



Canadian Grain
Commission

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des grains



A SCREENING PROTOCOL FOR WHEAT MILLING YIELD, FLOUR WATER ABSORPTION, DOUGH MIXING REQUIREMENT AND VISCOELASTICITY

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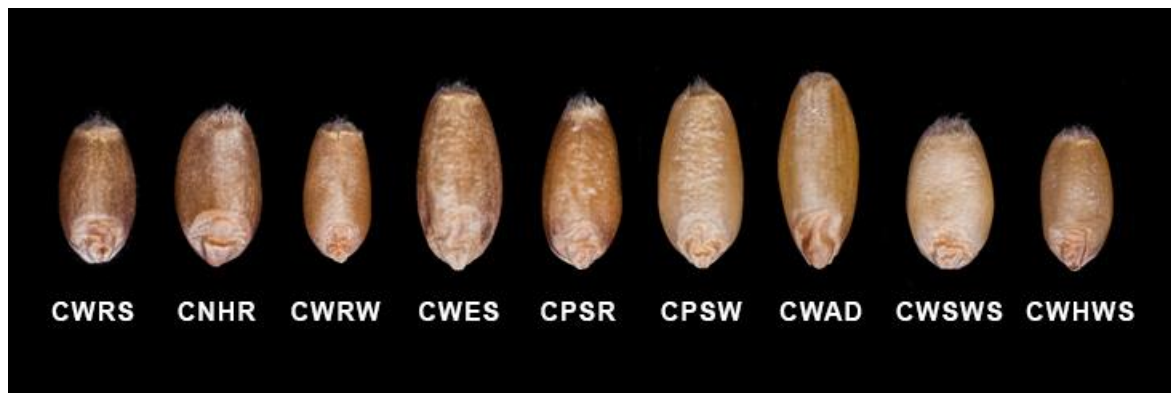
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Canada 

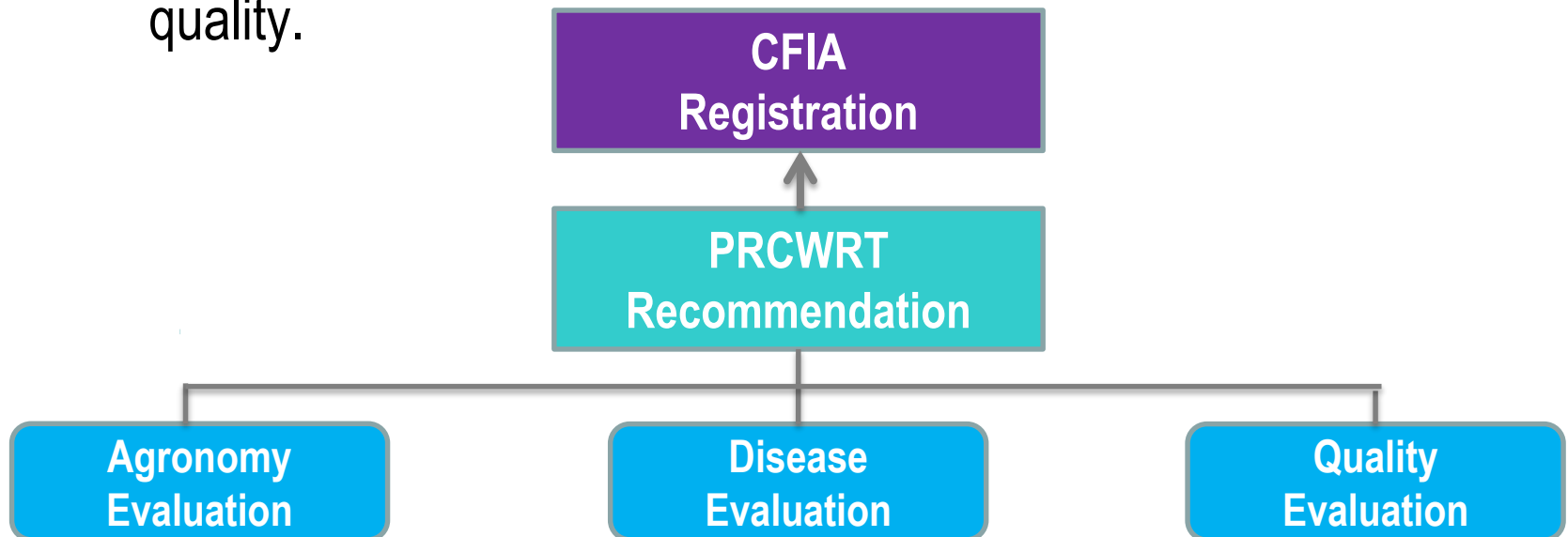
Canadian wheat classes – building quality for marketability

- Wheat classes are established by Canadian Grain Commission (CGC) through consultation with end-users, breeders, marketers and other stakeholders
- Quality objectives for each class are driven by end-users
- Quality objectives are defined with quality parameters
 - Established by a team of quality experts.
- Objectives are regularly reviewed and modified
 - Address changing market and marketing needs.



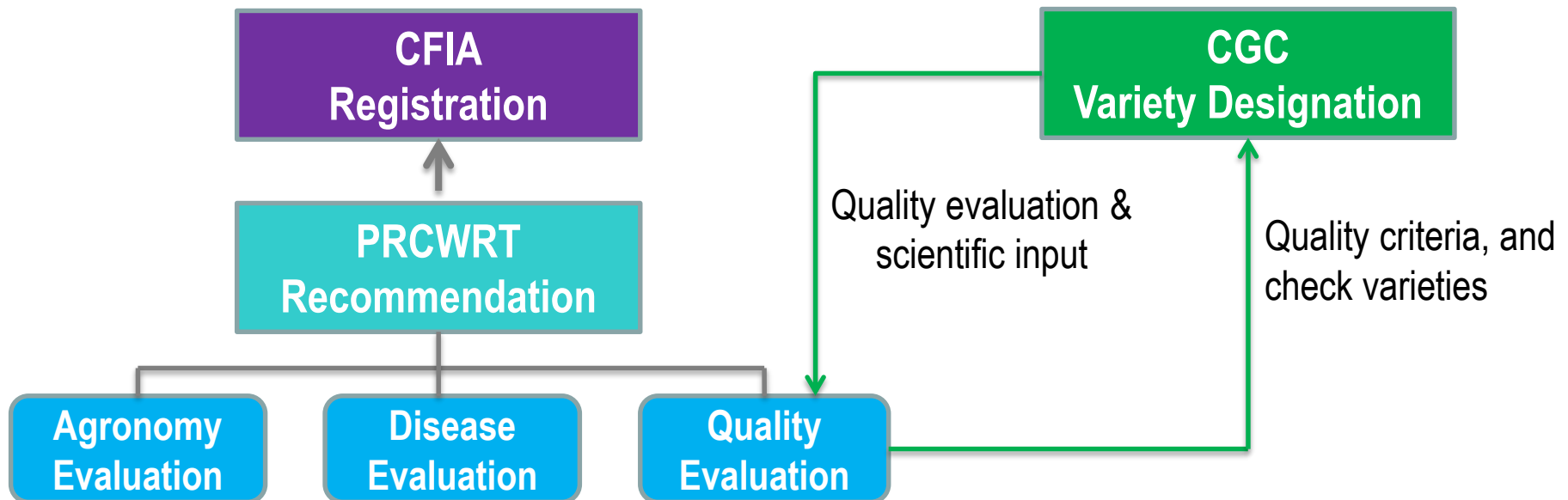
The Canadian system – wheat variety registration

- Science based Prairie Recommending Committee for Wheat, Rye and Triticale (PRCWRT).
 - Makes recommendation to Canadian Food Inspection Agency (CFIA) based on voting results of Evaluation Teams/Cultivar Voting Panel.
 - Recommended lines must have merit in agronomy, disease, or quality.



The Canadian system – class designation

- To be eligible for a class, new registered variety must meet the class-specific quality requirements.
- A negative vote by the Quality Evaluation Team means that line is unsuitable for the intended marketing class.
- CGC has authority to classify new wheat varieties.



