT, Slightly Sticky & Strong Dough, High Loaf Volume, Yellow Crumb Grain, Fine Elongated Cells, Good Resilient & Silky Texture
E	Long mix time, high absorp. Good dough at make up. Avg dull colored crumb grain. Lower volume. Good mix tol.
F	No comment.
G	Lower volume, good mix time, good dough
H	No comment.
I	No comment.
J	High protein, absorption, and mix time. Good stability and volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	No comment.
25-2424	MT2270_MT
A	Yellow flower. Overall acceptable quality.
B	Slightly soft dough handling with average mix time. Excellent loaf volume.
C	tough, excellent loaf externals
D	High Water Abs, Normal MT, Slightly Sticky & Strong Dough, Very High Loaf Volume, Yellow Crumb Grain, Fine Elongated Cells, Good Resilient & Silky Texture
E	Long mix time, high absorp. Tough dough at make up. Avg open irregular crumb grain. Good volume. Avg Mtol.
F	No comment.
G	Good volume, good mix time, good dough
H	No comment.
I	No comment.
J	High protein, absorption, and volume. Good stability and mix time.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	No comment.

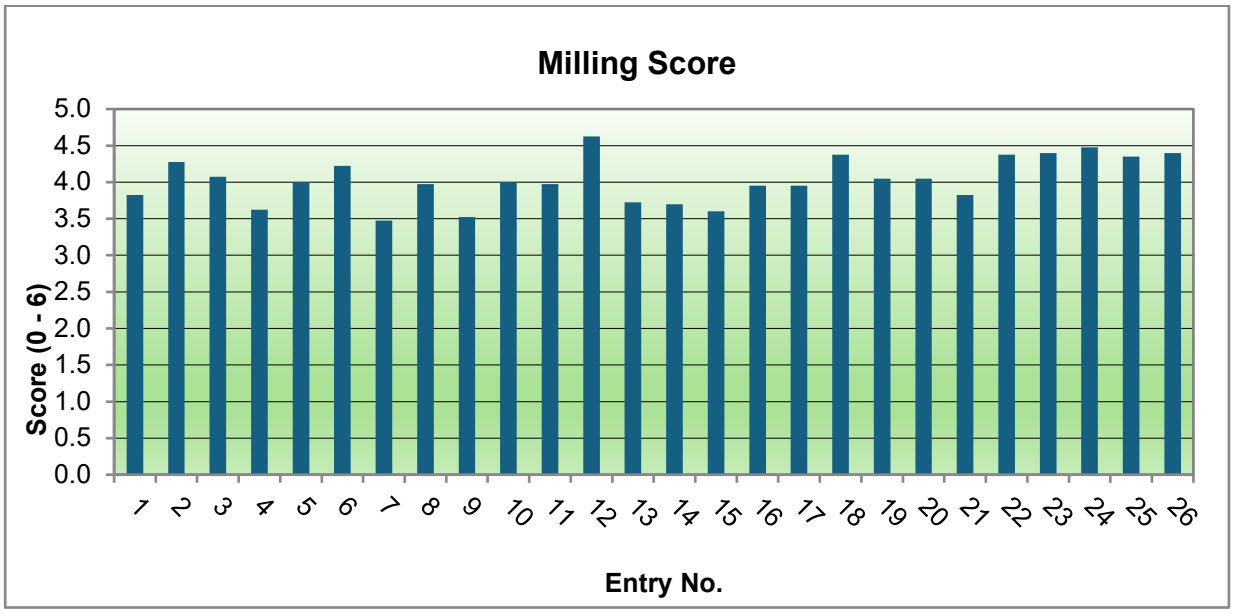
COOPERATOR'S COMMENTS
(Small Scale) Montana
Cooperators A – O

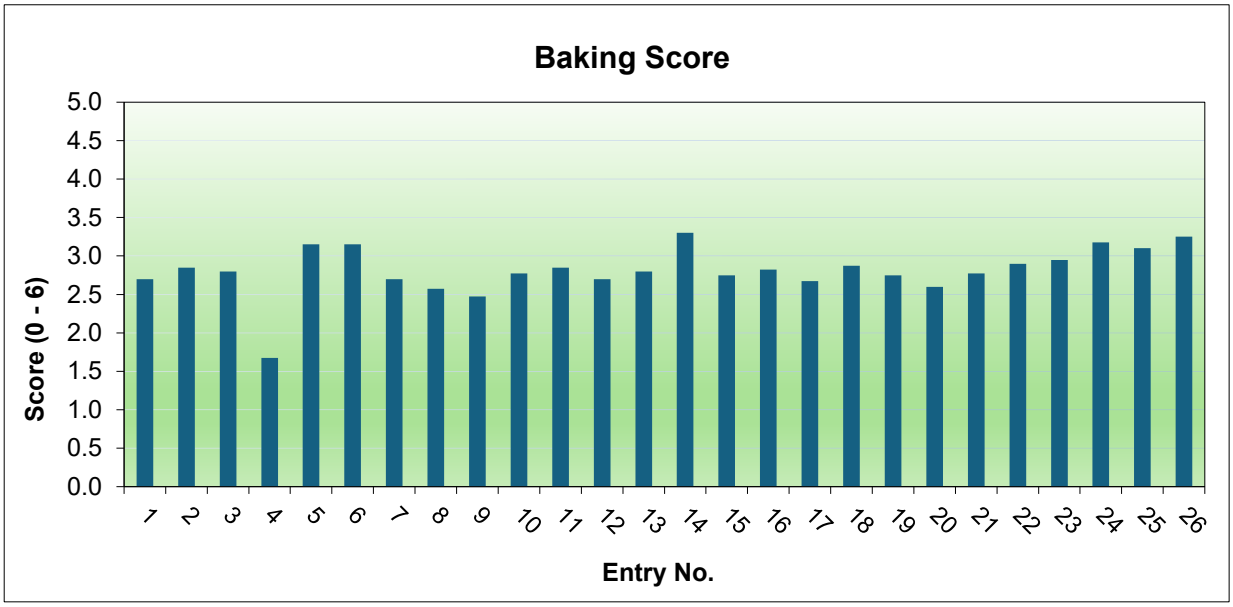
25-2425	MTS2286_MT
A	Slightly long mix time, tough dough out of mixer and slight improvement at make up. Overall acceptable quality.
B	Optimum dough handling with excellent absorption rating, mix time and volume.
C	rough break
D	High Water Abs, Long MT, Slightly Sticky & Strong Dough, High Loaf Volume, Yellow Crumb Grain, Open Elongated Cells, Good Resilient & Slightly Harsh Texture
E	Long mix time, high absorp. Tough dough at make up. Avg irregular crumb grain. Good volume. Excellent mix tol.
F	No comment.
G	Good volume, good mix time, good dough
H	No comment.
I	No comment.
J	High protein, absorption, and mix time. Good stability. Fair volume. (DOUBLE PEAK FARINO).
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	No comment.
25-2426	MTAX22120_MT
A	Good dough feel out of mixer but decline in dough feel to wet at make up. Poorer loaf volume than predicted with protein. Overall poorer quality
B	Excellent absorption with average mix time. Optimum dough handling. Excellent loaf volume.
C	nice loaf externals
D	High Water Abs, Normal MT, Slightly Sticky & Strong Dough, High Loaf Volume, Yellow Crumb Grain, Open Round Cells, Good Resilient & Slightly Harsh Texture
E	Long mix time, high absorp. Tough dough throughout, open, best grain. Good volume & mix tolerance.
F	No comment.
G	Good volume, good mix time, good dough
H	No comment.
I	No comment.
J	High protein and absorption. Good stability, mix time, and volume.
K	No comment.
L	No comment.
M	No comment.
N	No comment.
O	No comment.

2025 WQC Milling and Baking Marketing Scores

2025 WQC Milling & Baking Marketing Scores

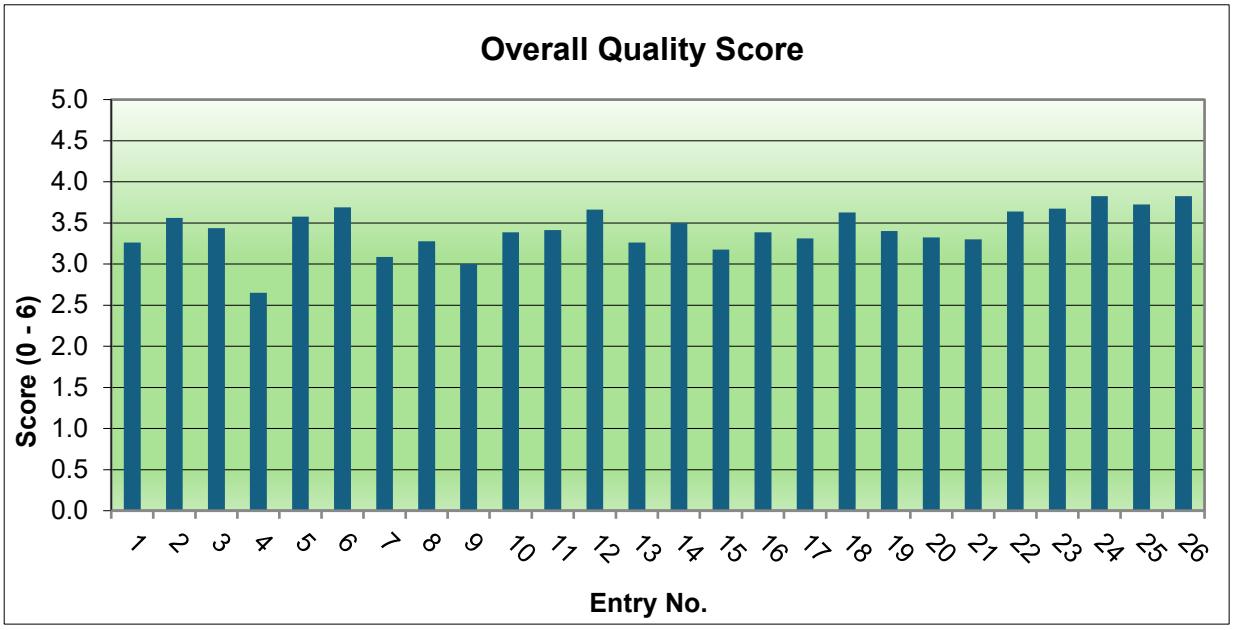
(Based upon HWWQL Quality Data and KSU Milling Data)





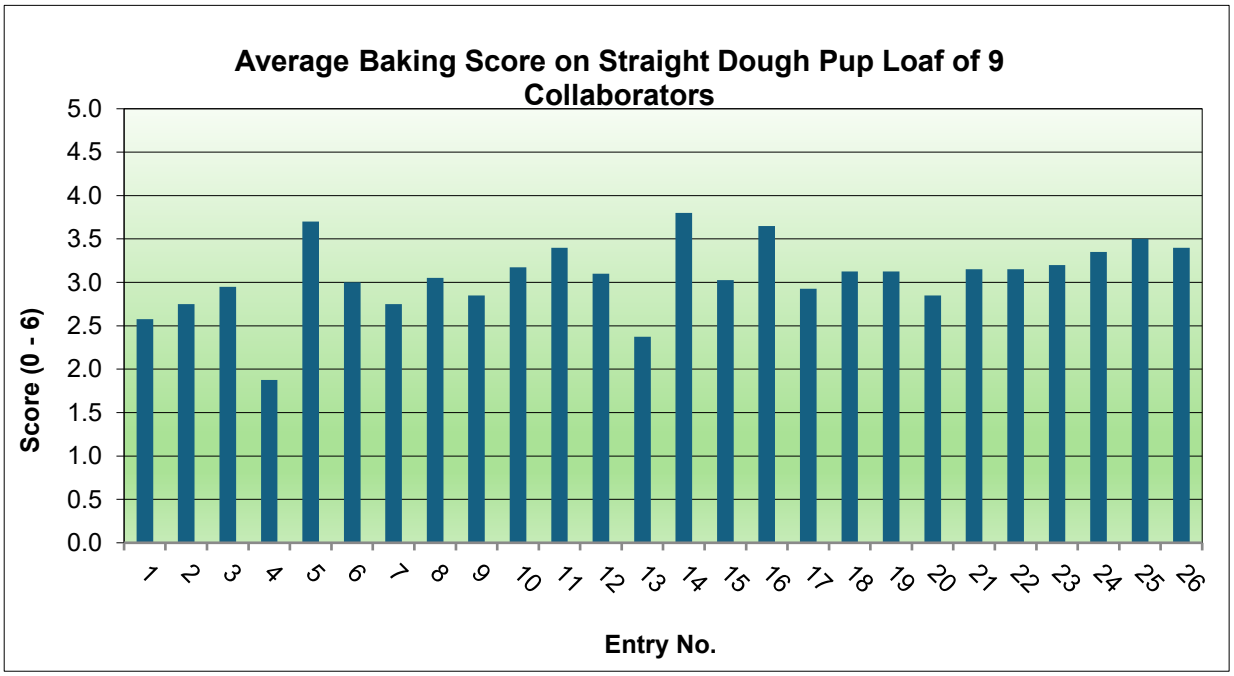
2025 WQC Milling & Baking Marketing Scores

(Based upon HWWQL Quality Data and KSU Milling Data)



2025 WQC Baking Marketing Scores

(Based upon Average Baking Data of Collaborators Pup-Loaf Straight Dough)



Marketing Scores

Achieving acceptable end-use (milling and baking) quality is a fundamental objective of wheat breeding programs throughout the U.S. hard winter wheat region. Numerous statistical methods have been developed to measure quality. Several years ago, Dr. Scott Haley (Colorado State University), in conjunction with the USDA-ARS Hard Winter Wheat Quality Laboratory (HWWQL), developed a relational database for summarization and interpretation of regional performance nursery wheat end-use quality data generated annually by the HWWQL (Scott D. Haley, Rod D. May, Bradford W. Seabourn, and Okkyung K. Chung. 1999. *Relational database system for summarization and interpretation of Hard Winter Wheat regional quality data*. Crop Sci. 39:309–315). Until that time, few tools were available to assist in the decision-making process when faced with a large number of parameters from comprehensive milling and baking tests. The database system uses a graphical interface that requires input from the user. The database system provides simultaneous assessment of multiple quality traits on a standardized scale, *user-specified prioritization* of end-use quality traits for numerical and qualitative ratings of genotypes, tabulation of major quality deficiencies of genotypes, and summarization of quality ratings for a genotype across multiple nurseries.

As an extension of this relational database, and in keeping with the precedent set by Dr. Gary Hareland and the Hard Spring wheat region with the introduction of a 'marketing score' into their 2004 annual crop report to the Wheat Quality Council, the HWWQL developed (using the HRS system as a guide) a similar marketing score for both milling and baking for the Hard Winter Wheat Region, as shown below.

Variation(+/-) from Target Value:	SCORE	TW lbs/bu	Kernel Size % Large	Kernel Weight g/1000	Wheat Protein 12%mb	Kernel Hardness NIR	Str Grd Flour Yield %	Wheat Ash 14%mb	Wheat Falling Number Seconds
	6	63	39	45	15.0	100	76	1.30	375
	5	62	36	40	14.0	90	74	1.40	350
	4	61	33	35	13.0	80	72	1.50	325
TARGET VALUE:	**3**	60	30	30	12.0	70	70	1.60	300
	2	59	26	25	11.0	60	68	1.70	275
	1	58	22	20	10.0	50	66	1.80	250
	0	57	18	15	9.0	40	64	1.90	225

Milling Marketing Score = (TW*1.5) + (largeK*1) + (1000KWT*0.5) + + (protein*2.5) + (NIRHS*1) + (YLD*1.5) + (ash*1) + (FN*1)/10 (where TW = test weight, largeK = large kernel size %, 1000KWT = thousand kernel weight, protein = protein content %, NIRHS = NIR hardness score, YLD = flour yield, ash = wheat ash content %, and FN = falling number value).

