Using the SRC Test Method as a tool for millers.

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Thanks and Notes:

- Thanks to my colleague Mr Peter Lloyd, Regional Technical Director from our Casablanca, Morocco office for sharing much of his valuable research on the milling part of this subject.

- Thanks also to the team at the Wheat Marketing Center of Portland, OR for teaching me all about SRC.

- Disclaimer: I am a simple baker and not a cereal scientist or a miller and do not pretend to know all about cereal chemistry or milling!

Why am I excited about SRC?

- SRC provides a quick, inexpensive way to give us a Functionality Profile for flour.
- Relatively linear response gives us the opportunity to use this test to blend.
- Proven success with soft wheat, which is moving now to hard (bread) wheat testing.
- Cumulative functionality testing of mill streams is now a possibility (previously prohibitively expensive outside Japan).

History

- Developed originally by the Nabisco Company in the US for cookie and cracker flour.
- SRC technology is a unique diagnostic tool for predicting flour functionality, and its applications in soft wheat breeding, milling, and baking are increasing markedly as a consequence of many successful, recently published demonstrations of its extraordinary power and scope.
- Increasingly SRC is being used in hard wheat applications for baking.

SRC Function

- SRC examines the glutenin characteristics of the flour, pentosan content and the starch damage from the milling process.
- These values describe the functionality of the flour's ability to absorb water during the mixing process and its ability to release that water during the baking process.
- The combined pattern of the four SRC values establishes a practical flour quality/functionality profile useful for predicting baking performance and specification conformance.

Four solvents are independently used to produce four SRC values:

- 50 percent **Sucrose SRC**; associated with pentosan characteristics
- 5 percent **Sodium carbonate SRC** ; associated with levels of damaged starch
- 5 percent **Lactic acid SRC**. associated with glutenin characteristics,
- **Water SRC**; is influenced by the other three SRC values.

*(Solvent Retention Capacity Profile 2009).

- SRC values are expressed as percent of flour weight, on a 14 percent moisture basis.

Gluten Performance Index

- A new predictive SRC parameter, the gluten performance index (GPI), defined as

$$\frac{\text{lactic acid SRC}}{\text{(sodium carbonate SRC+ sucrose SRC)}}$$

- has been found to be an even better predictor of the overall performance of flour glutenin in the environment of other modulating networks of flour polymers.

* AACC

Solvent Retention Capacity (SRC)
AACC Method 56-11

Flour Composition

Water	**13 – 14 %**
Starch	**70 – 75 %**
Protein	**9 – 14 %**
Pentosans	**< 2 %**
Fat	**< 1%**
Ash	**< 1 %**

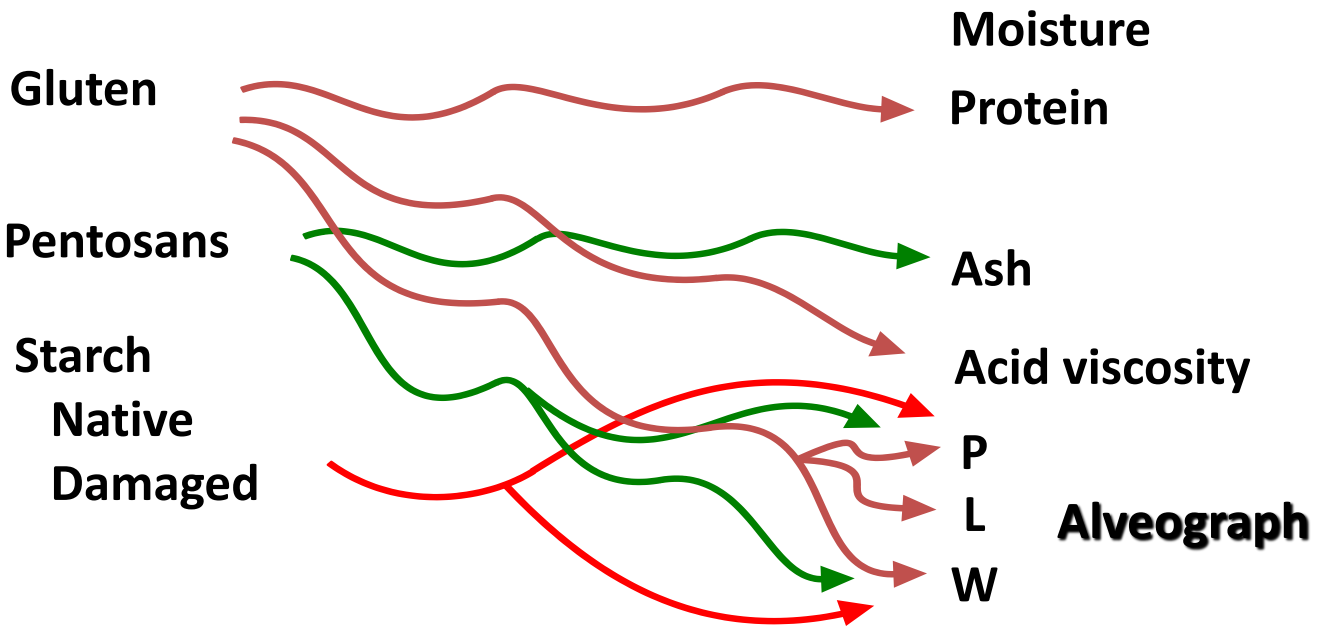
Literature Values for Water Holding Capacity