Three Canada Western Red Spring (CWRS) wheat trials

- **Central Bread Wheat Co-op**
 - Adaption of candidates to the rust and fusarium areas of Manitoba and central and southern areas of Eastern Saskatchewan
- **Western Bread Wheat Co-op**
 - Adaption of candidates for the non-rust areas of southern and central Alberta and Saskatchewan including the sawfly area
- **Parkland Bread Wheat Co-op**
 - Adaption of candidates for the shorter growing season in the northern and central parkland area

~ 12 locations in each trial

Preparation of composite for quality evaluation

- **Check grading**
 - ~ 250 g each check at each location
 - Grading by CGC inspectors
- **Composite recipe**
 - Test weight, protein, grade, grading factors
 - Recipe developed by GRL
- **Composite preparation**
 - Trial coordinators prepare composites based on recipe
 - Composites (8-12 kg) sent to CGC
- **Composite analysis**
 - Graded by CGC inspectors
 - Checks verified by DNA analysis
 - Follow PGDC WRT Operating Procedures for testing guidelines

Quality parameters & guidelines for assessment

Variety		Wheat and Flour Characteristics					Milling Performance				Dough Properties						Baking Quality		
		Wheat Pro	Flour Pro	Pro Loss	FN	Amyl Peak	Clean Wht Flr Yld	Flr Yld PB 0.50 Ash	Flour Ash	Starch Dmg	Farino Abs	Farino DDT	Farino Stab	EXT Area	EXT Rmax	EXT Length	LNT Abs	LNT LV	LNT LTR
GUIDELINES (Values \geq or \leq)															See comments				
Excellent		1.0	1.0		80	250	1.7	1.7	-0.06	-1.7	3.0				50	4.0	5	100	0.10
Improvement		0.4	0.4		40	150	0.8	0.8	-0.03	-0.8	1.5				30	2.0	3	50	0.05
Flag		-0.4	-0.4	0.4	-40	-150	-0.8	-0.8	0.03	0.8	-1.5					-2.0	-3	-50	-0.10
Poor		-1.0	-1.0		-80	-250	-1.7	-1.7	0.06	1.7	-3.0				-30	-4.0	-5	-100	-0.15
Mean of Checks		14.5	13.8	0.7	400	740	75.2	79.5	0.39	7.7	64.2	8.25	12.5	135	553	20.0	71	805	0.55
RATING RELATIVE TO MEAN OF CHECKS																			
BW 406	Glenn	14.7	14.0	0.7	375	815	75.0	80.0	0.38	7.8	64.9	10.00	15.0	164	669	19.5	72	860	0.65
BW 965	AAC Viewfi	14.3	13.8	0.5	420	780	75.0	79.0	0.40	7.6	63.9	8.75	13.0	121	514	19.5	71	765	0.60
BW 874	Carberry	14.5	13.7	0.8	400	620	75.7	79.5	0.39	7.6	63.9	6.25	9.0	121	476	20.9	71	785	0.45
BW 362	Unity (Pure	14.5	13.8	0.7	430	875	76.8	78.5	0.41	8.0	63.8	6.00	6.5	86	359	18.8	71	730	0.40
BWxxxx	1st	14.7	13.9	0.7	395	705	75.9	79.5	0.39	7.4	64.2	10.00	16.0	151	694	18.7	72	790	
BWxxxx	1st	14.8	14.0	0.8	400	620	74.3	79.0	0.40	7.1	65.6	6.50	8.0	95	387	20.2	73	665	0.63
BWxxxx	1st	14.1	13.2	0.9	390	610	75.7	80.0	0.38	7.6	63.7	9.00	12.5	127	563	19.1	71	815	0.50
BWxxxx	1st	13.9	12.9	1.0	415	600	77.1	80.0	0.38	7.5	63.9	7.50	9.0	101	438	18.6	71	800	0.53
BWxxxx	1st	14.4	13.4	1.0	415	595	75.4	79.5	0.39	8.3	65.2	7.75	10.5	123	540	18.9	72	790	0.41
BWxxxx	1st	14.3	13.8	0.6	400	665	76.1	79.0	0.40	6.6	62.8	8.25	16.0	142	598	19.5	70	825	0.57
BWxxxx	1st	14.4	13.5	0.9	390	580	76.4	80.5	0.37	7.6	64.4	9.50	16.0	162	681	19.6	72	765	0.39
BWxxxx	1st	14.4	13.7	0.7	380	545	77.2	78.5	0.41	8.2	63.6	8.00	11.0	146	583	20.5	71	820	0.54
BWxxxx	1st	13.9	13.1	0.7	395	485	75.2	78.5	0.41	8.3	63.2	7.25	9.0	106	437	19.9	70	780	0.55

A High throughput protocol with much reduced sample size requirement

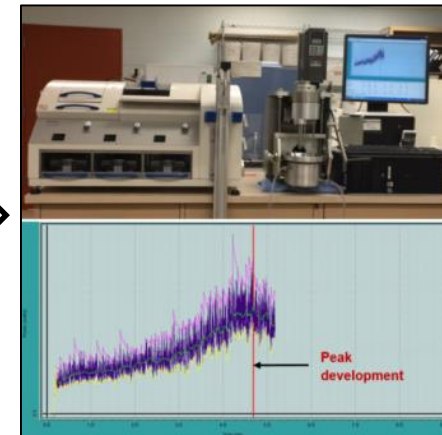
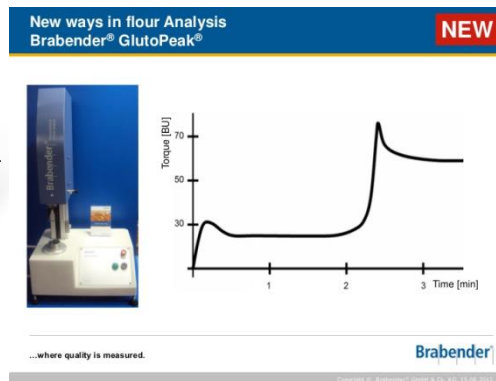
“Rapid, cost effective quality tests for screening quality in early generation lines and at point of delivery”

Canadian Wheat Research Priorities -2017-2022 Outlook

Wheat ⇒
(2.0 – 5.0 Kg)

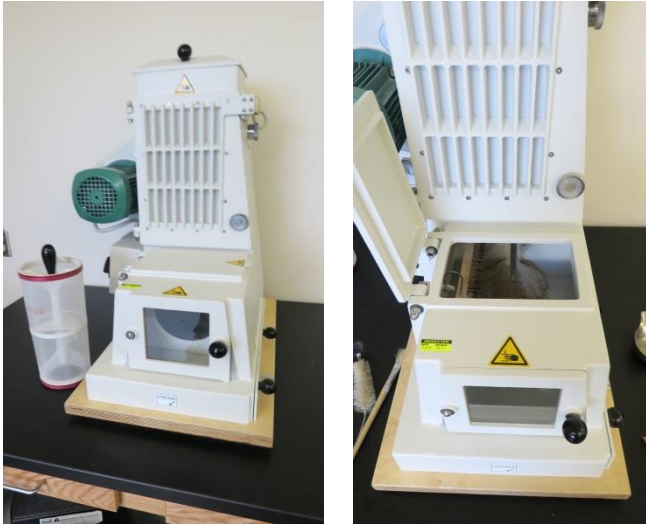


Wheat ⇒
(0.2 – 0.5 Kg)



Modified Quadrumat Junior (QJ) milling for flour preparation and yield prediction

Original reel sifter removed



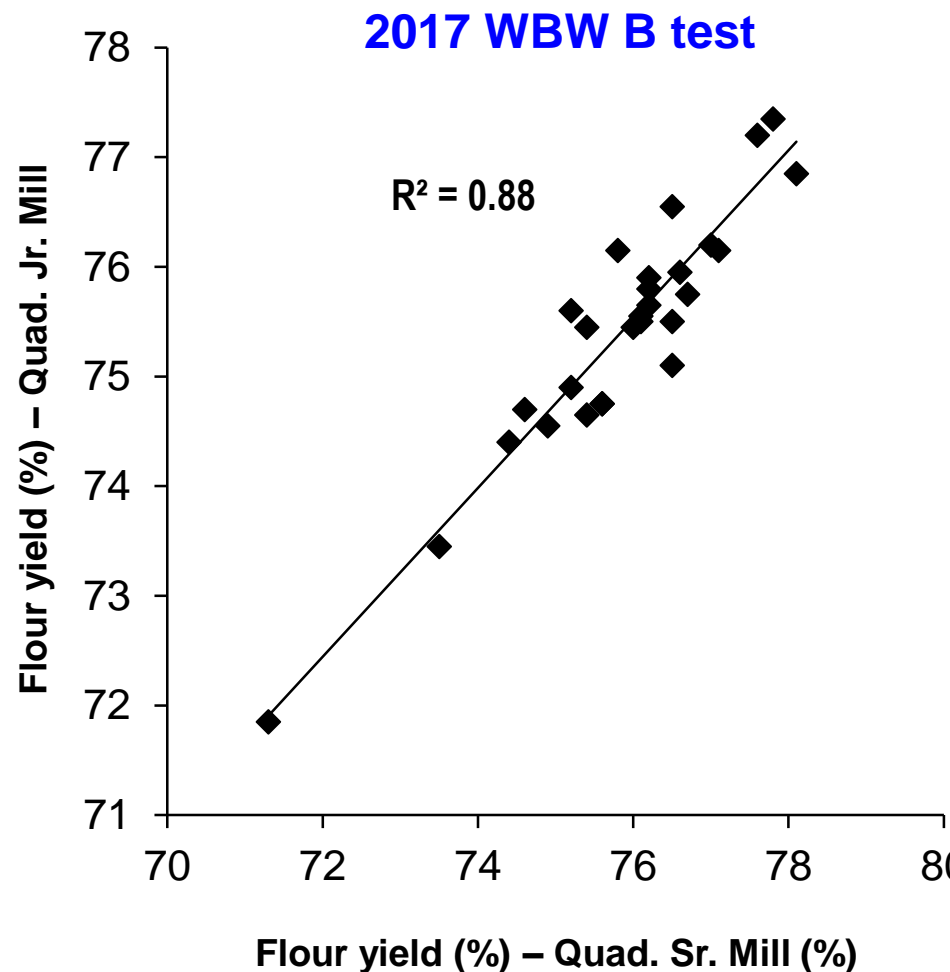
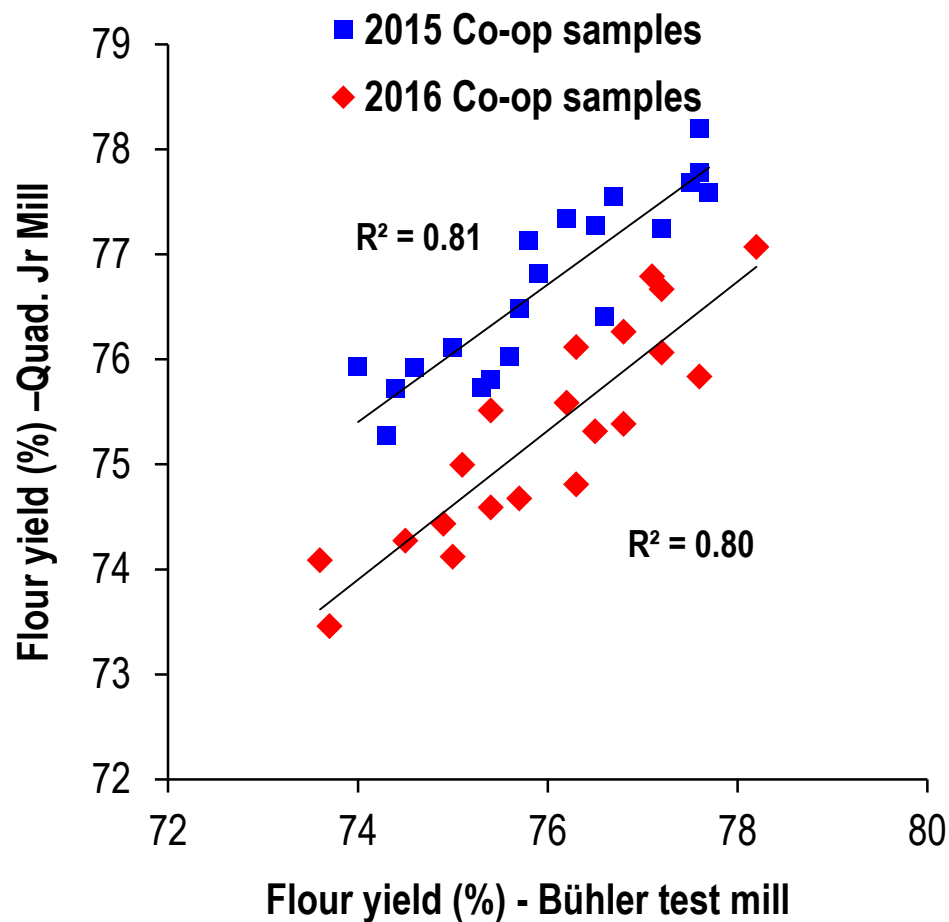
- Wheat amount (100-200 g)
- Tempering moisture (14.0-16.0%)