Variation(+/-) from Target Value:	SCORE	Absorption Actual (%)	Volume Actual (cc)	Color Rating Score	Grain Rating Score	Texture Rating Score	SCORE	Mix Time Actual (min)
	6	65	1050	6.0	6.0	6.0	**0**	5.00
	5	64	1000	5.4	5.4	5.4	**2**	4.50
	4	63	950	4.7	4.7	4.7	**4**	4.00
TARGET VALUE:	**3**	62	900	4.0	4.0	4.0	**6**	3.50
	2	61	850	3.3	3.3	3.3	**4**	3.00
	1	60	800	1.6	1.6	1.6	**2**	2.50
	0	59	750	1.0	1.0	1.0	**0**	2.00

Bake Marketing Score = (Abs*3) + (Lvol*2) + (color*1) + (grain*1.5) + (texture*1) + (MT*1.5)/10 (where Abs = mixograph water absorption %, Lvol = loaf volume [cc], color = crumb color [0-6 scale], grain = crumb grain [0-6 scale], texture = crumb texture [0-6 scale], and MT = mixograph mix time).

Alkaline Noodle Quality Tests

Of

2025 WQC Hard Winter Wheat Entries

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Alkaline Noodle Quality Report

Objectives: Evaluate alkaline noodle color and cooking characteristics.

Materials: 26 WQC hard winter wheat samples harvested in 2025.

Methods:

PPO (Polyphenol Oxidase) Test:

The PPO level in wheat meal was determined using a method modified from AACCI Approved method 22-85.01.

1. Grind wheat using an Udy Mill and blend the sample thoroughly on tumbling equipment.
2. Weigh 75 mg of wheat meal in a 2 mL microfuge tube.
3. Dispense 1.5 mL of 5 mM L-DOPA in 50 mM MOPS (pH 6.5) solution.
4. Vortex 10 min.
5. Centrifuge 4 min. at 10,000 rpm
6. Read absorbance at 475 nm.

Noodle Making:

Formulation:

Alkaline noodles were made with 100 g flour, 1 g Na_2CO_3, and 35 mL of water (fixed).

Procedure:

1. 100 g flour with 1 g Na_2CO_3 + 35 mL water.
2. Mix at medium speed for 10 min (100 g Micro Mixer – no pins in the bowl, National MFG. Co., Lincoln, NE)
3. Rest for 30 min in a plastic bag.
4. Plug roll gap with plastic tubing and add mixed dough.
5. Sheeting: roll gaps 4 (2x), 3, 2.3, 1.75, 1.35, 1.1 (mm).
6. Measure color at 0 and 24 hr.
7. Cutting

Measurement of Noodle Dough Color:

Noodle dough color (L*, lightness; a*, redness-greenness; b*, yellowness-blueness) was measured by Minolta Chroma Meter CR-410 at 0 and 24 hr.

Cooking Noodles:

1. After cutting noodles, rest noodles in plastic bags for 2 hr. at 21^{o}C.
2. Put the noodles (25 g) in boiling distilled water (300 mL).
3. Cook continuously with gentle stirring for 4 min 30 sec or until the core of noodle disappears.
4. Pour noodles and hot water through colander and collect the cooking water for calculation of cooking loss.
5. Immerse the cooked noodles in a bowl with distilled water (100 mL) for 1 min.
6. Drain water by shaking the colander 10 times. Measure the cooked noodle weight for calculation of water uptake.
7. Test noodle texture immediately.

Measurement of Cooking Loss and Water Uptake:

Cooking Loss:

1. Pre-weigh 500 mL beaker to 0.01 g.
2. Quantitatively transfer cooking/rinse water to beaker.
3. Evaporate to dryness (constant weight) in air oven at 95±5^{0}C. Drying time is about 20 hr.
4. Cool beakers and weigh to 0.01 g. For 25 g sample, multiply by 4 > % cooking loss.

Water Uptake:

Water Uptake (%) = (Cooked noodle weight – Raw noodle weight)/Raw noodle weight x100.

Texture Profile Analysis (TPA) of Noodle:

Immediately after cooking, noodle TPA was conducted using a TA-XTplus (Texture Technologies, NY) on 3 strings of noodle with 1-mm flat Perspex Knife Blade (A/LKB-F). TPA provides objective sensory results on various parameters as follows:

- **Hardness (N):** maximum peak force during the first compression cycle (first bite) and often substituted by the term “firmness”.
- **Springiness** (elasticity, ratio): ratio related to the height that the food recovers during the time that elapses between the end of the first bite and the start of the second bite.
- **Chewiness:** hardness x cohesiveness x springiness.
- **Resilience (ratio)**: measurement of how the sample recovers from deformation both in terms of speed and forces derived.

- **Cohesiveness (ratio)**: ratio of the positive force area during the second compression to that during the first compression.

Results:

The top 3 samples showing desirable properties were selected in each category.

Table I shows the following:

Noodle Color (L value, Higher is better) **at 0 hr.,** 2413 (81.13), 2422 (80.66), 2415 (80.29).

Noodle Color (L value, Higher is better) **at 24 hr.,** 2413 (71.16), 2415 (68.88), 2422 (68.55).

Delta L (Change of L value, lower absolute value is better).

2413 (-9.97), 2414 (-11.27), 2415 (-11.41)

PPO (Lower is better): 2411 (0.184), 2413 (0.204), 2414 (0.205).

Table II shows the following:

Hardness: 2402 (2.660), 2410 (2.539), 2419 (2.489).

Springiness: 2425 (0.915), 2422 (0.911), 2424 (0.909).

Chewiness: 2426 (1.533), 2422 (1.498), 2425 (1.496).

Resilience: 2425 (0.454), 2423 (0.443), 2413 (0.436).

Cohesiveness: 2413 (0.705), 2425 (0.704), 2426 (0.690).

Water Uptake: 2403 (88.80), 2414 (88.40), 2419 (88.40).

Cooking Loss: 2403 (6.40), 2413 (7.20), 2419 (7.20).

Discussion

Sample 2413 had the highest L-value (brightness) at both 0 and 24 hrs.; the lowest Delta L-value and the second lowest PPO value. This sample also had the highest cohesiveness and the third highest resilience in texture after cooking. Bright noodle color 24 hrs. after production and a firmer texture following cooking are considered desirable characteristics for alkaline noodles. Thus, sample 2413 would be considered the most favorable variety overall for alkaline noodle quality.

Sample 2415 had the third highest L-value (brightness) at 0 hrs. and the second highest L-value (brightness) at 24 hrs., the third lowest Delta L-value. This sample also had lower hardness and chewiness after cooking. Therefore, sample 2415 would be considered the most favorable variety overall for white salted noodle quality (Japanese Udon-type), which are preferred to have a bright, creamy white color, smooth, and soft texture.

Sample 2422 had the second highest L-value (brightness) at 0 hrs. and the third highest L-value (brightness) at 24 hrs. The sample also had the second highest springiness and the second highest Chewiness after cooking.

Table I. Noodle Color and PPO Level

Sample ID	*L** @ 0	*L** @ 24	*a** @ 0	*a** @ 24	*b** @ 0	*b**@ 24	delta *L**	delta *a**	delta *b**	PPO
2401	78.55	63.42	-0.50	1.52	19.53	23.33	-15.13	2.01	3.80	0.560
2402	75.20	63.56	-0.49	1.65	29.17	30.70	-11.64	2.14	1.53	0.510
2403	77.16	64.90	-0.69	1.86	24.64	27.77	-12.26	2.55	3.13	0.500
2404	75.83	64.38	-0.07	2.29	23.27	25.11	-11.45	2.35	1.84	0.565
2405	76.60	61.48	-0.24	2.24	21.09	23.59	-15.12	2.48	2.51	0.456
2406	79.37	65.37	-0.25	1.96	18.96	23.54	-14.00	2.20	4.58	0.484
2407	76.55	62.13	0.06	2.67	20.70	24.27	-14.42	2.61	3.57	0.546
2408	77.83	64.05	-0.03	2.26	19.71	22.69	-13.78	2.29	2.98	0.292
2409	77.33	63.38	-0.12	2.14	20.06	23.41	-13.96	2.26	3.35	0.586
2410	76.07	61.30	-0.33	2.28	21.22	23.50	-14.77	2.60	2.28	0.513
2411	77.92	66.02	-0.14	2.07	20.75	24.47	-11.90	2.20	3.72	0.184
2412	77.37	64.33	-0.11	2.07	21.58	24.70	-13.04	2.17	3.12	0.495
2413	81.13	71.16	-0.66	0.99	19.00	23.39	-9.97	1.65	4.39	0.204
2414	76.79	65.52	-0.04	2.50	20.83	24.99	-11.27	2.54	4.16	0.205
2415	80.29	68.88	-0.53	1.42	18.02	22.05	-11.41	1.94	4.03	0.602
2416	76.64	62.65	-0.04	2.49	20.23	24.01	-14.00	2.53	3.78	0.673
2417	79.43	66.93	-0.36	1.77	17.73	21.32	-12.51	2.13	3.59	0.324
2418	77.10	63.59	0.01	2.26	18.57	22.04	-13.51	2.25	3.47	0.578
2419	78.19	64.94	-0.41	2.01	19.65	23.96	-13.25	2.42	4.31	0.557
2420	78.64	65.11	-0.20	2.01	18.53	22.62	-13.53	2.21	4.09	0.563
2421	79.15	67.11	-0.25	1.73	18.08	21.95	-12.04	1.98	3.87	0.411
2422	80.66	68.55	-0.49	1.91	19.32	24.30	-12.11	2.40	4.98	0.234
2423	78.66	65.24	-0.10	2.65	19.46	24.03	-13.42	2.74	4.57	0.401
2424	79.40	65.98	-0.73	1.51	21.78	24.97	-13.42	2.24	3.20	0.397
2425	78.55	65.05	-0.45	2.14	21.41	24.17	-13.50	2.58	2.76	0.489
2426	76.33	63.28	0.28	3.07	21.55	25.05	-13.05	2.79	3.50	0.365
AVG	77.95	63.35	-0.11	2.29	20.54	24.19	-14.09	2.40	3.65	0.462

Table II. Texture Profile Analysis of Cooked Noodle and Water Uptake and Cooking Loss

Sample ID	Hardness	Springiness	Chewiness	Resilience	Cohesiveness	Water Uptake (%)	cooking loss (%)
2401	2.322	0.871	1.329	0.401	0.657	82.40	7.20
2402	2.660	0.834	1.413	0.376	0.637	80.80	7.60
2403	2.430	0.867	1.374	0.399	0.652	88.80	6.40
2404	2.258	0.855	1.218	0.366	0.631	77.60	8.00
2405	2.317	0.857	1.283	0.380	0.647	82.00	7.20
2406	2.316	0.888	1.383	0.413	0.673	82.40	7.60
2407	2.180	0.907	1.334	0.400	0.675	82.00	7.20
2408	2.313	0.865	1.347	0.413	0.673	76.80	7.60
2409	2.432	0.900	1.449	0.396	0.662	83.20	8.00
2410	2.539	0.865	1.418	0.378	0.646	77.60	8.40
2411	2.404	0.890	1.452	0.401	0.678	86.80	7.60
2412	2.457	0.876	1.410	0.395	0.656	83.60	7.60
2413	2.107	0.894	1.329	0.436	0.705	76.80	7.20
2414	2.429	0.859	1.383	0.396	0.663	88.40	7.20
2415	2.320	0.869	1.304	0.376	0.647	81.20	7.60
2416	2.462	0.867	1.377	0.378	0.645	81.60	7.60
2417	2.474	0.851	1.397	0.397	0.664	78.40	8.00
2418	2.486	0.880	1.469	0.398	0.671	76.00	8.40
2419	2.489	0.859	1.383	0.383	0.647	88.40	7.20
2420	2.407	0.880	1.398	0.390	0.660	87.60	8.40
2421	2.466	0.882	1.449	0.398	0.666	83.20	7.20
2422	2.396	0.911	1.498	0.423	0.687	76.80	7.60
2423	2.324	0.888	1.403	0.443	0.680	80.80	7.20
2424	2.310	0.909	1.445	0.435	0.688	83.60	7.20
2425	2.322	0.915	1.496	0.454	0.704	78.00	8.00
2426	2.456	0.905	1.533	0.435	0.690	77.20	7.60
AVG	2.389	0.888	1.431	0.418	0.674	79.80	7.40

TORTILLA BAKING TEST RESULTS OF 2025 WQC SAMPLES

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SUMMARY

This report includes the production and evaluation methods of wheat flour tortillas and data for the 2025 WQC samples. The report contains tortilla quality data for 26 samples (25-2401 to 25-2426). The production and fresh tortilla evaluation was carried out over two days with an internal control sample prepared on both days.

Samples 25-2402, 2404, 2405, 2406, 2410, 2411, 2412, 2414, 2422, 2425, and 2426 produced tortillas that were rated as "Excellent," based on their final diameter (≥14.65 cm) and subjective rollability score (>4.5 - very little cracking when rolled 16 days after baking). These samples also had good dough handling properties. Higher diameter and rollability scores suggest flour is moderately strong with good extensibility characteristics, resulting in tortillas with longer shelf life.

Samples 25-2407, 2409, 2415, 2419 and 2421 were rated as "poor," based primarily on their rollability scores (≤3 on day 16). The dough samples were strong with limited extensibility on hot-pressing and resulted in easily cracking tortillas. Sample 25-2409 produced higher diameter (15.46 cm), but the rollability score was too low (3 for both days 8 and 16).

The remaining samples had a general rating of “good” with rollability score of 4.0 and mostly lower diameters than the ones with “excellent” rating. Some of the samples (e.g. 2401, 2403, 2408, 2416, 20417, 2418, 2420, 2423 and 2424) had good diameters but their rollability scores were low on day 16.

Another interesting observation was that sample 25-2402 was especially yellow in color that was reflected in the a* and b* color readings (data not shown). The sample exhibited 3.83 a* value (reddish) versus average of 5.45 for the remaining samples and 19.23 b* value (yellowish) versus an average of 13.25 for the remaining samples. The color difference might indicate the presence of a unique pigment.