Sieving



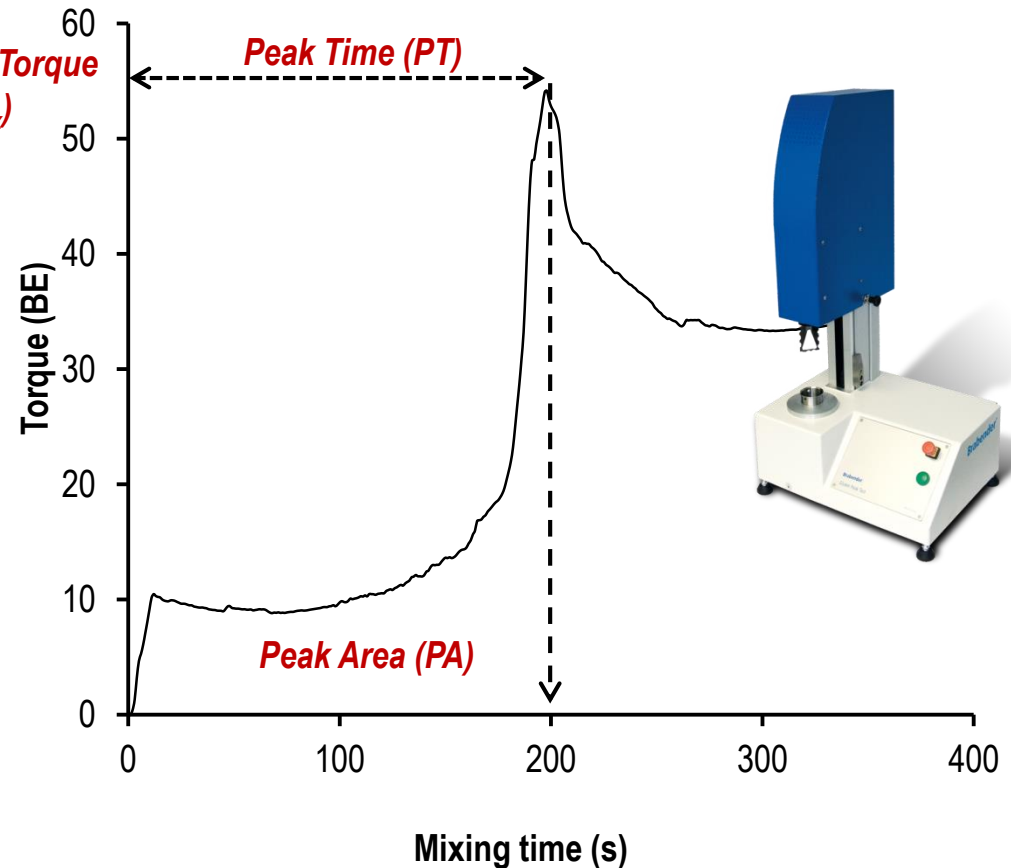
- Bühler universal lab sifter
- Screen size
- Sifting speed and time

Prediction of flour yield with modified Quad.Jr. milling protocol



Predicting farinograph water absorption (FAB) and gluten strength with GlutoPeak

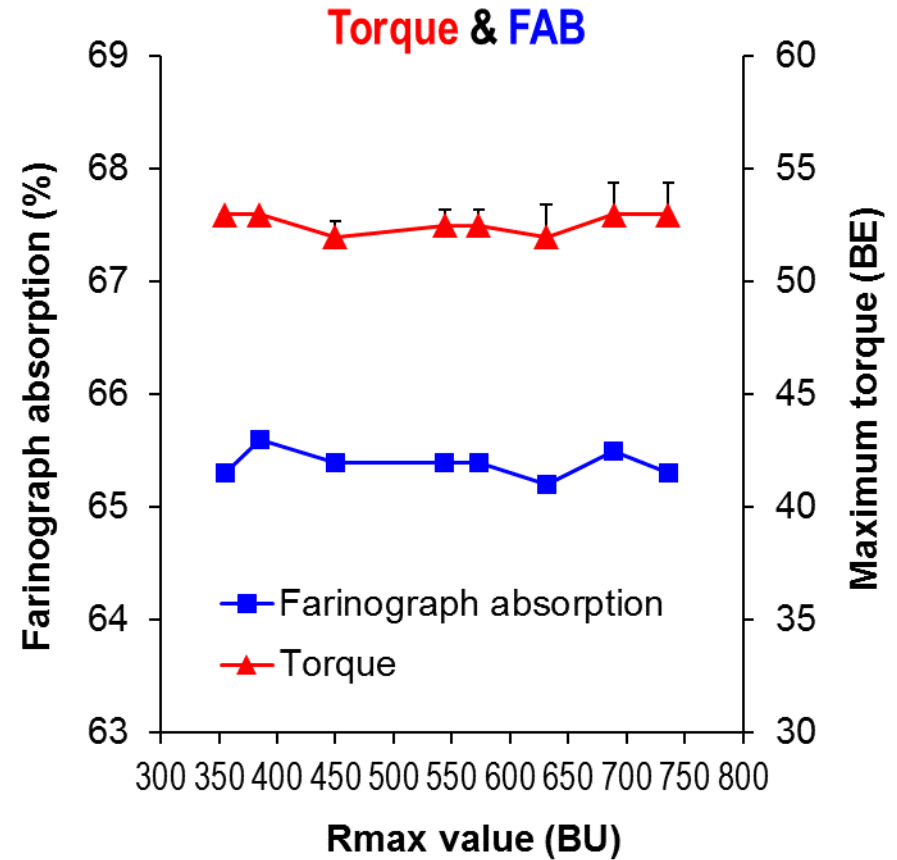
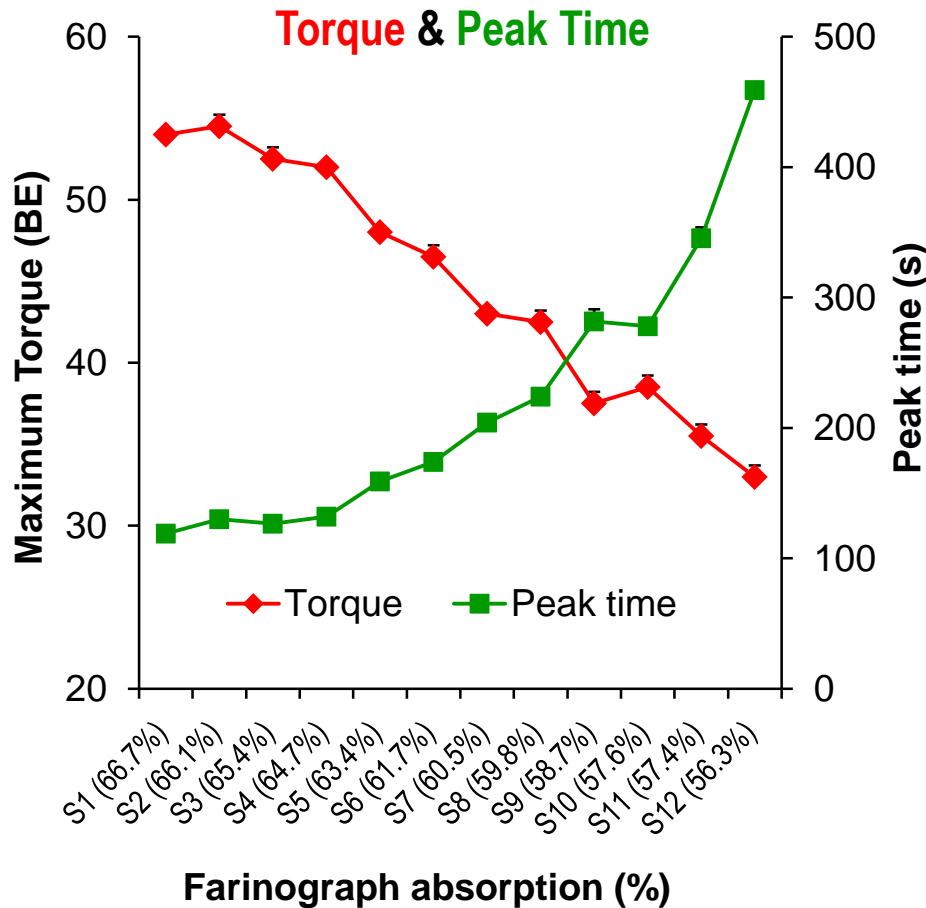
- **Brabender GlutoPeak**
 - high-speed shearing (2000-3000 rpm)
 - small sample size (<10 g)
 - short test time (<10 min)
- **Rapid tool to predict FAB and gluten strength?**