RESULTS

Tortilla quality parameters

Sample ID	Total Moisture (%), n=2	Average Fresh Weight (g), n=10	Average Thickness (cm), n=10	Average Diameter (cm), n=10	Specific Volume (cm^3/g)	Lightness (L*), n=2 (back, front)	Force (g)	Distance (mm)	Rollability Day 8, n=2	Rollability Day 16, n=2	#Average Rating, n=2
25-2401	34.55	39.48	0.36	14.03	1.393	75.36	1366.65	54.99	4.5	4	Good
25-2402	34.21	39.02	0.28	15.87	1.406	73.57	1263.96	55.00	5	5	Excellent
25-2403	34.64	39.04	0.31	14.95	1.387	76.20	991.09	54.99	3	4	Good
25-2404	33.75	39.16	0.33	15.07	1.500	73.48	822.92	54.99	2	5	Excellent
25-2405	34.57	39.40	0.32	15.36	1.493	74.91	1211.45	54.99	4.5	5	Excellent
25-2406	35.31	39.56	0.30	14.85	1.308	73.00	1226.64	54.99	5	5	Excellent
25-2407	33.15	39.34	0.34	14.48	1.431	73.89	1640.11	55.00	3	3	Poor
25-2408	35.22	39.96	0.33	13.94	1.274	72.70	1561.83	54.99	5	4	Good
25-2409	34.52	39.06	0.34	15.46	1.647	73.34	1219.92	54.99	3	3	Poor
25-2410	34.36	39.64	0.30	15.72	1.451	72.01	1616.05	54.99	5	5	Excellent
25-2411	37.03	39.70	0.29	14.65	1.252	72.05	1226.62	54.99	5	5	Excellent
25-2412	36.21	40.10	0.29	14.99	1.275	72.42	1769.45	54.99	5	5	Excellent
25-2413	36.89	39.90	0.33	13.58	1.189	70.97	1406.08	54.99	5	4	Good
25-2414	33.92	39.45	0.24	15.72	1.185	71.91	1178.74	54.99	5	5	Excellent
25-2415	34.97	39.36	0.34	13.77	1.290	74.98	1433.69	54.99	4.5	3	Poor
25-2416	33.84	38.88	0.25	15.84	1.242	71.23	1116.91	54.99	5	4	Good
25-2417	34.43	40.11	0.35	14.06	1.346	71.86	1631.42	55.00	5	4	Good
25-2418	35.05	39.76	0.30	14.47	1.255	70.58	1511.34	54.99	5	4	Good
25-2419	36.19	39.91	0.39	14.66	1.657	73.21	1568.67	55.00	4.5	3	Poor
25-2420	34.58	39.86	0.27	14.98	1.203	70.24	1100.90	55.00	5	4	Good
25-2421	33.53	39.88	0.28	14.48	1.160	70.61	1967.58	54.99	4.5	3	Poor
25-2422	35.12	39.91	0.30	14.66	1.272	72.93	1886.58	54.99	5	5	Excellent
25-2423	34.74	39.68	0.31	14.24	1.245	71.32	1677.21	54.99	5	4	Good
25-2424	35.28	39.66	0.31	14.66	1.330	73.50	1696.82	54.99	4.5	4	Good

Sample ID	Total Moisture (%), n=2	Average Fresh Weight (g), n=10	Average Thickness (cm), n=10	Average Diameter (cm), n=10	Specific Volume (cm^3/g)	Lightness (L*), n=2 (back, front)	Force (g)	Distance (mm)	Rollability Day 8, n=2	Rollability Day 16, n=2	#Average Rating, n=2
25-2425	35.34	39.76	0.33	14.83	1.427	72.64	1924.38	54.99	5	5	Excellent
25-2426	33.66	39.60	0.25	15.68	1.214	70.28	1726.96	54.99	5	5	Excellent

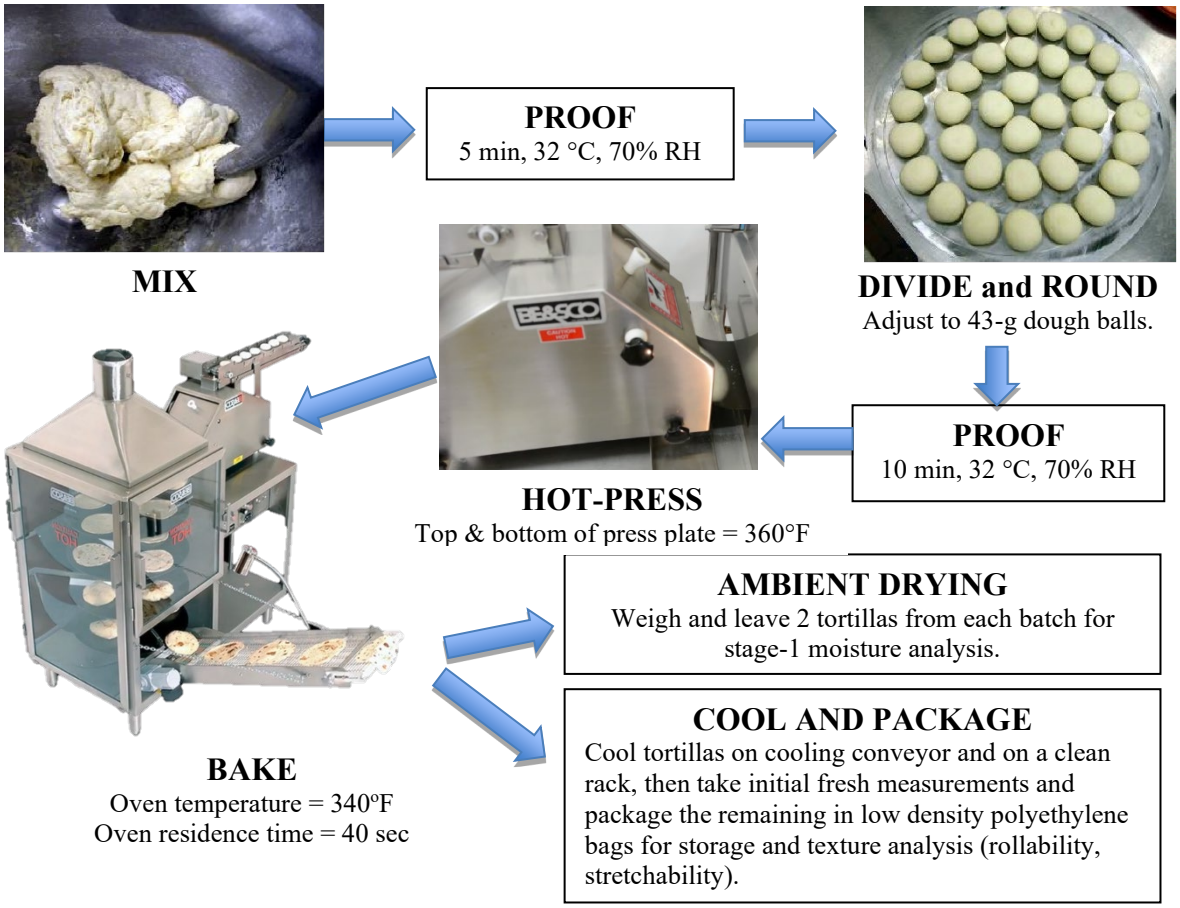
#Subjective rating based primarily on diameter and rollability. Excellent ≥4.5 on day 16, ≥14.66 cm diameter; Good: rollability score ≥3.5 on day 16, and any diameter. Poor: rollability score ≤3.0 on day 16, any diameter.

PRODUCTION AND EVALUATION OF WHEAT FLOUR TORTILLAS

Tortilla formulation (makes 15-18 tortillas per batch)

Ingredients	Amount	Batch (g)
Wheat flour	100%	499.5
Salt	1.5%	6.7
Sodium propionate	0.8%	3.6
Potassium sorbate	0.4%	1.8
All-purpose shortening	6.0%	27.0
Sodium bicarbonate	0.6%	2.7
Fumaric acid	0.5%	2.2
Sodium aluminum phosphate	0.82%	3.7
Water	54%	242.7
Batch Total	**165%**	**789.9**

Tortilla Processing



Key tortilla processing and analysis steps

Evaluation of Tortilla Properties

Tortillas were evaluated after processing for weight, diameter, thickness, moisture, and color. Texture tests were performed on day 3, and rollability assessment was performed on days 8 and 16 post-processing.

1. *Weight*

An average of 10 tortillas weighed on a balance were recorded and the reading was divided by 10 to estimate weight of a single tortilla (g).

2. *Diameter*

The average diameter of 10 tortillas was measured using a ruler in two perpendicular directions. This varies widely among wheat samples depending on flour quality; desired values are > 14.5 cm.

3. *Thickness*

This is the average height of 10 tortillas measured using a digital vernier caliper and then divided by 10 to estimate a value for a single tortilla.

4. *Moisture*

Moisture was determined using a two-stage procedure (AACC, Method 44-15.02, 2000). The measurement includes stage-1 moisture estimation based on ambient drying conditions (*A*) and a stage-2 oven drying (*B*) for the ambient dried samples after milling to finer particles.

Stage-1 Ambient drying:

$$A = \frac{W_1 - W_2}{W_1} \times 100$$

Where A = the moisture content in %, wb; W1 = weight of fresh tortillas (n=2); and W2 = weight of ambient dried tortillas (4-5 days).

$$B = \frac{W_1 - W_2}{W_1} \times 100$$

Where A = the moisture content in %, wb using the oven method for milled ambient dried tortillas; W1 = weight of milled tortillas before oven drying (n=2); and W2 = weight of oven dried tortillas (130ºC for 1 hr.).

$$MC\ (\%, wb) = A + \frac{(100 - A) \times B}{100}$$

Where MC = final moisture content; A = percent moisture loss on ambient air-drying; B = percent moisture loss determined by oven-drying of milled tortillas after ambient drying.

5. *Color Values*

The color values of lightness (L*), +a* (redness and greenness), and +b* (yellowness and blueness) of tortillas were determined using a handheld colorimeter (model CR-300, Minolta Camera Co., Ltd., Chuo-Ku, Osaka, Japan). Only L*-values are included in the report as they correlate with opacity and thus indicate the extent of starch gelatinization.

The typical values for refined flour tortillas often range between 68 (darker) to 76 (lighter). It is around 58-62 for whole grain wheat flour tortillas.

6. *Specific Volume*

This corresponds to the fluffiness of the tortilla; the desired values range between 1.0 to 1.50 cm^3/g, with higher values indicating limited extensibility and poor quality.

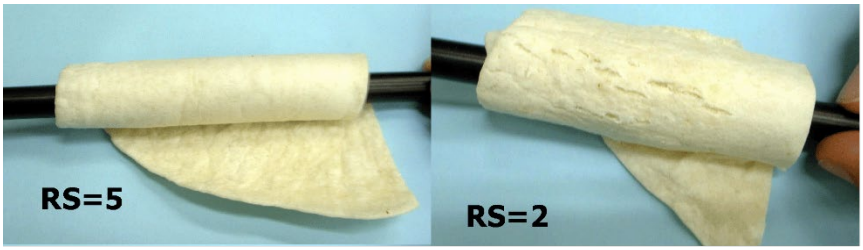
$$Specific\ volume\ \left[\frac{cm^3}{g}\right] = \frac{\pi * (\frac{Diameter}{2})^2 * Height}{Weight}$$

Estimation is based on the final values (estimates for single tortillas) of height (thickness), diameter (radius), and the average weight of tortillas.

7. *Tortilla Texture*

   a. *Rollability Score*

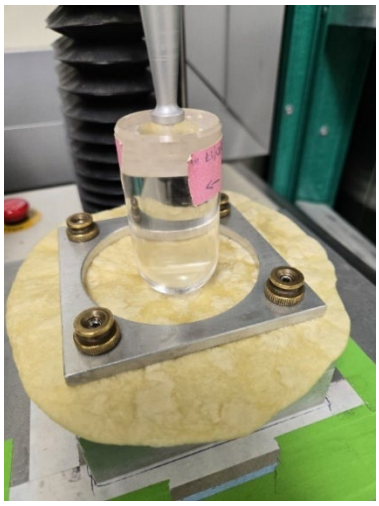
Two tortillas were evaluated on days 8 and 16 of storage by wrapping a tortilla around a dowel (1.0 cm diameter). The cracking and breakage of the tortilla were rated using a numerical scale of 1-5 (5 = no cracking; 4 = signs of cracking, but no breaking; three = cracking and breaking beginning on the surface; two = cracking and breaking imminent on both sides; 1 = unrollable, breaks easily). This measures shelf stability, and the desired value is often >3 on the 16^{th} day.



Tortilla rollability rating examples

   b. *Instrumental texture (puncture test)*

Tortilla stretchability, breaking point and firmness test was conducted using a Texture Profile Analyzer (TA. XT Plus, Model: PLUS-UPGRADE, Texture Technologies, MA, USA). Testing was done on day 3 post-baking. The machine was equipped with 5 kg load-cell and a round edge probe. Positive force (g) required to rapture a single tortilla and the stretch distance (mm) before the rapture were recorded for two representative tortillas and average values are reported.



Tortilla stretchability, breaking point and firmness analysis set up.

2025 WQC HARD WINTER WHEAT FLOUR PROTEIN ANALYSIS

Michael Tilley, Ph.D. and Bruna Mattioni, Ph.D.

USDA, CGAHR, Manhattan, KS

Results of Flour Protein Analysis
Hard Winter Wheat WQC 2025 Crop Protein Analysis

	High Molecular Weight Glutenin Subunits			Polymeric/Monomeric protein ratio
	Glu-A1	**Glu-B1**	**Glu-D1**	
WQC 2401	2*	7 + 9	5 + 10	0.96
WQC 2402	1	7 + 8	5 + 10	0.86
WQC 2403	2*	7 + 8	5 + 10	1.03
WQC 2404	null	7 + 8	5 + 10	0.81
WQC 2405	2*	7 + 8	5 + 10	0.84
WQC 2406	2*	7 + 8	5 + 10	0.82
WQC 2407	2*	7 + 9	5 + 10	0.78
WQC 2408	2*	7 + 9	5 + 10	0.90
WQC 2409	1	17 +18	5 + 10	0.91
WQC 2410	2*	7 + 9	5 + 10	0.91
WQC 2411	1	17 +18	5 + 10	0.87
WQC 2412	1	7 + 8	5 + 10	0.91
WQC 2413	2*	7^{OE} +8	5 + 10	0.93
WQC 2414	2*	7 + 9	5 + 10	0.87
WQC 2415	1	7 + 9	5 + 10	0.87
WQC 2416	2*	7 + 8	2 + 12	0.84
WQC 2417	2*	7 + 9	5 + 10	0.89
WQC 2418	2*	7 + 9	5 + 10	0.88
WQC 2419	2*	7 + 8	5 + 10	0.84
WQC 2420	2*	7 + 9	5 + 10	0.84
WQC 2421	1	17 +18	5 + 10	0.85
WQC 2422	1	7 + 9	5 + 10	0.78
WQC 2423	2*	7 + 9	5 + 10	0.81
WQC 2424	2*	7 + 9	5 + 10	0.86
WQC 2425	1	7 + 8	5 + 10	0.74
WQC 2426	2*	7 + 8	5 + 10	0.77

Procedure for the separation of glutenins for determination of HMW glutenin subunits on Agilent 2100 Lab-on-a -Chip- bioanalyzer

- Weight 100 mg of flour and add 1ml of 0.3 M Sodium Iodide solution containing 7.5 % isopropanol
- Include controls Karl 92 (1, 7+8, 5+10) and Chinese spring (null, 7+8, 2+12)
- Vortex shake for 15 min. and centrifuge for 5 min at 12,000 x g at room temp. Discard the supernatant.
- To the pellet add 1ml of deionized water, vortex shake for 5 min and centrifuge as above.
- Discard the supernatant.
- To the pellet add 1ml of 12.5 mM sodium borate buffer pH 10.0 + 2% SDS + 2% BME.
- Vortex shake for 30 minutes, centrifuge for 5 min. at 12,000 x g at room temperature and collect the supernatant (contains glutenins).
- Glutenins were separated on the 2100 Bioanalyzer (Agilent Technologies, Palo Alto, CA, USA), microfluid electrophoresis, following the manufacturer's instructions. Using the Protein 230 assay kit (Agilent Technologies, Palo Alto, CA, USA) was used for HMW-GS identification.

Overexpression of Glu-Bx1 7 (7^{OE}) was defined if the proportion of HMW-GS 7 to the total amount of HMW-GS was 35% or greater as described by Ragupathy et al. (2008).