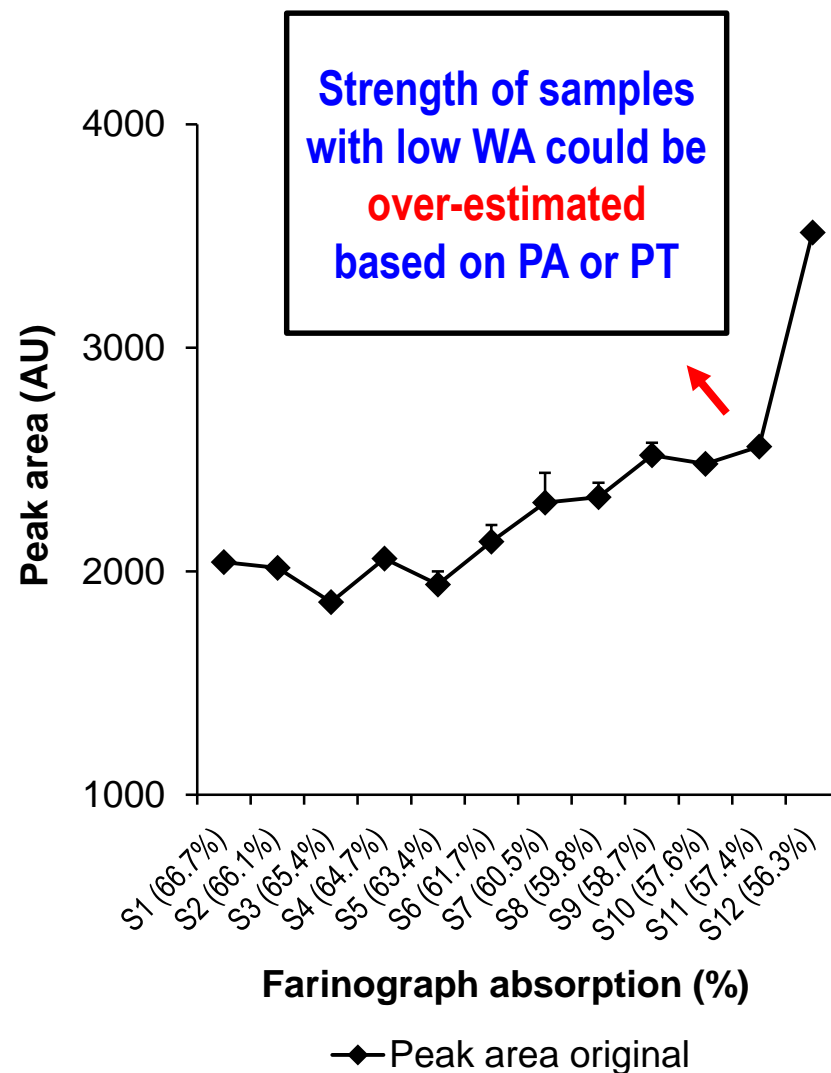
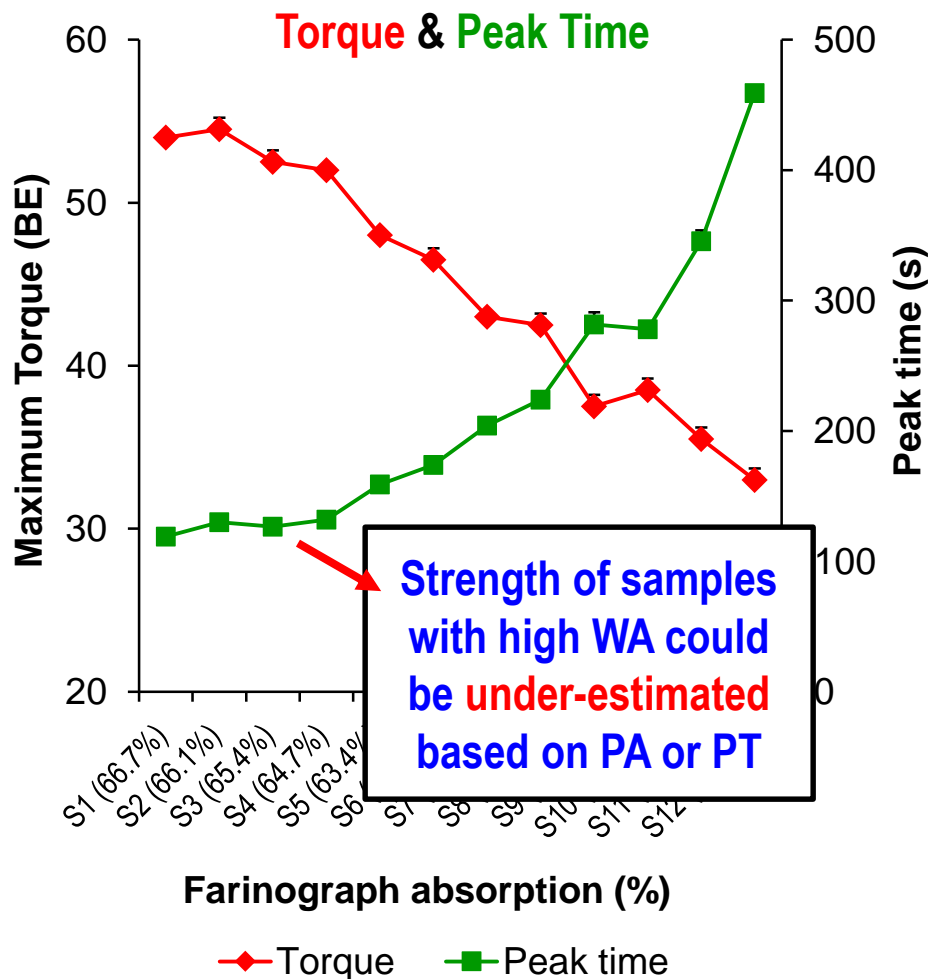
Effect of water absorption and strength on gluten aggregation behavior in GlutoPeak

- **GlutoPeak test conditions for CWRS wheat**
 - Flour/water ratio: 8/10 (w/w)
 - Speed & temperature: 2700 rpm at 34 °C
- **Two sets of flour samples selected**
 - Set I: samples with similar strength (R_{\max} : 531-594 BU) but with diverse FAB (56.3-66.7%)
 - effect of FAB without impact of gluten strength
 - Set II: samples with similar FAB (65.2-65.8%) but with diverse gluten strength (R_{\max} : 355-736 BU)
 - effect of gluten strength without impact of FAB

Effect of water absorption on max. torque (T_{\max}) of GlutoPeak test



Effect of water absorption on peak time and area of GlutoPeak test for Samples with similar strength