Determination of polymeric to monomeric protein ratio

Protein extraction

- Weight 10 mg flour and add 1 ml 0.05M Sodium phosphate buffer (Na_2HPO_4), pH 6.9, containing 0.5% SDS (w/v)
- Vortex the samples for 15 min.
- Sonicate the samples in ice for 15s at a power output of 6W. Collect the supernatant (contains total protein).
- Filter the supernatant in a 0.45 µm filter and analyze samples by size-exclusion HPLC (SE-HPLC).

SE-HPLC

- SE-HPLC was conducted using a 300.0 x 7.8 mm Yarra™ SEC-4000 column (Phenomenex, Torrance, CA) on an Agilent 1100 HPLC system, kept at 30°C, with a constant gradient composed of 50/50 ratio of HPLC grade water + 0.1% Trifluoroacetic acid (TFA) and Acetonitrile + 0.1% TFA flow rate of 0.50 ml/min during 30 min.
- The chromatograms were manually integrated. The area of the first peak corresponds to polymeric proteins and the area of the second peak to monomeric proteins. The ratio was determined using the areas of the chromatograms.

2025 WQC HARD WINTER WHEAT GLUTOPEAK ANALYSIS

Rhett Kaufman, Ph.D. and Michael Tilley, Ph.D.

USDA-ARS, CGAHR, Manhattan, KS

Objective:

Evaluation of Winter Wheat Samples by the GlutoPeak instrument with comparison to the WQC established functionality tests.

Materials and Methods:

Materials:
White flour produced Quadrumat Sr. mills from the wheat composites

Method:

There are many methods for analysis by the GlutoPeak instrument. There were two specific methods chosen for this set of testing.

Method 1. Distilled Water method (Wang et al, 2017)

9 grams of Flour
9 grams of Distilled Water solution
2700 RPM paddle speed
34°C Bowl Temperature

The liquid is weighed into the GlutoPeak bowl, then the flour/meal is added to the bowl. The bowl is placed in the machine and the procedure begins as soon as the paddle is lowered into the bowl.

Results:

The samples were analyzed using the standard and extended evaluation method from the GlutoPeak software. The measurements reported are:

PMT—Peak Mixing Time
BEM—Peak Torque
AM—Torque 15 seconds before Peak
PM—Torque 15 seconds after Peak
Peak Area—Area under curve between AM and PM (also called Aggregation Energy)
GSI—Calculated Index (BEM*Peak Area)/1000 (Wang et al., 2017)
GSI2—Calculated Index (BEM*PMT)/1000

Table 1. GlutoPeak analysis of Quadrumat Sr. produced white flour analyzed using the Distilled water method.

		PMT	BEM	AM	PM	Peak Area	GSI	GSI2
Southern Growout	25-QS02401	187	56	24	46	1415	79.2	264.6
	25-QS02402	156	53	23	44	1338	70.9	208.7
	25-QS02403	104	57	25	49	1445	82.4	150.3
	25-QS02404	194	50	22	42	1255	62.8	243.5
	25-QS02405	77	58	24	47	1479	85.8	113.9
	25-QS02406	103	62	22	52	1561	96.8	160.8
	25-QS02407	120	56	25	49	1437	80.5	172.5
	25-QS02408	184	62	30	52	1614	100.1	297.0
	25-QS02409	150	56	20	45	1317	73.8	197.6
	25-QS02410	119	56	22	45	1409	78.9	167.7
	25-QS02411	46	74	30	61	1853	137.1	85.3
	25-QS02412	51	70	30	56	1736	121.5	88.5
	25-QS02413	114	78	37	64	1986	154.9	226.4
Northern Growout	25-QS02414	69	60	21	49	1441	86.5	99.4
	25-QS02415	184	58	28	48	1508	87.5	277.5
	25-QS02416	107	58	25	51	1535	89.0	164.3
	25-QS02417	195	60	27	52	1505	90.3	293.5
	25-QS02418	123	64	26	52	1573	100.7	193.5
	25-QS02419	106	62	26	47	1525	94.6	161.7
	25-QS02420	86	62	28	50	1542	95.6	132.6
	25-QS02421	193	55	22	42	1311	72.1	253.0
	25-QS02414	69	60	21	49	1441	86.5	99.4
Montana	25-QS02422	135	64	28	51	1603	102.1	217.0
	25-QS02423	152	66	24	53	1593	105.1	242.1
	25-QS02424	97	64	26	52	1608	102.9	156.0
	25-QS02425	141	63	28	57	1682	106.0	237.2
	25-QS02426	99	63	29	53	1679	105.8	166.2

APPENDIX A
Credits and Methods

CREDITS

Milling, Sample Analysis, Ingredients and Report Preparation

Single Kernel Analysis, Kernel Size Distribution, and Test Weight	USDA/ARS/HWWQL Manhattan, KS
Flour Milling (Miag Multomat)	KSU Dept.Grain and Food Science Manhattan, KS
Wheat Grading	GIPSA, USDA Kansas City, MO
Moisture, Ash, Protein, and Minolta Flour Color	USDA/ARS/HWWQL Manhattan, KS
Mixograph, Farinograph Tests, Extensigraph, and Alveograph Tests	USDA/ARS/HWWQL Manhattan, KS
Rapid Visco-Analyzer, and Sedimentation Tests	USDA/ARS/HWWQL Manhattan, KS
Marketing Scores Sedimentation Tests	USDA/ARS/HWWQL Manhattan, KS
Flour Protein Analysis	USDA/ARS/GQSRU Manhattan, KS
Falling Number Test and Starch Damage	USDA/ARS/HWWQL Manhattan, KS
Doh-Tone 2 as Fungi α-amylase	Corbion Kansas City, MO 64111
Tortilla Evaluation	TAMU, Cereal Quality Lab College Station, TX
Alkaline Noodle Evaluation	USDA/ARS/HWWQL Manhattan, KS
Data Compilation and Final Report	USDA/ARS/HWWQL Manhattan, KS
Statistical Analysis of Bake Data	Dr. Scott Haley at CSU Fort Collins, CO

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USDA/ARS/WWQL E-202 FSHN Washington State Univ. Pullman, WA 99614	Wheat Quality Lab	**Alecia Marie Kiszonas** (509) 335-4062 alecia.kiszonas@wsu.edu
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USDA/ARS/HRSQL Harris Hall North Dakota State Univ. Fargo, ND 58105	Wheat Quality Lab	**Linda Dykes** (701)239-1412 Linda.Dykes@usda.gov
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University of Idaho 1693 S 2700 W Aberdeen, ID 83210	Wheat Quality Lab	**Sarah Windes** (208) 844-6350 Swindes@uidaho.edu

METHODS

Test Weight – AACC Approved Method 55-10. Test weight is the weight per Winchester bushel expressed to the nearest tenth of a pound. This method determines the weight of dockage-free grain.

Weight per Hectoliter - Weight per Winchester Bu x 1.292 + 1.419 (all wheats except Durum) expressed to the nearest tenth of a kilogram. Example: 60.5 lb/bu x 1.292 + 1.419 = 79.6 kg/hl.

1000 Kernel Weight - The weight in grams of 300 kernels of wheat, determined by SKCS, and converted to 1000.

Wheat Kernel Size Test - 200g of wheat are placed on the top sieve of a stack of 3 (8inch diameter) Tyler No. 7, 9 & 12 sieves (2.79, 1.98, & 1.40 mm openings; US Equiv. No. 7, 10 & 12) and sifted for 60 seconds on a Ro-Tap sifter. The percentage remaining on each sieve is reported.

Wheat and Flour Moisture - AACC Approved Method 44-15A. Wheat (ground in Falling Number 3303 burr-type mill to prevent drying before grinding) or flour is dried in a forced air oven at 130^0 C for one hour.

Wheat and Flour Protein - AACC Approved Method 46-30 wheat meal and flour. Combustion nitrogen method.

Ash - AACC Approved Method 08-01. Sample remaining after ignition is expressed as percent.

Experimental Milling Test - Brabender Quadrumat Sr. is used to mill wheat samples with 15% of tempering moisture for more than 16 hours and feed rate is 150 g/min.

Miag Multomat (Small Scale) Milling - Each coded variety is cleaned with a Carter dockage tester, placed in drums, and sampled for physical wheat tests and analysis. Each variety is then tempered using a double cone blender with enough added water to bring the wheat moisture to 16%. The tempered wheat is held in drums for approximately 20 hours before milling. Milling is performed on the Miag Multomat, which consists of 3 breaks, 5 reductions, and a bran duster. Feed rate is set at 850 to 900 grams per minute. The mill is warmed up and adjusted using KSU mill mix, after which 2-3 bushels of each coded experimental sample are milled.

Break rollers are adjusted to the following releases through a U.S. 20 S.S. sieve:

First Break	50%
Second Break	50%
Third Break	clean-up

Flour yields are calculated from scale weights and expressed as percentage of total products recovered from the mill.

Flour Color – Evaluated using Minolta Chroma Meter. The flour color results are reported in terms of 3-dimensional color values based on L*, a*, and b*.

Wet Gluten - AACC Approved Method (38-12). 10 g. of flour and 5.2 ml. of 2% salt solution are mixed in a Glutomatic test chamber for 20 seconds and then washed for 5 minutes to separate the gluten and the soluble starch products. The gluten ball is divided and placed in a centrifuge for one minute to remove excess water. Percent Wet Gluten is calculated as weight of the centrifuged gluten x 10.

Dry Gluten - Gluten from the wet gluten test is dried between two heated, Teflon coated plates for approximately 4 minutes. Percent Dry Gluten is calculated as weight of the dry gluten x 10.

Falling Number - AACC Approved Method 56-18A. Determination is made by the method of Hagberg (Cereal Chemistry 38:202, 1961) using 7g of flour.

Wheat Hardness - AACC Approved Methods 39-70A (NIR hardness) and 55-31 (using Perten 4100 Single Kernel Characterization System).

Damaged Starch - AACC Approved Method 76-33 using SDmatic. Results are given in an iodine absorption index percentage (AI%) and AACC 76-31 results converted from the testing.

Flour Treatment - Fungal alpha-amylase is added to the flour by each baking cooperator.

Mixograph and Farinograph - AACC Approved Methods (54-40A and 54-21) respectively. These instruments measure and record the resistance to mixing of a flour-and-water dough. The recorded curve rises to a "peak" as the gluten is developed and then falls as the gluten is broken down by continued mixing. Curves made by the two instruments are not directly comparable.

The time required for a Mixograph or Farinograph curve to reach the "peak" is an estimate of the amount of mixing required to properly develop the dough for handling and baking. The rate at which a curve falls and narrows after the peak and stability of peak height on

either side of the peak are indicators of mixing tolerance. Terms used to describe the Farinograph curve or "farinogram" include:

Absorption - Reported on a 14% moisture basis. Percentage of water required to center the curve on the 500 Farinograph Unit (FU) line at maximum dough consistency (peak). This may not be optimum absorption in a bakery, because baking ingredients influence absorption and flours vary in "slacking-out" during fermentation.

Peak Time - Also called Mixing Time or Dough Development Time. Time (minutes) required for the curve to reach its full development or maximum consistency. High peak values are usually associated with strong wheats that have long mixing requirements.

Stability - Also called Tolerance. This is the time (minutes) that the top of the curve remains above the 500 FU line. Greater stability indicates that the flour can stand more mixing abuse and longer fermentation.

Rapid Visco-Analyzer Test – AACC Approved Methods (61-02).

Sedimentation Test - AACC Approved Methods (56-60).

Alveograph – AACC Approved Methods (54-30A). The instrument measures resistance of dough extension, extensibility, and dough strength. A sheet of dough of definite thickness prepared is expanded by air pressure into a bubble until it is ruptured. The internal pressure in bubble is recorded on automated integrator. P = Tenacity (resistance to extension), L = extensibility, W = baking strength (curve area), P/L = curve configuration ratio, G = swelling index (the square root of the volume of air needed to rupture the bubble), Ie = P200/P, elasticity index (P200: pressure 4 cm from the start of the curve, Ie will be 0 if the extensibility is shorter than 4 cm).

Extensigraph – AACC Approved Method (54-10). The Extensograph® -E stretches the dough prepared by a modified method published in AACC International's Cereal Chemistry (86(5):582-589). The instrument measures resistance of dough extension (R), extensibility (E), maximum resistance (Rmax), and energy (W).

Cumulative Ash and Protein Curves

Ideally, the miller would like to separate wheat bran from endosperm, and reduce endosperm particle size, without producing any bran powder at any stage of the milling process. Unfortunately, current milling technology does not allow this "ideal" situation to occur, and once bran powder is produced it goes into the flour and can never be removed. Ash determination has traditionally been used as an analytical tool in managing the extraction rate of wheat during the milling process. Ash determination consists of burning a known mass of the material to be analyzed and then measuring the residue. Since burning destroys everything but the mineral components, the mass of the residue provides an indication of the contribution that minerals made to the original material. The application of this method to determining bran content of flour has been justified by the fact that

endosperm has a lower mineral content than bran. Ash content is lowest in the center of the kernel and increases toward the outer parts because the bran layer contains several times more minerals than pure endosperm.

Many millers have flour refinement specifications (ash content or flour color) that must be met. Therefore, the overall milling value of a wheat sample is determined not only by flour yield, but also flour refinement. A commonly used index of wheat milling value is the cumulative ash curve (Lillard and Hertsgaard 1983). Cumulative ash curves are determined by arranging millstreams in ascending order of ash content, and tabulating the ash content of the total flour produced with the addition of successive millstreams. Wheat that gives low ash content at low extraction, and a slow rate of ash content increase with increasing extraction rate, has a high milling value because of the potential to produce a high percentage of patent flour, which usually sells for a premium in many markets. It should be noted that several authors have indicated that ash curves can be influenced by hardness, variety, whole grain ash, and milling system (Seibel 1974; Posner and Deyoe 1986; Li and Posner 1987, 1989). Natural endosperm ash is typically regarded to be 0.30%; anything above that is generally considered to be due to the milling process.

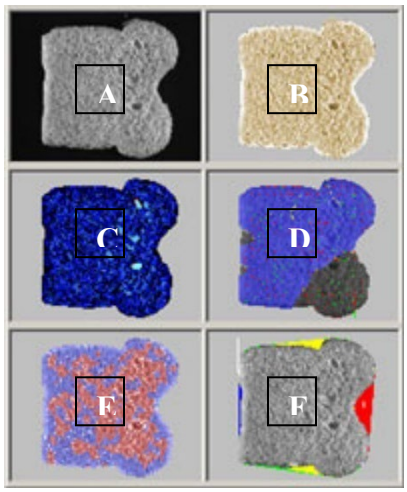
Similarly, cumulative protein curves are determined by arranging millstreams in ascending order of protein content, and tabulating the protein content of the total flour produced with the addition of successive millstreams. Wheat that gives high protein content at low extraction, and a fast rate of protein content increase with increasing extraction rate, has a high milling value because high protein flour typically sells for a premium in many markets.

LI, Y. Z., and POSNER, E. S. 1987. The influence of kernel size on wheatmillability. Bull. Assoc. Operative Millers November: 5089-5098.
LI, Y. Z., and POSNER, E. S. 1989. An experimental milling techniquefor various flour extraction levels. Cereal Chem. 66:324-328.
LILLARD, D.W. and HERTSGAARD, D.M. 1983. Computer analysis and plotting of milling data: HRS wheat cumulative ash curves. Cereal Chem. 60:42-46.