Effect of water absorption & strength on gluten aggregation behaviours

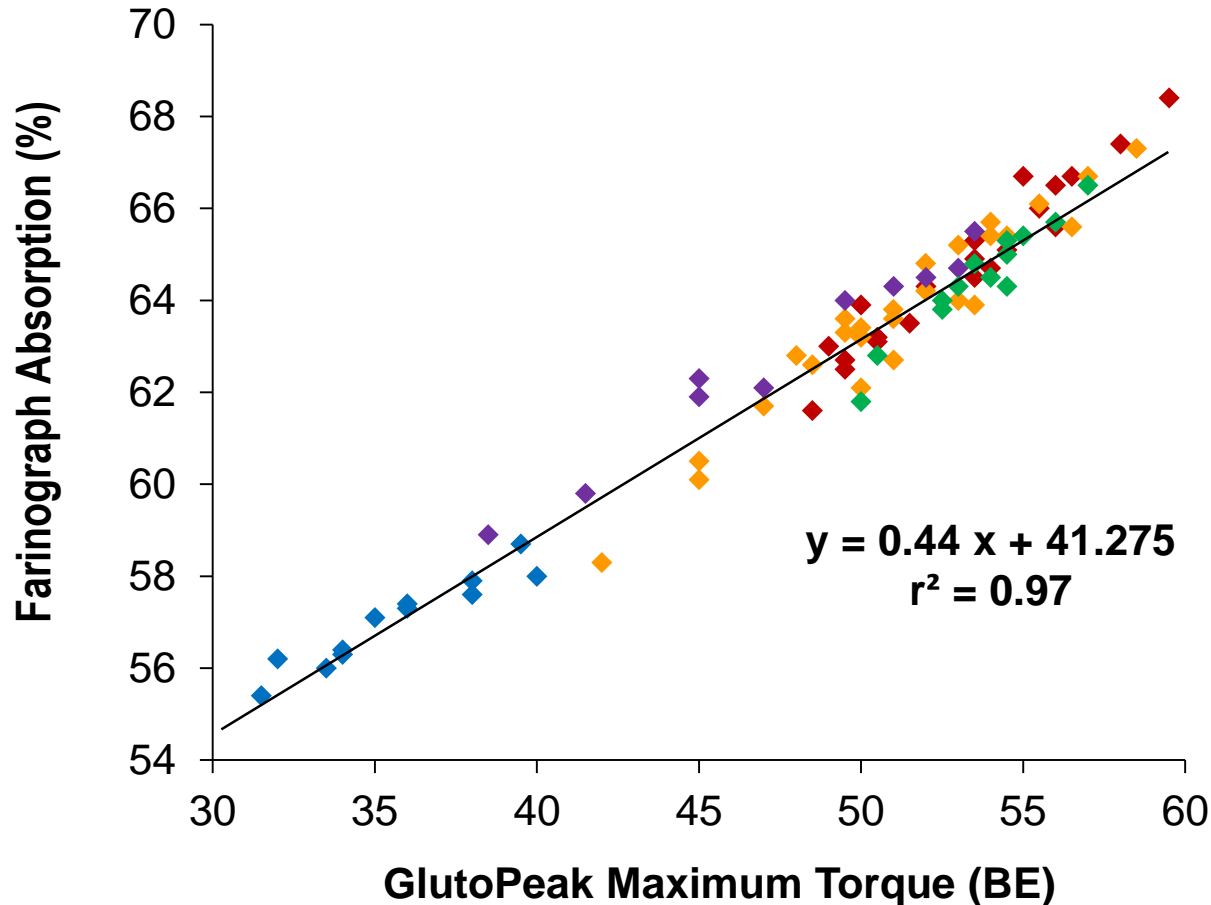
- **GlutoPeak gluten aggregation is affected by**
 - Flour water absorption and gluten strength
- **GlutoPeak maximum torque is**
 - Solely related to water absorption
 - Independent of gluten strength
 - Useful indicator for FAB?
- **GlutoPeak peak time and peak area**
 - Could be useful for predicting gluten strength
 - However, the impact of FAB on peak time and area must be corrected for accurate strength prediction

Verification of T_{\max} for FAB prediction

- Five wheat classes with wide range of FAB
- Flour samples were prepared with Bühler test mill and Quad.Jr. mill

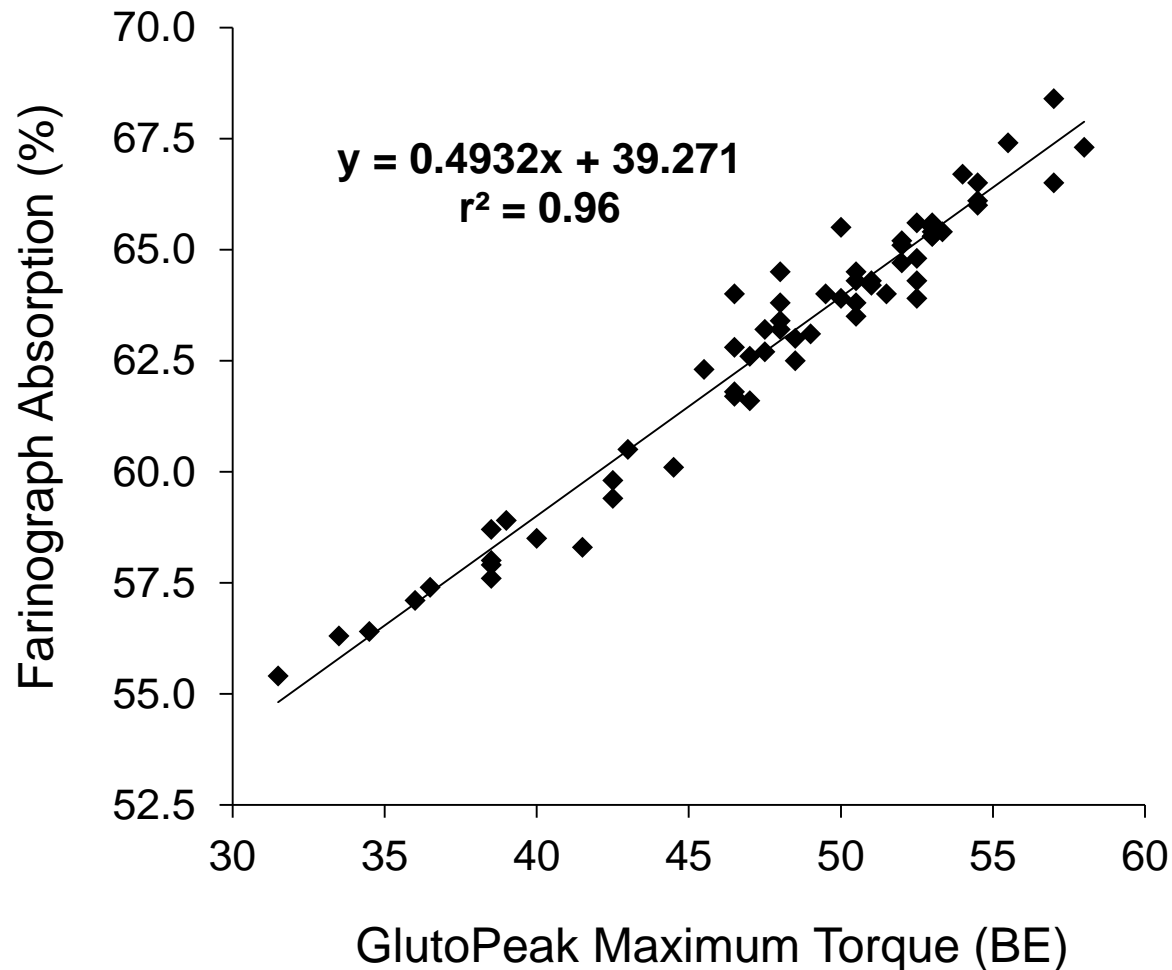
Wheat class	Number of wheat lines (n)	Farinograph absorption (%)	Correlation coefficient (<i>r</i>) between FAB and T_{\max} for Bühler milled flour
CWRS	30	61.6-68.4 (64.4±1.6)	0.93
CPSR	18	58.3-67.3 (63.0±2.6)	0.94
CNHR	10	58.9-65.5 (62.8±2.2)	0.97
CWHWS	13	61.8-66.5 (64.5±1.2)	0.93
CWRW	12	55.4-58.7 (56.7±1.2)	0.91

Relationship between GlutoPeak T_{\max} and FAB of Bühler milled flour samples



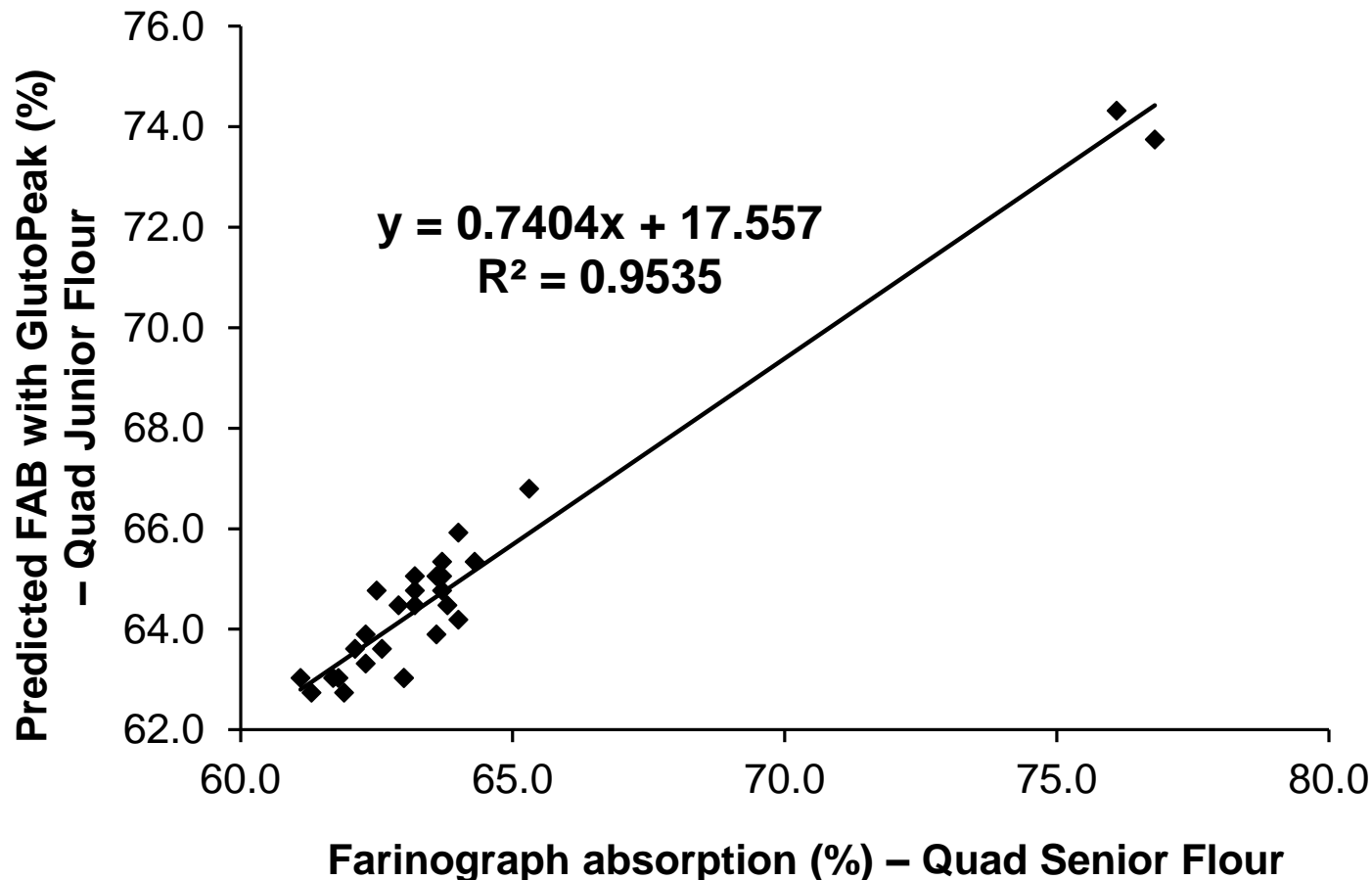
- ◆ Canada Western Red Spring (CWRS)
- ◆ Canada Prairie Spring Red (CPSR)
- ◆ Canada Northern Hard Red (CNHR)
- ◆ Canada Western Hard White Spring (CWHWS)
- ◆ Canada Western Red Winter (CWRW)