C-Cell Image Analysis

Pup loaves were baked in duplicate and evaluated with the C-Cell system and its image analysis software (Campden & Chorleywood Food Research Association (CCFRA) and Calibre Control International©) at the USDA-ARS Hard Winter Wheat Quality Laboratory (HWWQL) in Manhattan, KS. Two slices from each loaf were scanned: with the break facing the observer, slice 4 and 5 from the right end of the loaf were selected and evaluated with the break side of the slice oriented on the left. Images of the internal grain and crumb structure of each slice represent only the fourth slice of replicate 1, and are shown in the report. Selected numerical data from the image analysis of slice 4 represent the average of slice 4 from replicates 1 and 2, and are shown in the report. General capabilities of the instrument and image analysis are shown below:

Images:



(A) Raw Image *(B) Brightness Correction Image*

(C) Cell Image *(D) Elongation Image*

(E) Cell Distribution Image *(F) Cell Size & Shape Image*

Data:

Forty-eight (48) individual measurements are presented in the data display screens and are saved to the database.

Cell Size: Numbers and dimensions of cells and holes are measured. Wall thickness & coarse/fine clustering.

Cell Elongation and Orientation: Cell alignment and elongation, circulation and curvature

Dimensions: Sample area, height, breadth, ratios and wrapper length.

Brightness: Sample brightness and cell contrast.

Shape: Various physical features including, break, concavity and roundness.

Slice Area: The total area of a product slice (mm^2).

Slice Brightness: The mean grey level (0-255) of pixels within the slice. The value is lower for products with a darker crumb and for products with larger or deeper cells that contribute to greater shadows. The measurement provides a useful indication of product reflectance.

Number of Cells: The number of discrete cells detected within the slice. Higher values may be due to a finer structure or a larger total slice area. The cells are shown in the Cell image. When interpreting this image, cells only touching diagonally are considered to be discrete.

Wall Thickness: The average thickness of cell walls (mm). for bright slices, saturation of some regions may be interpreted as thick walls. Walls close to the edge of the slice are given a reduced weighting in the calculation.

Cell Diameter: The average diameter of cells (mm), based on measurements of the average cell area. This is a good general purpose indicator of the coarseness of the texture, but does not take the depth of cells into account.

Non-Uniformity: A measure of the lack of uniformity between fine and coarse texture (including holes) across the slice. High values indicate less uniformity of texture. The value is useful for comparing slices of similar types of product, but comparisons between products of differing type tend to be less easily interpreted.

Average Cell Elongation: The average length to breadth ratio of cells, independent of their relative orientation. Lower weighting is given to cells close to the edge of the slice. Values close to 1 indicate rounded cells. Higher values indicate greater elongation.

Cell Angle to Vertical (^{0}): The angle (degrees) of the direction of Net Cell Elongation, measured clockwise from the slice vertical. Lower weighting is given to cells close to the edge of the slice. Values are given in the range of -90 to +90 degrees. Values close to 0 represent a vertical orientation. Values close to + or – 90 represent a horizontal orientation.

Collaborators' Baking Test Profiles and Other Information

2025 WQC COLLABORATORS' BAKING TEST PROFILES AND OTHER INFORMATION

Coop	No.	Test Methods	Flour Wt (g)	Est Dough Wt (g)	Mixing Tolerance	Fermentation Time (min)	Oven Temp (F)	Baking Time (min)
A	1	Pup-loaf Straight Dough	100	176	Mixograph	90	400	25
B	2	Sponge and Dough	675	540	Mixing Series	210 (Sponge) + 10 (fermentation)	410	23
C	3	Pup-loaf Straight Dough	100	165	Mixograph	90	400	25
D	4	Pup-loaf Straight Dough	100	172	Mixograph	180 Fermentation + 60 Proof	420	25
E	5	Pup-loaf Straight Dough	100	170	Mixograph	120	420	18
F	6	Pup-loaf Straight Dough	100	151	Mixograph	100	410	21
G	7	Sponge and Dough	600	480	Other	240 (Sponge time) and 45 (fermentation)	420	20
H	8	Pup-loaf Straight Dough	100	230	Mixograph	90	425	21
I	9	Pup-loaf Straight Dough	100		Farinograph	120	425	25
J	10	Sponge and Dough	630	500	Mixing Series	330	410	25
K	11	Sponge and Dough	700	500	Farinograph		425	25
L	12	Straight Dough	200	170	Mixograph	180	419	24
M	13	Straight Dough	700	525	Farinograph	135	400	25
N	14	Pup-loaf Straight Dough	100	170	Farinograph	120	400	24
O	15	Straight Dough	700	500	Farinograph		420	20

APPENDIX B
HWWQC Technical Board and Goals for HWW Breeders

Hard Winter Wheat Quality Council

2025 Technical Board Officers

CHAIR:	**Gang Guo,** Ardent Mills
VICE CHAIR:	**Kevin Kloberdanz,** Grain Craft
SECRETARY:	**Scott Baker,** Bay State Milling
MEMBER:	**Josh Reasoner,** ADM Milling
MEMBER:	**Rhett Kaufman,** USDA/ARS

Hard Winter Wheat Quality Council (HWWQC)

Charter
Revised and Approved (February 20, 2003)

Mission, Policy, and Operating Procedure

The mission of the HWWQC is to provide a forum for leadership and communication in promoting continuous quality improvement among the various elements of the community of hard winter wheat interests. The HWWQC will provide an organization structure to evaluate the quality of hard winter wheat experimental lines and cultivars that may be grown in the traditional growing regions of the United States. The HWWQC also will establish other activities as requested by the membership. The HWWQC operates under the direction and supervision of the Wheat Quality Council (WQC).

Objectives

- Encourage wide participation by all members of the hard winter wheat industry.
- Determine, through professional consulting expertise, the parameters and ranges that adequately describe the performance characteristics that members seek in new and existing cultivars.
- Promote the enhancement of hard winter wheat quality in new cultivars.
- Emphasize the importance of communication across all sectors and provide resources for education on the continuous quality improvement and utilization of hard winter wheat.
- Encourage the organizations vital to hard winter wheat quality enhancement to continue to make positive contributions through research and communications.
- Offer advice and support for the U.S.D.A. - A.R.S. Hard Winter Wheat Quality Laboratory in Manhattan, KS.

Membership

- The membership of the HWWQC will consist of members of the WQC.

HWWQC Technical Board

- The Technical Board shall be the administrative unit responsible for managing the functions of the HWWQC.
- The Technical Board shall consist of five members, elected from the membership, to serve three-year terms.
- Officers of the technical board shall consist of a chair, vice-chair, and secretary.
- Each officer serves three years in his or her office.
- Terms start the day after the annual meeting of the HWWQC.
- The vice-chair generally replaces the chair at the conclusion of the chair's term and the secretary generally replaces the vice-chair at the conclusion of the vice-chair's term.
- Officers (normally only the secretary) shall be elected annually at the annual meeting of the HWWQC by nomination and majority vote.
- Any eligible member may be reelected after being out of office for one year.
- Vacancies that occur during the term of office of the members of the technical board shall be filled by nomination and majority vote of the remaining members of the technical board and the WQC Executive Vice President. The appointee will serve the remaining term of the vacancy (up to three years).
- Exceptions to the above may be granted if voted on by the Technical Board or by majority vote of the HWWQC at the annual meeting.

Duties of the Technical Board

- The chair shall be responsible to establish a meeting place and preside at all meetings of the technical board and Wheat Quality Council (selected elements of the General Meeting).
- The vice-chair shall preside at meetings in absence of the chair and assume such duties as may be assigned by the chair of the technical board.
- The secretary shall be responsible for taking minutes of the technical board meetings.
- The Technical Board will direct the Executive Vice President of the WQC on disbursement of allocated funds.
- The chair shall be responsible for communicating budget needs to the Executive Vice President.
- The Technical Board is responsible for presenting budget updates to the general membership at the annual meeting.

Compensation

- Technical Board members shall serve without compensation.

Expenses

- The WQC Executive Vice President for some technical board functions may authorize certain paid expenses.

Hard Winter Wheat Quality Evaluation and Advisory Committee

Committee Purpose

A technical committee entitled "Hard Winter Wheat Quality Evaluation and Advisory Committee" shall be established and consist of the five technical board members and key WQC members working on hard winter wheat. Those members should include, but are not limited to:

- The director of the USDA Hard Winter Wheat Quality Laboratory, Manhattan, KS.
- At least one hard winter wheat breeder from the Great Plains area.
- At least one cooperator from hard winter wheat milling or baking laboratories.
- The senior scientist/editor responsible for the hard winter wheat quality annual report.

Evaluation and Responsibilities

- Establish procedures and requirements for the annual grow out (if applicable), handling, evaluation and reporting of the experimental test line quality evaluation program.
- Annual approval of the samples submitted by hard winter wheat breeders.
- The collection milling and reporting of the experimental and check samples.
- Distribution of samples to cooperators (member companies willing to conduct testing and baking evaluations on the samples prepared)
- Preparation of an annual quality report.

Sample/Locations

- Each breeder entity shall have the privilege of submitting two experimental test lines and one check cultivar each year for evaluation. If slots are available by some breeders not submitting the full allotment, other breeders may submit more than two up to a maximum of 30 samples annually.

Annual Meeting

- The annual meeting of the HWWQC shall coincide with the annual meeting of the WQC. If for some reason the WQC annual meeting is not held, it shall be the duty of the technical board chair to establish an annual meeting time and place.
- The purpose of the meeting shall be to discuss the results of the cooperators quality testing program, elect board members and carry on other business as required by the HWWQC.
- The Technical Board may establish other meetings determined to be necessary.

Finances and Budget

- The executive board of the WQC shall designate the finances required to meet the operating expenses of the HWWQC.
- The budget shall be presented for membership approval at the annual meeting.

Amendments

- Amendments to the policy and operation procedure of the HWWQC can be made by majority vote of the HWWQC members.
- The proposed changes must be submitted in writing and must be in the hands of the membership two weeks prior to voting on the change.

Outlined Goals for Hard Winter Wheat Breeders

Developed by the Grain Trade, Operative Millers, and Mill Chemists Subcommittees of the Wheat Quality Council Hard Winter Wheat Technical Committee

1. Adaptability. Varieties should be adaptable and retain their quality integrity over a large geographic area.

2. Varieties should be resistant to diseases, to insect infestation (including stored grain insects), and to sprouting.

3. Emphasize quality evaluation in earlier generations. Obtain milling and baking data before F7. Grain and Texture should be considered along with loaf volume, absorption, mixing, and dough properties when evaluating baking quality.
4. Kernel Characteristics:
   A. Visual Appearance typical of class.
   B. Hardness significantly greater than soft wheat, but not so hard that milling or flour properties are negatively influenced.
   C. Uniformly large, plump, vitreous.

	Objective	Minimum Acceptable
Bushel Weight (lb.)	60+	58
Thousand Kernel Wt. (g)	30+	24
Over 7 Wire (%)	60+	50

5. Milling Performance. Should mill easily to produce a high extraction (yield) of quality flour. Reduction, sifting, and stock-handling consistent with class history.

Performance on KSU Pilot Mill

	Objective	Acceptable
Straight Grade Extraction % at .48% ash	76	74 (minimum)
Str.-Gr. Agtron Color	50	40 (minimum)
Str.-Gr. Flour Ash (%)	0.46	0.50 (maximum)

6. Gluten Strength-Mixing Time. About 60% strong and 40% mellow should be acceptable in the seeded acreage. A reasonably broad range of gluten strength

is needed to meet current demands of various flour users. One variety or gluten type is undesirable.

7. Improved Mixing Tolerance with ‘extensible gluten’, not bucky or tough.

APPENDIX C
Hard Red Winter Wheat Quality Targets

RECOMMENDED* QUALITY TARGETS FOR HARD RED WINTER WHEAT

HWW Quality Targets Committee
Approved February, 2006

** "The purpose of Recommended Quality Targets (RQT) for Hard Red Winter Wheat (HRW) is to provide specific quality 'goals' for the breeding community, wheat producers, and marketing programs in order to assist and guide the decisions needed to maintain the consistency and end-use quality of the U.S. HRW market class. The RQT will be dynamic over time in direct response to the primary needs of the marketplace (domestic and foreign), and the needs of the U.S. industry to breed, produce and market wheats to meet market needs. The RQT should NOT be used as essential criteria for variety release decisions in breeding programs, or as marketing/grading standards for private companies or federal/state agencies. This* ***Statement of Purpose*** *must accompany all published forms of the RQT." HWWQT Committee, 2006*

Quality Parameter (End-Use: Pan Bread)	Recommended Target Value
Wheat	
Test Weight (lb/bu)	***> 60***
SKCS-Hardness Index (SK-HI)	***60 – 80***
SK-HI Standard Deviation	***< 17.0***
SKCS-Weight (SK-WT, mg)	***> 30.0***
SK-WT Standard Deviation	***< 8.0***
SKCS-Diameter (SK-SZ, mm)	***> 2.40***
SK-SZ Standard Deviation	***< 0.40***
Protein Content (%, 12% mb)	***> 12.0***
Ash Content (%, 12% mb)	***< 1.60***
Falling Number (sec)	***> 300***
Straight Grade Flour Yield (%)	***> 68***
Flour	
Flour Color L-Value (Minolta Colorimeter)	***> 90***
Gluten Index	***> 95***
Sedimentation Volume (cc)	***> 40***
Farinograph:	
Water Absorption (%, 14% mb)	***62+***
Peak Time (min)	***4.00 – 8.00***
Stability (min)	***10.00-16.00***
Mixograph:	
Water Absorption (%, 14% mb)	***62+***
Peak Time (min)	***3.00 – 6.00***
Mixing Tolerance (HWWQL Score, 0-6)	***3.0***
Straight Dough Pup Method:	
Water Absorption (%, 14% mb)	***62+***
Mix Time (min)	***3.00 – 5.00***
Loaf Volume (cc)	***> 850***
Crumb Score (HWWQL Score, 0-6)	***> 3.0***

CONTACT:
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Hard Winter Wheat Quality Laboratory
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APPENDIX D
Hard White Wheat Quality Targets Adopted from PNW for Great Plains

Hard White Wheat Quality Targets

Dual Purpose -- Chinese Noodles and Western Pan Bread

Updated on March 1, 2002 at Hard White Wheat Quality Targets Meeting
Wheat Marketing Center, Portland, Oregon

	Chinese Hard-Bite Noodles (1)	**Pan Bread**
Wheat Quality Parameter		
Test Weight (lb/bu)	60 Minimum	60 Minimum
Kernel Hardness (SKCS 4100)	65 - 90	65 Minimum
Kernel Diameter (mm) (SKCS 4100)	2.5 Minimum	2.5 Minimum
Falling Number (seconds)	300 Minimum	300 Minimum
Protein (%, 12% mb)	11-15.0	11.5-14.0
Ash (%, 14% mb)	1.4 Maximum	1.6 Maximum
PPO Level by L-DOPA (WWQL Method)	0	N/A
Flour Quality Parameter		
Protein (%, 14% mb)	10-13.5	10.2-13
Ash (14% mb)	0.38-0.45	N/A
Patent Flour Yield at 0.4% Ash (%)	60 (by Buhler)	N/A
Straight-Grade Flour Yield at 0.45% Ash (%)	70 (by Buhler)	N/A
L* (Minolta Colorimeter CR 310)	91 Minimum	N/A
Wet Gluten (%, 14% mb)	30 Minimum (2)	28
Farinograph Absorption (%, 14% mb)	60 Minimum (2)	60
Farinograph Stability (minutes)	12 Minimum (2)	12
Amylograph Peak Viscosity (Bu) (3)	500-850	500 minimum
Mixograph Peak Time (minutes)	N/A	3-7 @ 5.5 mm peak ht.
Mixograph Absorption (%)	N/A	60
Chinese Raw Noodle Quality Parameter (Refer to WMC Protocol) (4)		
Chinese Raw Noodle Dough Sheet L*24 h	72 Minimum	N/A
Chinese Raw Noodle Dough Sheet L*0-L*24	10 Maximum	N/A
Chinese Raw Noodle Dough Sheet b* 24 h	25 Maximum	N/A
Cooked Noodle Hardness (g)	1250 Minimum (2)	N/A
Pan Bread Quality Parameter		
Pup Loaf Volume (cc)	N/A	900 @11% flour protein

Notes:

(1) Chinese raw, Chinese wet, Chinese instant fried, Philippine instant fried, Malaysia hokkien and Thai bamee noodles.

(2) Straight-grade flour of 12% protein wheat.

(3) Method: 65 g untreated flour + 450 ml deionized water.

(4) Noodle formula: straight-grade flour, 100%; water, 28%; and sodium chloride, 1.2%.
Noodle sizes: 2.5 mm (width) x 1.2 mm (thickness).
Noodle textural measurement: cook 100 g noodles in 1000 ml deionized water for 5 min, rinse in 27^0C water and drain. Measure noodle texture on five noodle strands by compressing to 70% of noodle thickness with a 5-mm flat probe attached to TA.XT2 Texture Analyzer.

These end-use quality targets emphasize the broadest possible utilization of hard white wheats.

Wheat Marketing Center, Portland, Oregon

	Korean Instant Noodles	Chinese Northern-Type Steamed Bread	Hamburger/Hotdog Buns
Wheat Quality Parameter			
Test Weight (lb/bu)	60 Minimum	60 Minimum	60 Minimum
Kernel Hardness (SKCS 4100)	65 Minimum	65 Minimum	65 Minimum
Kernel Diameter (mm) (SKCS 4100)	2.5 Minimum	2.5 Minimum	2.5 Minimum
Falling Number (seconds)	300 Minimum	350-400	300 Minimum
Protein (%, 12% mb)	10-11.0	10-11.5	13-15.0
Ash (%, 14% mb)	1.4 Maximum	1.4 Maximum	1.6 Maximum
PPO Level by L-DOPA (WWQL Method)	0-0.2	0-0.2	N/A
Flour Quality Parameter			
Protein (%, 14% mb)	8.5-9.5	8.5-10.0	12.2-13.0
Ash (14% mb)	0.38-0.40	0.38-0.45	N/A
Patent Flour Yield at 0.4% Ash (%)	60 (by Buhler)	60 (by Buhler)	N/A
Straight-Grade Flour Yield at 0.45% Ash (%)	70 (by Buhler)	70 (by Buhler)	N/A
L* (Minolta Colorimeter CR 310)	91 Minimum	91 Minimum	N/A
Wet Gluten (%, 14% mb)	N/A	28-30	34.5
Farinograph Absorption (%, 14% mb)	58-60	60-62	64
Farinograph Stability (minutes)	7.5-8.5	4-6.0	15-18.0
Amylograph Peak Viscosity (Bu) (1)	800 Minimum	500 Minimum	500 Minimum
Amylograph Breakdown (Bu)	200 Minimum	N/A	N/A
Mixograph Peak Time (minutes)	N/A	N/A	4-7 @ 5.8 mm peak ht.
Mixograph Absorption (%)	N/A	N/A	64
Pan Bread Quality Parameter			
Pup Loaf Volume (cc)	N/A	N/A	980 @ 13% flour protein

Notes:
(1) Method: 65 g untreated flour + 450 ml deionized water.

APPENDIX E
WQC Business Meeting Minutes Feb. 19, 2025

Minutes for 2025 Hard Winter Wheat Quality Council

Wheat Quality Council
February 19, 2025
8:00 am, Embassy Suites Olathe Kansas

Meeting was called to order by chairman Shawn Thiele.
Welcome and opening Comments given by Dave Green and Shawn Thiele. Review of the 2024 minutes and agenda items for 2025 meeting – Shawn Thiele
Nomination and election of new members – Shawn Thiele Chairman – Scott Baker moved to elect the board as stated for 2025. Seconded by Reuben McLean. Motion passed.
Dave Green spoke about the process of getting new individuals onto the board and encouraged any interested parties to reach out to him for future consideration.
Announcing Board for 2025 – Shawn Thiele

Chairman---Gang Guo—Ardent Mills
Vice Chairman—Kevin Kloberdanz—Grain Craft
Secretary—Scott Baker—Bay State Milling
Member--Rhett Kaufman--USDA/ARS
Member--Josh Reasoner--ADM Milling

Motion to accept election of Officers- Motion by Rich Kendrick-GPAL, second by Bart Bender-Ardent Mills.

Overview of Wheat Tours – Dave Green, WQC
- Hard Winter Wheat Tour will be held May 12-15, 2025.
- Comments provided about the wheat tour opportunities for new and young people in the industry to see wheat crops in the field and really understand what's happening. Wheat tours are also a great opportunity to network and learn from others in the industry.

Overview of Milling of Wheat Samples at KSU – Shawn Thiele gave the report for Paul Blodgett, KSU Manhattan
- Milling started on October 29th, 2024, and finished on November 5th, 2024.
- Milled 23 samples. Samples were tempered to 16.5% moisture for 24 hrs.
- Average flour moisture was 14.35%
- Average flour ash was 0.51%
- Average flour protein was 11.59%
- Average Extraction was 74.97%
- Questions and discussion on lower than expected starch damage on the samples. Last year's samples were high starch damage,
-

Wheat Quality Council HRW Report for 2024 – Rhett Kaufman, USDA/ARS Manhattan
- Discussion on current and upcoming retirements through USDA and current structure of responsibilities.
- 10 Programs 23 entries across two grow-out locations in 2024.

- 16 Bake lab collaborators in 2024. USDA/ARS is always looking for more collaborators so please reach out if interested.

Review of 2024 Wheat Crop – Royce Schaneman, Plains Grains Inc.

Grow Out Program for Hard Winter Wheat – Marla Barnett, Limagrain
Soft Wheat Update – Byung-Kee Baik, USDA/ARS, Soft Wheat Quality Council
- Announced the upcoming meeting in Wooster OH. March 18,

2025 State Crop Reports
2024 Crop Conditions –
- Texas – Jackie Rudd – TX Wheat
- Oklahoma – Mike Schulte, Oklahoma Wheat Commission, Aaron Harries read the report for Mike Schulte
- Kansas – Aaron Harries, Kansas Wheat Commission
- Nebraska – Royce Schaneman, Nebraska Wheat Board
- Colorado – Brad Erker, Colorado Wheat
- South Dakota – Reid Christopherson, SD Wheat Commission-Absent from meeting, no report.
- Montana – Max Cederberg, Montana Wheat and Barley Committee

Financial Report – Dave Green, WQC
- No new money reported but enough in the budget for 2025. Membership stable.
- Hard Winter Wheat Budget is approved for this year.

Exhibitor Sessions:
Short overview from each of the exhibitors in attendance this year.
-Midland Scientific-Katy Gondring, Neo-Spectra- Seth Bryan, CW Brabender/Anton Paar-Katie Caten, TAS Inc- Kathleen Trivette
Adjourned at 9:55 am. Move to adjourn Brian Hefron-King Milling, Second- Vance Lamb, Ardent Mills

Minutes by-Kevin Kloberdanz Grain Craft

APPENDIX F

Past WQC Hard Winter Wheat Entries from 2001 to 2025

Past WQC Hard Winter Wheat Entries

2025

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
CO19D087R	25-2401	HRW	Yes	Outlaw	2024	CSU
CO200037R	25-2402	HRW	Yes	Gabriel	2024	CSU
TX18DH287	25-2403					TAMU
LCH22-7138	25-2404	HRW	Yes	LCS Troubadour AX		Limagrain
LCH21-1343	25-2405	HRW	Yes	LCS High Noon		Limagrain
KS20HD134	25-2406	HRW	Yes	KS Flintlock	2025	KSU-Hays
KS21H30	25-2407	HRW	Yes	KS Tradition	2025	KSU-Hays
SY Monument	25-2408					Check
WB4650	25-2409	HRW	Yes	WB4650	2025	Bayer/WestBred
XH4002	25-2410					Bayer/WestBred
KS22U7907.13.RS002	25-2411					USDA-Manhattan
OK20738	25-2412					OSU
OK15Bx7-8-34-20-3	25-2413					OSU
23Nord-191	25-2414					NDSU
SD20D009-9	25-2415					SDSU
SD21B102-4	25-2416					SDSU
SY Monument	25-2417					Check
NE20620	25-2418					UNL
NEB 148-42	25-2419					UNL
XH4027	25-2420					Bayer/WestBred
WB4650	25-2421	HRW	Yes	WB4650	2025	Bayer/WestBred
Yellowstone	25-2422					Check
SY Monument	25-2423					Check
MT2270	25-2424					Montana
MTS2286	25-2425					Montana
MTAX22120	25-2426					Montana

2024

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
SY Monument	24-2401					Check
XG4108	24-2402					Westbred/Bayer
WB4347	24-2403	HRW	Yes	WB4347	2024	Westbred/Bayer
WB4445CLP	24-2404	HRW	Yes	WB4445CLP	2024	Westbred/Bayer
TX18DH287	24-2405					TAMU

TX18DH313	24-2406					TAMU
OK198417C	24-2407	HRW	Yes	Orange Blossom CL+		OSU
OK20708	24-2408	HRW	Pending			OSU
KS20H124	24-2409	HRW	Yes	KS Homesteader CL+	2024	KSU-Hays
LCH21-9398	24-2410	HRW	Yes	LCS Mojo	2024	Limagrain
LCH16ACC403-1	24-2411	HRW	Yes	LCS Cowie AX	2024	Limagrain
CO19S129W	24-2412					CSU
CO19410R	24-2413					CSU
SY Monument	24-2414					Check
Yellowstone	24-2415					Check
MTS2068	24-2416	HRW	Yes	MT Meadowlark	2024	Montana
MTV2164	24-2417					Montana
SY Monument	24-2418					Check
23Nord-181	24-2419	HRW				NDSU
23Nord-184	24-2420	HRW				NDSU
SD20B088-2	24-2421	HRW	Yes	SD Vivian	2025	SDSU
SD20D100-9	24-2422					SDSU
XG4108	24-2423					Westbred/Bayer

2023

Entry ID	Entry No.	Entry Class	Released	Release Name	Release Year	Program
SY Monument	23-2401					Check
CO18035RA	23-2402					Colorado
CO18042RA	23-2403					Colorado
CO18D007W	23-2404	HWW	yes	Telluride		Colorado
OK15MASBx7 ARS 8-19-18-4	23-2405					Oklahoma
OK16107123-19-9	23-2406					Oklahoma
OK19225	23-2407					Oklahoma
LCH19DH-152-6	23-2408	HRW	yes	LCS Radar	2023	Limagrain
LCH16ACC421-64	23-2409	HRW	yes	LCS Warbird AX	2023	Limagrain
KS16DH0010-17	23-2410	HRW	yes	KS Mako	2023	KSU-Manhattan
KS19H10	23-2411	HRW	Yes	KS Bill Snyder	2023	KSU-Hays
XF4412	23-2412					Westbred (Bayer)
XF4402	23-2413					Westbred (Bayer)
WB4422	23-2414	HRW	Yes	WB4422	2022	Westbred (Bayer)
TX18A001119	23-2415					Texas AM
TX18A001132	23-2416					Texas AM
SY Monument	23-2417					Check
21Nord-160	23-2418	HRW	No			NDSU
XF4102	23-2419					Westbred (Bayer)

SD18B072-2	23-2420					SDSU
SD19B033-2	23-2421					SDSU
NE16562	23-2422					Nebraska
NW15443	23-2423					Nebraska
Yellowstone	23-2424					Check
SY Monument	23-2425					Check
MT2019	23-2426					Montana
MTCL2010	23-2427					Montana
MTF20189	23-2428	HRW	Yes	MT Cash	2023	Montana

2022	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
Jagalene_CK	22-2401					Check
SY Monument_CK	22-2402					Check
19Nord-124_ND	22-2403	HRW	no			NSDU
SD15007-11_SD	22-2404					SDSU
SD18B025-8_SD	22-2405	HRW	Yes	SD Pheasant	2023	SDSU
NE17443_NE	22-2406					Nebraska
NE17441_NE	22-2407					Nebraska
WB4727_WB	22-2408	HRW	Yes	WB4727	2022	Westbred
SY Monument_CK	22-2409					Check
Jagalene_CK	22-2410					Check
LCH18-9027_LG	22-2411	HWW	yes	LCS White Lightning	2022	Limagrain
TX16M9216_TX	22-2412	HRW	yes	GO 9216H	2022	TAMU
BASF7_BF	22-2413					BASF
BASF12_BF	22-2414					BASF
WB4523_WB	22-2415	HRW	Yes	WB4523	2022	Westbred
WB0433004_WB	22-2416					Westbred
OK18510_OK	22-2417	HRW	yes	High Cotton	2023	Oklahoma
OK16107125C-17HR-2_OK	22-2418					Oklahoma
OKP17D101A666_OK	22-2419					Oklahoma
KS18H111-3_KH	22-2420	HRW	yes	KS Territory	2022	Kansas_Hays
CO16SF027_CO	22-2421	HRW	yes	Amplify SF	2021	Colorado
CO18D297R_CO	22-2422	HRW	yes	Sheridan	2024	Colorado
KS13DH0041-35_KM	22-2423	HRW	yes	KS Providence	2022	Kansas_Manhattan
SY Monument_CK	22-2424					Check
Yellowstone_CK	22-2425					Check
MTFH1908_MT	22-2426					Montana
MTS1908_MT	22-2427					Montana
MTCL19151_MT	22-2428	HRW	yes	CS Bridger CLP	2023	Montana

2021	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Jagalene	21-2401					Check
19NORD122	21-2402	HRW	no			NDSU
19NORD127	21-2403	HRW	no			NDSU
10BC329-17-5	21-2404	HRW	yes	AP Bigfoot	2021	AgriPro(Syngenta)
NHH17450	21-2405	HRW	no			UNL
NHH17612	21-2406	HRW	no			UNL
SD12DHA01373	21-2407	HRW	yes	SD Midland	2021	SDSU
SD15035-2	21-2408					SDSU
LCH18-7071	21-2409	HRW	yes	LCS Steel AX	2021	Limagrain
SY Monument	21-2410					Check
Jagalene	21-2411					Check
LCH17-4196	21-2412	HRW	yes	LCS Runner	2021	Limagrain
SYMonument	21-2413					Check
OK15MASBx7 ARS 8-29	21-2414	HRW	yes	Paradox	2023	OSU
AP Roadrunner	21-2415	HRW	yes	AP Roadrunner	2020	AgriPro(Syngenta)
OK15DMASBx7 ARS 6-8	21-2416	HRW	yes	Firebox	2023	OSU
CO13007-F6R	21-2417					CSU
CO16D1487	21-2418					CSU
TX15M8024	21-2419	HRW	yes	Amigos	2021	Texas A&M
XE4101	21-2420	HRW	yes	WB4422	2022	Westbred(Bayer)
WB4401	21-2421	HRW	yes	WB4401	2020	Westbred(Bayer)