Relationship between FAB of Bühler milled flour and GlutoPeak T_{\max} of QJ milled flour samples



Application of GlutoPeak Torque for FAB Prediction in WBW B Test

- Water absorption was measured by Farinograph and predicted with GlutoPeak



Introduction of GlutoPeak strength index (GSI) to account for the impact of water absorption

- **Proposing of a new GlutoPeak parameter**
 - $GSI = \text{Peak area} \times \text{Torque}$
- **Verification of GSI for prediction of gluten strength**
 - Sample set I: 56 wheat lines with diverse dough strength and wide variation in FAB (55 - 68%)
 - Sample set II: 30 advanced lines with diverse dough strength but narrow FAB (63 - 66%)

Relationship between GlutoPeak parameters and dough rheological properties

GlutoPeak parameters	Farinograph Mixing Parameters			Extensograph Parameters		
	FAB	Stability	MTI	Rmax	Extensibility	Area
Sample set one: 56 wheat lines with wide variation in FAB (55 - 68%)						
Tmax	0.96 ***	-0.08 ns	-0.07 ns	-0.18 ns	0.48 ***	0.11 ns
PT	-0.80 ***	0.42 **	-0.31 *	0.57 ***	-0.62 ***	0.25 *
PA	-0.53 ***	0.69 ***	-0.54 ***	0.84 ***	-0.62 ***	0.56 ***
GSI	0.02 ns	0.77 ***	-0.64 ***	0.91 ***	-0.42 **	0.77 ***
Sample set two: 30 advanced lines with narrow range of FAB (63 - 66%)						
Tmax	0.93 ***	-0.44 *	0.36 ns	-0.33 ns	0.08 ns	-0.33 ns
PT	-0.62 ***	0.65 ***	-0.58 ***	0.75 ***	-0.43 *	0.59 ***
PA	-0.42 *	0.69 ***	-0.60 ***	0.88 ***	-0.53 **	0.69 ***
GSI	-0.22 ns	0.65 ***	-0.57 ***	0.88 ***	-0.55 ***	0.68 ***

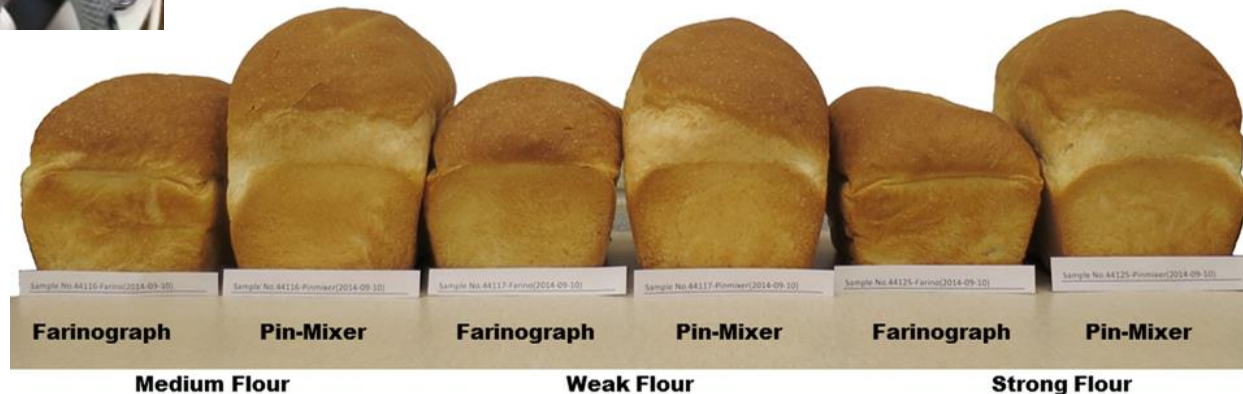
*, **, *** = significance at 5, 1, and 0.1% level, respectively; ns = not significant ($P > 0.05$). FAB = farinograph absorption; MTI = mixing tolerance index; Rmax = dough maximum resistance; EA= extensigram area; Tmax = GlutoPeak maximum torque; PT = peak time; PA = peak area; GSI = GlutoPeak strength index.

A rapid extensigraph protocol for measuring dough viscoelasticity and mixing requirement

Rapid extensograph method

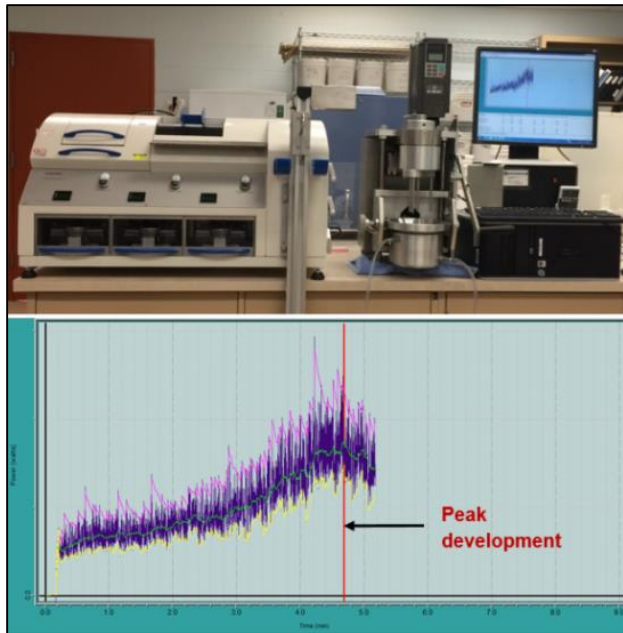
- Limitation of extensograph
 - Large amount of flour
 - Prerequisite farinograph water absorption
 - Long dough resting time
- Objectives of rapid extensograph
 - Reduced wheat sample size (e.g. 200 g) with QJ milling
 - Development of dough with pin mixer/Mixograph, either at
 - Constant water absorption
 - Or adjusted absorption based on GlutoPeak
 - New dough resting regime to reduce test time

Extensograph: how dough should be prepared?



Rapid extensograph: dough preparation & resting regime

Mixing



Rounding, shaping, and resting (45min)