2020	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Byrd	20-2401					Colorado
Jagalene (CC01)	20-2402					Colorado
CO14A055-258	20-2403	HRW	yes	Kivari AX	2020	Colorado
CO15D098R	20-2404	HRW	yes	Steamboat	2020	Colorado
CO16SF070	20-2405					Colorado
Jagalene (CC02)	20-2406					BASF
BASF1	20-2407					BASF
BASF2	20-2408					BASF
Jagalene (CC03)	20-2409					Limagrain
DH11HRW55-4	20-2410					Limagrain
LCH13DH-47-1675	20-2411	HRW	yes	LCSJULEP	2020	Limagrain
LCH15ACC-13-4	20-2412	HRW	yes	LCSPHOTONAX	2020	Limagrain
Jagalene (CC04)	20-2413					Kansas-Hays
Danby	20-2414					Kansas-Hays
KS15H137-2-2	20-2415	HRW	yes	KS Hamilton	2020	Kansas-Hays
Jagalene (CC05)	20-2416					Bayer

MODI4-6036	20-2417					Bayer
NEDI4-5064	20-2418	HRW	yes	WB4401	2020	Bayer
Jagalene (CC06)	20-2419					Oklahoma
Baker's Ann	20-2420					Oklahoma
OK14124-2	20-2421	HRW	Yes	Butler's Gold	2020	Oklahoma
OK15MASBx7 ARS8-22	20-2422		not yet			Oklahoma
OK15818	20-2423	HRW	unofficially	Gallagher Purific	2019	Oklahoma
OK12716W Comp I	20-2424		not yet			Oklahoma
Jagalene (CC07)	20-2425					Montana
Yellowstone	20-2426					Montana
MTCL1737	20-2427		no			Montana
MT1745	20-2428					Montana
Everest	20-2429					Kansas-Manhattan
Jagalene (CC08)	20-2430					Kansas-Manhattan
KS12DH0156-88	20-2431					Kansas-Manhattan
KS090616K-1	20-2432					Kansas-Manhattan
Jagalene (CC09)	20-2433					Northern States
17NORD-94	20-2434	HRW	no			North Dakota
17NORD-96	20-2435	HRW	Yes	ND Allison	203	North Dakota
NE14434	20-2436		no			Nebraska
NE14696	20-2437		no			Nebraska
PSB13NEDH-14-83W	20-2438		no			Nebraska
09BC308-14-16	20-2439	HRW	yes	AP EverRock		Syngenta
SD12DHA03282	20-2440	HRW	yes	SD Andes		South Dakota

2019	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
Byrd	19-2401	HRW	check			Colorado
Jagalene (CC01)	19-2402	HRW	check			Colorado
CO13D0787	19-2403	HRW	yes	Guardian	2019	Colorado
CO15SFD107	19-2404	HRW	yes	Fortify SF	2019	Colorado
CO15D098R	19-2405	HRW	yes	Steamboat	2020	Colorado
TAM 114	19-2406					Texas
TX14A001035	19-2407	HRW	yes	TAM 116	2021	Texas
TX14M7061	19-2408					Texas
Jagalene (CC02)	19-2409					Oklahoma
Ruby Lee	19-2410					Oklahoma
OK16D101089	19-2411	HRW	yes	Uncharted	2020	Oklahoma
OK168512	19-2412	HRW	yes	Breakthrough	2020	Oklahoma
OCW04S717T-6W	19-2413	HW	yes	Big Country	2020	Oklahoma
OK12912C-138407-2	19-2414	HRW	yes	Strad CL+	2020	Oklahoma

Jagalene (CC03)	19-2415					Limagrain
ERYTHR02420-2010	19-2416					Limagrain
Jagalene (CC04)	19-2417					Kansas-Hays
KS15H116-6-1	19-2418	HRW	yes	KS DALLAS	2019	Kansas-Hays
KS15H161-1-4	19-2419	HRW	yes	KS WESTERN STAR	2019	Kansas-Hays
Danby	19-2420					Kansas-Hays
Jagalene (CC05)	19-2421					Monsanto
MODI4-5179	19-2422	HRW	yes	WB4505	2019	Monsanto
NEDI4-5304	19-2423	HRW	yes	WB4309	2019	Monsanto
Jagalene (CC06)	19-2424					Northern States
NW13493	19-2425	HWW	yes	NW13493	2021	Nebraska
NE14691	19-2426	HRW	no			Nebraska
SD14113-3	19-2427	HRW	yes	Draper	2019	South Dakota
MTCS1601R	19-2428	HRW	yes	StandClear CLP	2019	Montana
MT1683	19-2429					Montana

2018	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
Jagalene (CC01)	18-2401					Texas
TAM 111	18-2402					Texas
TX12V7415	18-2403	HRW	yes	TAM 205	2019	Texas
LINK	18-2404					Limagrain
Jagalene (CC02)	18-2405					Limagrain
DH11HRW53-34	18-2406					Limagrain
LCI13DH-22-22	18-2407					Limagrain
MOD14-4919	18-2408				TBD	Monsanto
Jagalene (CC03)	18-2409					Monsanto
H4N13-0253	18-2410	HRW	yes	N/A	2017	Monsanto
Danby	18-2411					Kansas-Hays
Jagalene (CC04)	18-2412					Kansas-Hays
KS14H180-4-63	18-2413		no			Kansas-Hays
Jagalene (CC05)	18-2414					Syngenta
10BC107#115	18-2415					Syngenta
SY Monument	18-2416					Syngenta
08BC379-40-1	18-2417					Syngenta
Jagalene (CC06)	18-2418					Oklahoma
Ruby Lee	18-2419					Oklahoma
OK12716-159319-13	18-2420	HRW	yes	Showdown	2018	Oklahoma
OK13621	18-2421	HRW	yes	Baker's Ann	2018	Oklahoma
OK12206-127206-2	18-2422	HRW	yes	OK Corral	2019	Oklahoma
OK1059018-129332-5	18-2423	HRW	no			Oklahoma
Jagalene (CC07)	18-2424					Northern States

NE10478-1	18-2425	HRW		LCS Valiant	2019	Nebraska
NHH144913-3	18-2426	SRW	no			Nebraska
MT1564	18-2427	HWW	yes	Flathead	2019	Montana
MTS1588	18-2428	HRW	yes	Bobcat	2019	Montana
NORD58	18-2429	HWW	no			North Dakota
NORD62	18-2430	HWW	no			North Dakota
SD09227	18-2431	HRW	yes	Thompson	2017	Sourth Dakota
SD14115-5	18-2432	HRW	yes	Winner	2019	Sourth Dakota

2017	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
SY Monument	17-2401	HRW				Syngenta
SY Achieve CL2	17-2402	XWHT	yes	SY Achieve CL2	2017	Syngenta
SY 517 CL2	17-2403	HRW	yes	S 517 CL2	2017	Syngenta
Jagalene (CC01)	17-2404	HRW				Syngenta
Jagalene (CC02)	17-2405	HRW				Texas
TAM 111	17-2406	HRW				Texas
TX11A001295	17-2407	HRW	yes	TAM 115	2019	Texas
TX12M4068	17-2408	HRW	no			Texas
Byrd	17-2409	HRW				Colorado
CO12D1770	17-2410	HRW	yes	Canvas	2018	Colorado
Jagalene (CC03)	17-2411	HRW				Colorado
CO13D1783	17-2412	HRW	yes	Whistler	2018	Colorado
CO12D2011	17-2413	HDWH	yes	Breck	2017	Colorado
Jagalene (CC04)	17-2414	HRW				Kansas-Hays
KS13HW92-3	17-2415	HDWH	yes	Venada	2018	Kansas-Hays
Danby	17-2416	HDWH				Kansas-Hays
KS14HW106-6-6	17-2417	HDWH	YES	KS SILVERADO	2019	Kansas-Hays
Yellowstone	17-2418	HRW				Montana
MT1465	17-2419	HRW	yes	FourOsix	2018	Montana
Jagalene (CC05)	17-2420	HRW				Montana
MTW1491	17-2421	HDWH	yes	Numont	2020	Montana
NI13706	17-2422	HRW	no			Nebraska
NE12561	17-2423	HRW	yes	Siege	2020	Nebraska
Jagalene (CC06)	17-2424	HRW				Nebraska
Jagalene (CC07)	17-2425	HRW				Monsanto
WB4623CLP	17-2426	HRW	yes	WB4623CLP	2014	Monsanto
WB4721	17-2427	HRW	yes	WB4721	2015	Monsanto
Ruby Lee	17-2428	HRW				Oklahoma
OK13621	17-2429	HRW	yes	Baker's Ann	2018	Oklahoma
OK12D22004-016	17-2430	HRW	no			Oklahoma

OCW04S7171T-6W	17-2431	HDWH	pending		2020	Oklahoma
Jagalene (CC08)	17-2432	HRW				Oklahoma

2016	Entry No.	Entry Class	Released	Release Name	Release Year	Program
LCH13-048	16-2401	HRW				Limagrain
LCH13NEDH-12-27	16-2402	HRW				Limagrain
Jagalene (CC01)	16-2403	HRW				Limagrain
PSB13NEDH-11-26	16-2404	HRW				Limagrain
LCI13-069	16-2405	HWW				Limagrain
PSB13NEDH-14-83	16-2406	HWW				Limagrain
KS1256-6-4	16-2407	HRW	yes	Tatanka	2016	Kansas-Hays
Danby	16-2408	HWW				Kansas-Hays
Jagalene (CC02)	16-2409	HRW				Kansas-Hays
LCH13NEDH-14-53	16-2410	HWW	no			Nebraska
Jagalene (CC03)	16-2411	HRW				Nebraska
LCHNEDH-4-16	16-2412	HWW	no			Nebraska
Postrock	16-2413	HRW				Syngenta
Jagalene (CC04)	16-2414	HRW				Syngenta
AP11T2409	16-2415	HRW				Syngenta
Jagalene (CC05)	16-2416	HRW				Monsanto
HV9W10-0458	16-2417	HRW	yes	WB4515	2015	Monsanto
Jagalene (CC06)	16-2418	HRW				Oklahoma
Ruby Lee	16-2419	HRW				Oklahoma
OK10126	16-2420	HRW	yes	Spirit Rider	2017	Oklahoma
OK12D22004-016	16-2421	HRW	no			Oklahoma
OK12912C	16-2422	HRW				Oklahoma
OK13209	16-2423	HRW	yes	Green Hammer	2018	Oklahoma
Everest	16-2424	HRW				Kansas-Manhattan
Jagalene (CC07)	16-2425	HRW				Kansas-Manhattan
Larry	16-2426	HRW				Kansas-Manhattan
Zenda	16-2427	HRW				Kansas-Manhattan

2015	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Jagalene (CC01)	15-2401	HRW				Kansas-Hays
Danby (IC)	15-2402	HRW				Kansas-Hays
KS11HW39-5	15-2403	HRW	yes	Joe	2015	Kansas-Hays
Jagalene (CC04)	15-2404	HRW				Nebraska
NE1059	15-2405	HRW	yes	Ruth	2016	Nebraska
Jagalene (CC06)	15-2406	HRW				Monsanto

BZ9W09-2075	15-2407	HWW	yes	WB4575	2015	Monsanto
HV9W10-1002	15-2408	HWW	yes	WB4303	2015	Monsanto
Jagalene (CC09)	15-2409	HRW				Colorado
Byrd (IC)	15-2410	HRW				Colorado
CO11D1397	15-2411	HRW				Colorado
CO11D1539	15-2412	HRW				Colorado
CO11D1767	15-2413	HRW				Colorado
Jagalene (CC14)	15-2414	HRW				Oklahoma
Gallagher (IC)	15-2415	HRW				Oklahoma
OK11D25056	15-2416	HRW	yes	Smith's Gold	2017	Oklahoma
OK13625	15-2417	HRW	yes	Skydance	2017	Oklahoma
OK10728W	15-2418	HWW	yes	Stardust	2017	Oklahoma
Jagalene (CC19)	15-2419	HRW				Montana
Yellowstone (IC)	15-2420	HRW				Montana
MTS1224	15-2421	HRW	yes	Loma	2016	Montana
MT1265	15-2422	HRW				Montana
Ideal (IC)	15-2423	HRW				South Dakota
SD10257-2	15-2424	HRW	yes	Oahe	2016	South Dakota
LCH13DH-20-87	15-2425	HRW	yes	LCS Chrome	2015	Limagrain

2014	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
Jagalene (CC01)	14-2401	HRW				Kansas_Hays
Danby (IC)	14-2402	HWW				Kansas_Hays
KS11HW15-4	14-2403	HWW				Kansas_Hays
KS11W39-5	14-2404	HWW				Kansas_Hays
Jagalene (CC05)	14-2405	HRW				Texas_Amarillo
TAM 111 (IC)	14-2406	HRW				Texas_Amarillo
TX08A001249	14-2407	HRW				Texas_Amarillo
TX09A001194	14-2408	HRW				Texas_Amarillo
TX09D1172	14-2409	HRW				Texas_Amarillo
Jagalene (CC10)	14-2410	HRW				Colorado
Byrd (IC)	14-2411	HRW				Colorado
CO11D174	14-2412	HRW	yes	Avery	2015	Colorado
CO11D446	14-2413	HRW	yes	Langin	2016	Colorado
Jagalene (CC)	14-2414	HRW				Nebraska
Camelot (IC)	14-2415	HRW				Nebraska
NE07531	14-2416	HRW				Nebraska
NE09521	14-2417	HRW				Nebraska
Jagalene (CC18)	14-2418	HRW				Montana
Yellowstone (IC)	14-2419	HRW				Montana
MT1078	14-2420	HRW				Montana

MT1138	14-2421	HRW				Montana
Jagalene (CC22)	14-2422	HRW				Oklahoma
Ruby Lee (IC)	14-2423	HRW				Oklahoma
OK09125	14-2424	HRW	yes	Bentley	2015	Oklahoma
OK10126	14-2425	HRW	yes	Spirit Rider	2017	Oklahoma
Jagalene (CC26)	14-2426	HRW				Kansas_Manhattan
KanMark	14-2427	HRW				Kansas_Manhattan
06BC722#25	14-2428	HRW	yes	SY Flint	2015	Agripro
06BC796#68	14-2429	HRW	yes	SY Sunrise	2015	Agripro

2013	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
Check Blend (check)	13-2401	HRW				Limagrain
LCH08-80	13-2402	HRW				Limagrain
LCS Mint	13-2403	HRW	yes	LCS Mint	2012	Limagrain
Danby (check)	13-2404	HWW				Kansas-Hays
Oakley CL	13-2405	HRW	yes	Oakley CL	2013	Kansas-Hays
KS10HW78-1	13-2406	HWW				Kansas-Hays
Lyman (check)	13-2407	HRW				South Dakota
SD08200	13-2408	HRW				South Dakota
SD09192	13-2409	HRW				South Dakota
Postrock (check)	13-2410	HRW				Agripro
04BC574-2	13-2411	HRW	yes	SY Monument	2014	Agripro
Millennium (check)	13-2412	HRW				Nebraska
NE09521	13-2413	HRW				Nebraska
NE08499	13-2414	HRW				Nebraska
Yellowstone (check)	13-2415	HRW				Montana
MT1090	13-2416	HRW				Montana
MTW08168	13-2417	HWW	yes	WB3768	2013	Montana
Ruby Lee (check)	13-2418	HRW				Oklahoma
Doublestop CL+	13-2419	HRW	yes	Doublestop CL+	2013	Oklahoma
OK09125	13-2420	HRW	yes	Bentley	2015	Oklahoma

2012	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
WB-Stout (check)	12-2401	HRW				Westbred
HV9W07-1028	12-2402	HRW				Westbred
Millennium (check)	12-2403	HRW				Nebraska
NW07505	12-2404	HWW				Nebraska
NE06545	12-2405	HRW	yes	Freeman	2012	Nebraska