WA: 55%
R_{max}: 419 BU
Ext.: 11.7 cm

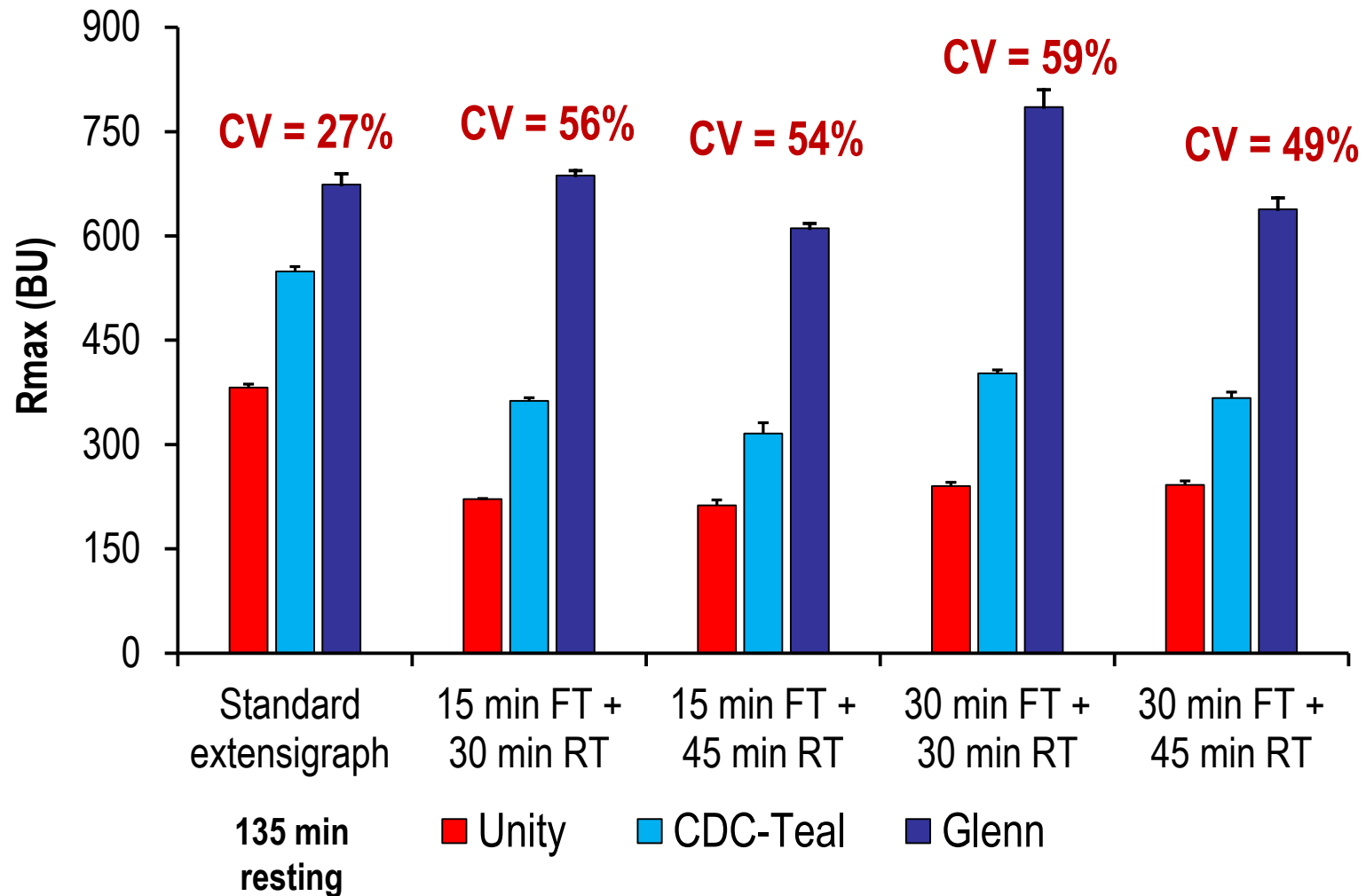
WA: 67.5%
R_{max}: 245 BU
Ext.: 18.8 cm

Floor time (15 min),
rounding, shaping, and
resting (30 min)



WA: 67.5%
R_{max}: 393 BU
Ext.: 18.5 cm

Rapid extensograph: effect of dough resting conditions



Rapid extensograph: other adjustments

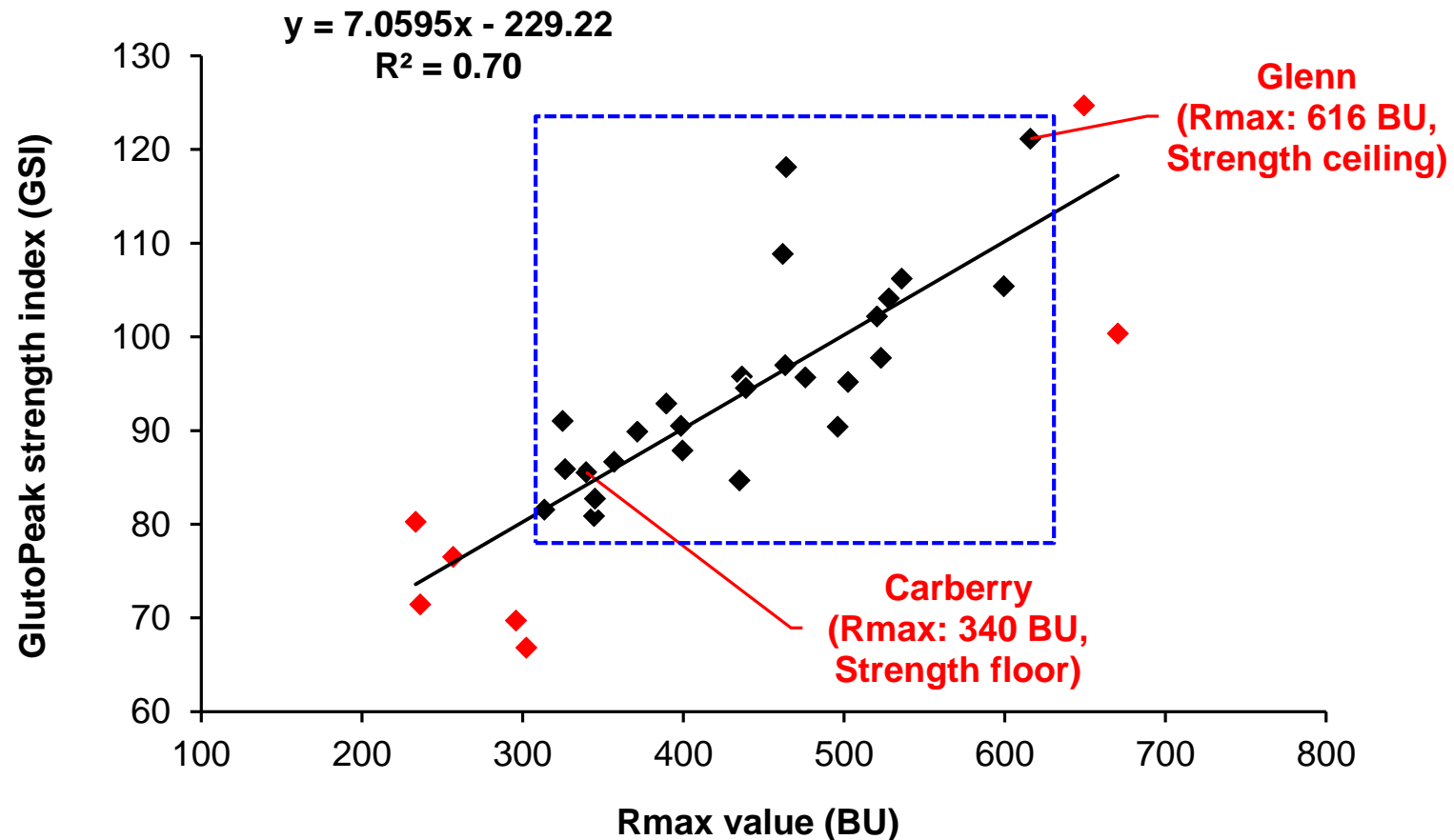
- Salt level reduced to 1% from 2%
- Water absorption increased by 6-7%
- Flour sample size reduced to 100 g from 300 g

Rapid extensograph: advantages

- **Reducing wheat sample size requirement**
 - Only ~150 g of wheat for a single extensograph test
- **Eliminating prerequisite farinograph testing**
 - Fixed WA for comparison of wheat varieties from same class
 - Mixing time and energy generated with pin mixer
- **Increasing throughput to ~20 samples/day**
 - New dough resting regime (15 min FT, 30 min RT)
 - Fast dough preparation with pin mixer

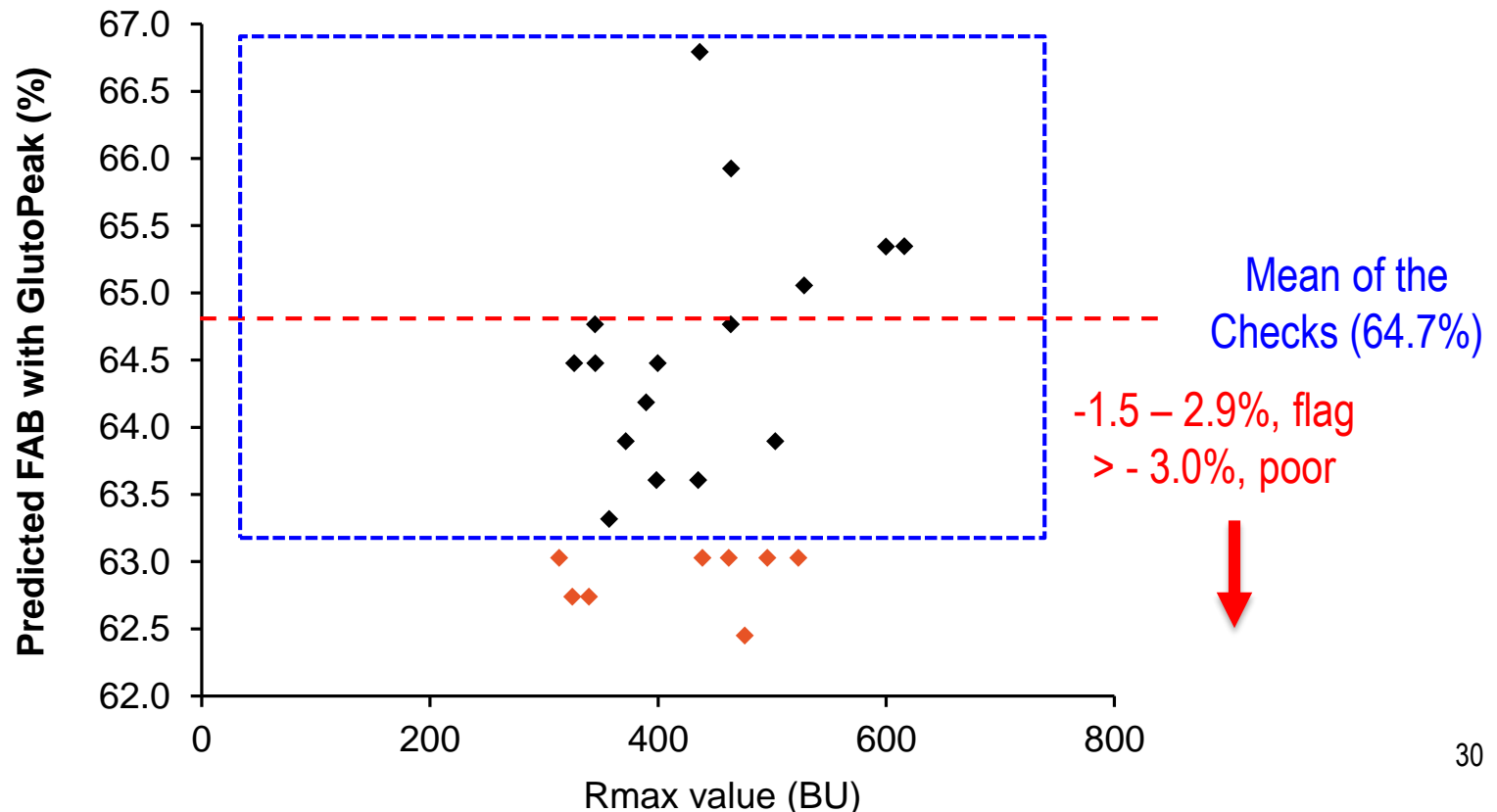
Application of the proposed protocol in selection for quality