NE06607	12-2406	HRW				Nebraska
Byrd (check)	12-2407	HRW				Colorado
Snowmass (check)	12-2408	HWW				Colorado
CO07W245	12-2409	HWW	yes	Antero	2012	Colorado
CO07W722-F5	12-2410	HWW				Colorado
Billings (check)	12-2411	HRW				Oklahoma
Ruby Lee	12-2412	HRW				Oklahoma
Gallagher (OK07214)	12-2413	HRW	yes		2012	Oklahoma
Iba (OK07209)	12-2414	HRW	yes		2012	Oklahoma
OK09634	12-2415	HRW	no			Oklahoma
Lyman (check)	12-2416	HRW				South Dakota
SD08080	12-2417	HRW				South Dakota
SD06158	12-2418	HRW	yes	Redfield	2013	South Dakota
Yellowstone (check)	12-2419	HRW				Montana
MT08172	12-2420	HRW	yes	Colter	2012	Montana
MT0978	12-2421	HRW	yes	Northern	2015	Montana
TAM 111 (check)	12-2422	HRW				Texas
TX07A001505	12-2423	HRW				Texas
TX03A0563-07	12-2424	HRW				Texas

2011	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
Danby (check)	11-2401	HWW				Kansas-Hays
Tiger	11-2402	HWW	yes			Kansas-Hays
KS08HW35-1	11-2403	HWW	yes	Clara CL	2011	Kansas-Hays
PostRock (check)	11-2404	HRW				AgriPro
SY Wolf	11-2405	HRW	yes			AgriPro
Syngenta Exp 138-45	11-2406	HRW	yes	SY Southwind	2012	AgriPro
Fuller (check)	11-2407	HRW				Kansas-Manhattan
KS020319-7-3	11-2408	HRW	yes	1863	2012	Kansas-Manhattan
KS020633M-13	11-2409	HRW	no			Kansas-Manhattan
McGill (check)	11-2410	HRW				Nebraska
NE05496	11-2411	HRW	no			Nebraska
NE05548	11-2412	HRW	no			Nebraska
NI08708	11-2413	HRW	no			Nebraska
Jagalene (check)	11-2414	HRW				Westbred
HV9W06-509	11-2415	HWW	yes	WB-Grainfield	2012	Westbred
Yellowstone (check)	11-2416	HRW				Montana
MTS0808	11-2417	HRW	yes	Warhorse	2013	Montana
MT0871	11-2418	HRW	no			Montana
Lyman (check)	11-2419	HRW				South Dakota
SD06158	11-2420	HRW	yes	Redfield		South Dakota

SD07184	11-2421	HRW	no			South Dakota

2010	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Lyman (check)	10-2401	HRW				SDSU
SD05118-1	10-2402	HRW	yes	Ideal	2011	SDSU
SD06158	10-2403	HRW	yes	Redfield		SDSU
Hatcher (check)	10-2404	HRW				CSU
CO050303-2	10-2405	HRW	yes	Denali	2011	CSU
CO06052	10-2406	HRW	yes	Brawl CL Plus	2011	CSU
CO06424	10-2407	HRW	yes	Byrd	2011	CSU
Millennium (check)	10-2408	HRW				NU
NE03490	10-2409	HRW	no			NU
NE04490	10-2410	HRW	no			NU
Billings (check)	10-2411	HRW				OSU
OK05526	10-2412	HRW	yes	Ruby Lee	2011	OSU
OK05212	10-2413	HRW	yes	Garrison	2011	OSU
OK07231	10-2414	HRW	no			OSU
Smoky Hill (check)	10-2415	HRW				Westbred
HV9W06-262R	10-2416	HRW	no			Westbred
HV9W06-218W	10-2417	HWW	no			Westbred
Yellowstone (check)	10-2418	HRW				MSU
MTS0721	10-2419	HRW	yes	Bearpaw	2011	MSU
TAM 111 (check)	10-2420	HRW				TAMU
TX05A001822	10-2421	HRW	no			TAMU
TX06A001263	10-2422	HRW	no			TAMU

2009	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Smoky Hill (check)	09-2401	HRW				Westbred
Stout (HV9W03-539R)	09-2402	HRW	yes	WB-Stout	2009	Westbred
RonL (check)	09-2403	HWW				KSU-Hays
Tiger	09-2404	HWW	yes			KSU-Hays
Hatcher (check)	09-2405	HRW				CSU
CO04393	09-2406	HRW	no			CSU
CO04499	09-2407	HRW	no			CSU
OK Bullet (check)	09-2408	HRW				OSU
Billings	09-2409	HRW	yes			OSU
OK05526	09-2410	HRW	yes	Ruby Lee	2011	OSU
PostRock (check)	09-2411	HRW				AgriPro
CJ	09-2412	HRW	yes			AgriPro

SY Gold (AP00x0100-51)	09-2413	HRW	yes	SY Gold	2010	AgriPro
Yellowstone (check)	09-2414	HRW				MSU
MT06103	09-2415	HRW	no			MSU
MTS0713	09-2416	HRW	yes	Judee	2011	MSU
TAM 111 (check)	09-2417	HRW				TAMU
TX02A0252	09-2418	HRW	yes	TAM 113	2010	TAMU
Millennium (check)	09-2419	HRW				NU
NE01481	09-2420	HRW	yes	McGill	2010	NU
NI04421	09-2421	HRW	yes	Robidoux	2010	NU

2008	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
Jagalene (check)	08-2401	HRW				AgriPro
Art	08-2402	HRW	yes			AgriPro
Hawken	08-2403	HRW	yes			AgriPro
NuDakota	08-2404	HRW	yes			AgriPro
Hatcher (check)	08-2405	HRW				CSU
Thunder CL	08-2406	HWW	yes	Thunder CL	2008	CSU
CO03W054	08-2407	HWW	yes	Snowmass		CSU
CO03064	08-2408	HRW	no			CSU
Danby (check)	08-2409	HWW				KSU-Hays
Tiger	08-2410	HWW	yes			KSU-Hays
Karl 92 (check)	08-2411	HRW				KSU-Manhattan
KS970093-8-9-#1	08-2412	HRW	yes	Everest	2009	KSU-Manhattan
OK Bullet (check)	08-2413	HRW				OSU
OK03305	08-2414	HRW	yes	Pete	2009	OSU
OK03522	08-2415	HRW	yes	Billings	2009	OSU
OK03825-5403-6	08-2416	HRW				OSU
Tandem (check)	08-2417	HRW	yes	STARS0601W	2006	SDSU
SD05W030	08-2418	HWW	no			SDSU

2007	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
Hatcher (check)	07-2401	HRW				CSU
CO03W239	07-2402	HWW	yes	Thunder CL	2008	CSU
CO03W054	07-2403	HWW	yes	Snowmass		CSU
CO02W237	07-2404	HWW	no			CSU
Millennium (check)	07-2405	HRW				NU
NH03614	07-2406	HRW	yes	Settler CL	2008	NU
OK Bullet (check)	07-2407	HRW				OSU
OK00514-05806	07-2408	HRW	no			OSU

OK05737W	07-2409	HWW	no			OSU
OK03522	07-2410	HRW	yes	Billings	2009	OSU
OK02405	07-2411	HRW	no			OSU
Tandem (check)	07-2412	HRW				SDSU
SD98W175-1	07-2413	HRW	no			SDSU
SD01058	07-2414	HRW	no			SDSU
SD0111-9	07-2415	HRW	yes	Lyman	2008	SDSU
SD01273	07-2416	HRW	no			SDSU
Genou (check)	07-2417	HRW				MSU
MT0495	07-2418	HRW	no			MSU
MTS04114	07-2419	HRW	no			MSU

2006	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
Overley (check)	06-2401	HRW				KSU-Manhattan
Fuller	06-2402	HRW	yes			KSU-Manhattan
KS990498-3-&~2	06-2403	HRW	no			KSU-Manhattan
KS970274-14*9	06-2404	HRW	no			KSU-Manhattan
Overley (check)	06-2405	HRW				Westbred
Smoky Hill	06-2406	HRW	yes			Westbred
Aspen	06-2407	HRW	yes			Westbred
Millennium (check)	06-2408	HRW				NU
NW98S097	06-2409	HRW	yes	Anton	2008	NU
N02Y5117	06-2410	HRW	yes	Mace	2007	NU
NE01643	06-2411	HRW	yes	Overland	2007	NU
NE02584	06-2412	HRW	no			NU
OK Bullet (check)	06-2413	HRW				OSU
Duster	06-2414	HRW	yes			OSU
OK01420	06-2415	HRW	no			OSU
OK02405	06-2416	HRW	no			OSU
OK02522W	06-2417	HWW	yes	OK Rising	2008	OSU
Tandem (check)	06-2418	HRW				SDSU
SD96240-3-1	06-2419	HRW	no			SDSU
SD01122	06-2420	HRW	no			SDSU
SD01W065	06-2421	HWW	no			SDSU
TAM 111 (check)	06-2422	HRW				TAMU
TAM 112	06-2423	HRW	yes			TAMU
TX01A5936	06-2424	HRW	no			TAMU
TX01D3232	06-2425	HRW	yes	TAM 304	2006	TAMU
TX01V5314	06-2426	HRW	yes	TAM 203	2007	TAMU

2005	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Akron (check)	05-2401	HRW				CSU
CO00016	05-2402	HRW	yes	Ripper	2006	CSU
Jagger (check)	05-2403	HRW				KSU-Hays
2137	05-2404	HRW	yes			KSU-Hays
KS03HW6-6	05-2405	HWW	no			KSU-Hays
KS03HW158-1	05-2406	HWW	yes	RonL		KSU-Hays
Jagger (check)	05-2407	HRW				AgriPro
Neosho	05-2408	HRW	yes			AgriPro
W03-20	05-2409	HRW	yes	Postrock	2005	AgriPro
Goodstreak (check)	05-2410	HRW				NU
Infinity CL	05-2411	HRW	yes			NU
OK Bullet (check)	05-2412	HRW				OSU
OK93p656H3299-2c04	05-2413	HRW	yes	Duster	2006	OSU
OK01307	05-2414	HRW	no			OSU
OK03918C	05-2415	HRW	yes	Centerfield	2006	OSU
OK00611W	05-2416	HWW	no			OSU
Tandem (check)	05-2417	HRW				SDSU
Crimson	05-2418	HRW	yes			SDSU
SD97059-2	05-2419	HRW	no			SDSU
SD01W064	05-2420	HWW	no			SDSU

2004	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Jagger (check)	04-2401	HRW				KSU-Hays
2137	04-2402	HRW	yes			KSU-Hays
KS02HW34	04-2403	HWW	yes	Danby	2005	KSU-Hays
KS02HW35-5	04-2404	HWW	no			KSU-Hays
KS03HW158	04-2405	HWW	yes	RonL	2006	KSU-Hays
Antelope (check)	04-2406	HRW				NE-USDA-ARS
Arrowsmith	04-2407	HRW	yes			NE-USDA-ARS
NW99L7068	04-2408	HRW	no			NE-USDA-ARS
Millennium (check)	04-2409	HRW				NU
NE99495	04-2410	HRW	yes	NE99495	2005	NU
OK102 (check)	04-2411	HRW				OSU
OK00618W	04-2412	HWW	yes	Guymon	2005	OSU
OK99212	04-2413	HRW	no			OSU
OK00514	04-2414	HRW	yes	OK Bullet	2005	OSU
OK02909C	04-2415	HRW	yes	Okfield	2005	OSU
Tandem (check)	04-2416	HRW				SDSU
SD97W609	04-2417	HWW	yes	Alice	2006	SDSU

SD97538	04-2418	HRW	no			SDSU
SD98102	04-2419	HRW	yes	Darrell	2006	SDSU

2003	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Akron (check)	03-2401	HRW				CSU
CO980607	03-2402	HRW	yes	Hatcher	2004	CSU
CO00D007	03-2403	HRW	yes	Bond CL	2004	CSU
Jagger (check)	03-2404	HRW				KSU-Hays
2137	03-2405	HRW	yes			KSU-Hays
KS01HW152-6	03-2406	HWW	no			KSU-Hays
KS01HW163-4	03-2407	HWW	no			KSU-Hays
KS02HW34	03-2408	HWW	yes	Danby	2005	KSU-Hays
Jagger (check)	03-2409	HRW				KSU-Manhattan
2137	03-2410	HRW	yes			KSU-Manhattan
Overley	03-2411	HRW	yes			KSU-Manhattan
KS940786-6-9	03-2412	HRW	no			KSU-Manhattan
OK 102 (check)	03-2413	HRW				OSU
OK94P549-11	03-2414	HRW	yes	Endurance	2004	OSU
OK98690	03-2415	HRW	yes	Deliver	2004	OSU
Crimson (check)	03-2416	HRW				SDSU
SD97W604	03-2417	HWW	yes	Wendy	2004	SDSU
SD92107-5	03-2418	HRW	no			SDSU

2002	Entry No.	Entry Class	Released	Release Name	Release Year	Program
Jagger (check)	02-2401	HRW				AgriPro
Cutter	02-2402	HRW	yes			AgriPro
Dumas	02-2403	HRW	yes			AgriPro
Jagalene	02-2404	HRW	yes			AgriPro
G1878 (check)	02-2405	HRW				Cargill
G980723	02-2406	HRW	no			Cargill
G970252W	02-2407	HWW	no			Cargill
Prowers (check)	02-2408	HRW				CSU
CO980376	02-2409	HRW	no			CSU
CO980607	02-2410	HRW	yes	Hatcher	2004	CSU
CO980630	02-2411	HRW	no			CSU
Jagger (check)	02-2412	HRW				KSU-Manhattan
KS940748-2-2	02-2413	HRW	no			KSU-Manhattan
KS940786-6-7	02-2414	HRW	yes	Overley	2003	KSU-Manhattan
KS940786-6-9	02-2415	HRW	no			KSU-Manhattan

Millennium (check)	02-2416	HRW				NU
NE97V121	02-2417	HRW	no			NU
NE98466	02-2418	HRW	no			NU
NE98471	02-2419	HRW	yes	Hallam	2004	NU
NI98439	02-2420	HRW	no			NU
2174 (check)	02-2421	HRW				OSU
OK102	02-2422	HRW	yes			OSU
OK95548-54	02-2423	HRW	no			OSU
OK95616-56	02-2424	HRW	no			OSU
OK96705-38	02-2425	HRW	no			OSU
OK98699	02-2426	HRW	no			OSU

2001	**Entry No.**	Entry Class	Released	Release Name	Release Year	Program
Jagger (check)	01-2401	HRW				Cargill
G970380A	01-2402	HRW	no			Cargill
G970209W	01-2403	HWW	no			Cargill
Prowers 99 (check)	01-2404	HRW				CSU
CO970547	01-2405	HRW	no			CSU
Millennium (check)	01-2406	HRW				NU
NE97426	01-2407	HRW	no			NU
NE97465	01-2408	HRW	yes	Goodstreak	2002	NU
NE97638	01-2409	HRW	yes	Empire	2002	NU
NE97669	01-2410	HRW	no			NU
NE97689	01-2411	HRW	yes	Harry	2002	NU
2174 (check)	01-2412	HRW				OSU
OK96717-99-6756	01-2413	HRW	no			OSU
OK97508	01-2414	HRW	yes	Ok102	2002	OSU

Thank you for reviewing this report of 2025 WQC Hard Winter Wheat milling and baking. Please let me know if you have any comments on this report. I can be reached at (785)776-2751 or by email, rhett.kaufman@usda.gov