- By applying rapid extensograph/GlutoPeak for strength
 - Selecting lines with gluten strength within the defined target



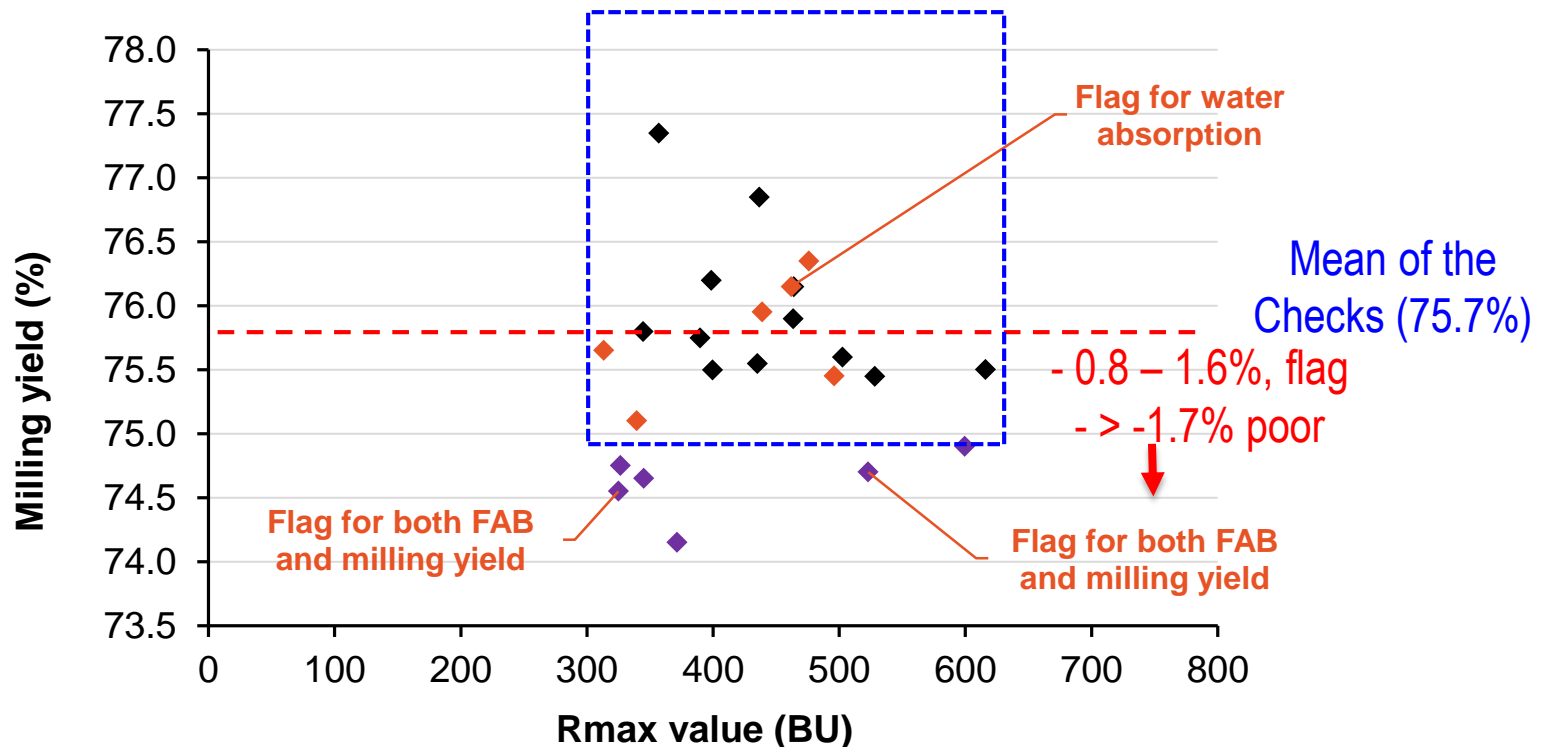
Application of the proposed protocol in selection for quality

- By further applying GlutoPeak for water absorption
 - Remaining lines will be flagged or rated as poor for water absorption based on assessment guidelines. Poor rating of water absorption results in rejection.

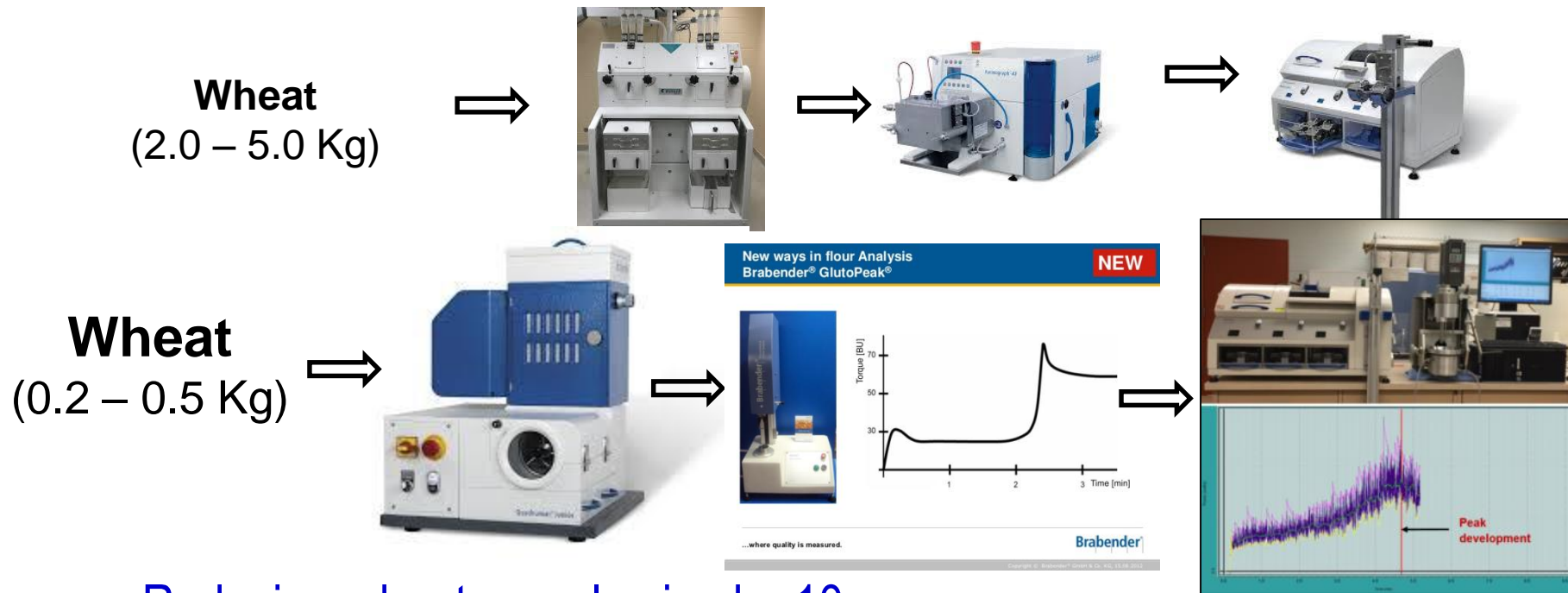


Application of the proposed protocol in selection for quality

- By further applying QJ milling yield
 - Remaining lines will be flagged or rated as poor for milling yield based on assessment guidelines. Poor rating of milling yield results in rejection.



A High throughput protocol with much reduced sample size requirement



- Reducing wheat sample size by 10 x
- Discriminating good from poor in milling yield
- Predicting flour water absorption in < 10 min with < 10 g flour
- Measuring dough viscoelasticity and mixing requirements rapidly
- Increasing overall sample throughput by ~5 x



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