(Wheat: Chem & Tech, 3rd ed, 1988)

Components	Water Holding Capacity
Gluten (gliadins and glutenins)	2.8 g H_2O / g dry gluten
Non glutenin proteins	Negligible
Pentosans (Soluble and Insoluble)	10 g H_2O / g dry pentosan
Starch	
Native raw	0.3 - 0.45 g H_2O/g dry starch
Damaged raw	1.5 – 10 g H_2O/g dry starch
Gelatinized/pasted	≥ 10 g H_2O/g dry starch

Link Functional Components to Flour Specifications?

Kweon, Miklus, Slade, & Levine (2003)



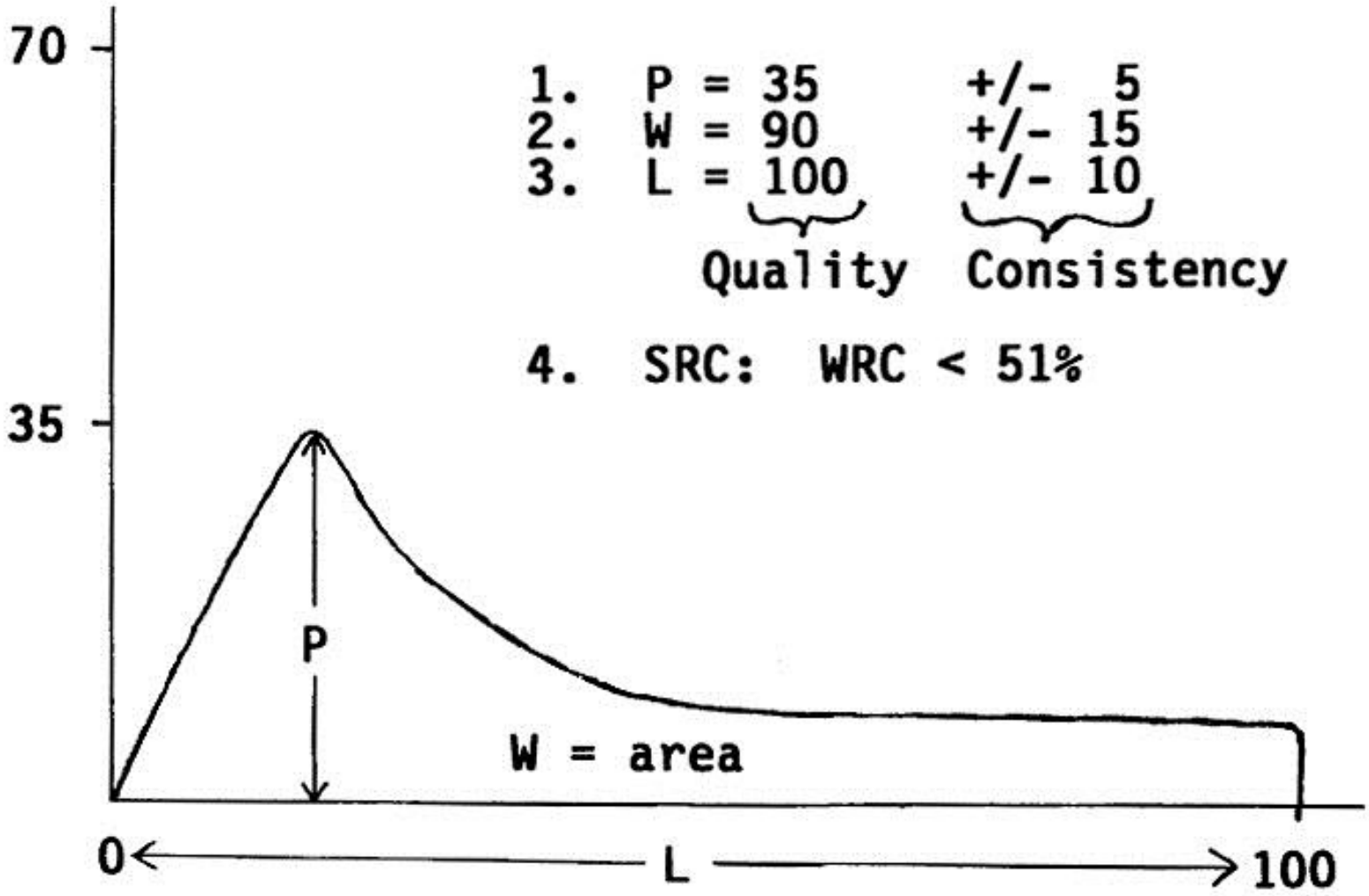
Protein

Gluten vs. Nongluten
Gliadins vs. Glutenins

Pentosans $\neq$ Ash

Idealize Alveograph Profile - cookies

Kweon, Miklus, Slade, & Levine (2003)



How Can We Measure Contributions From Functional Components Directly?

Slade, & Levine (1993h)

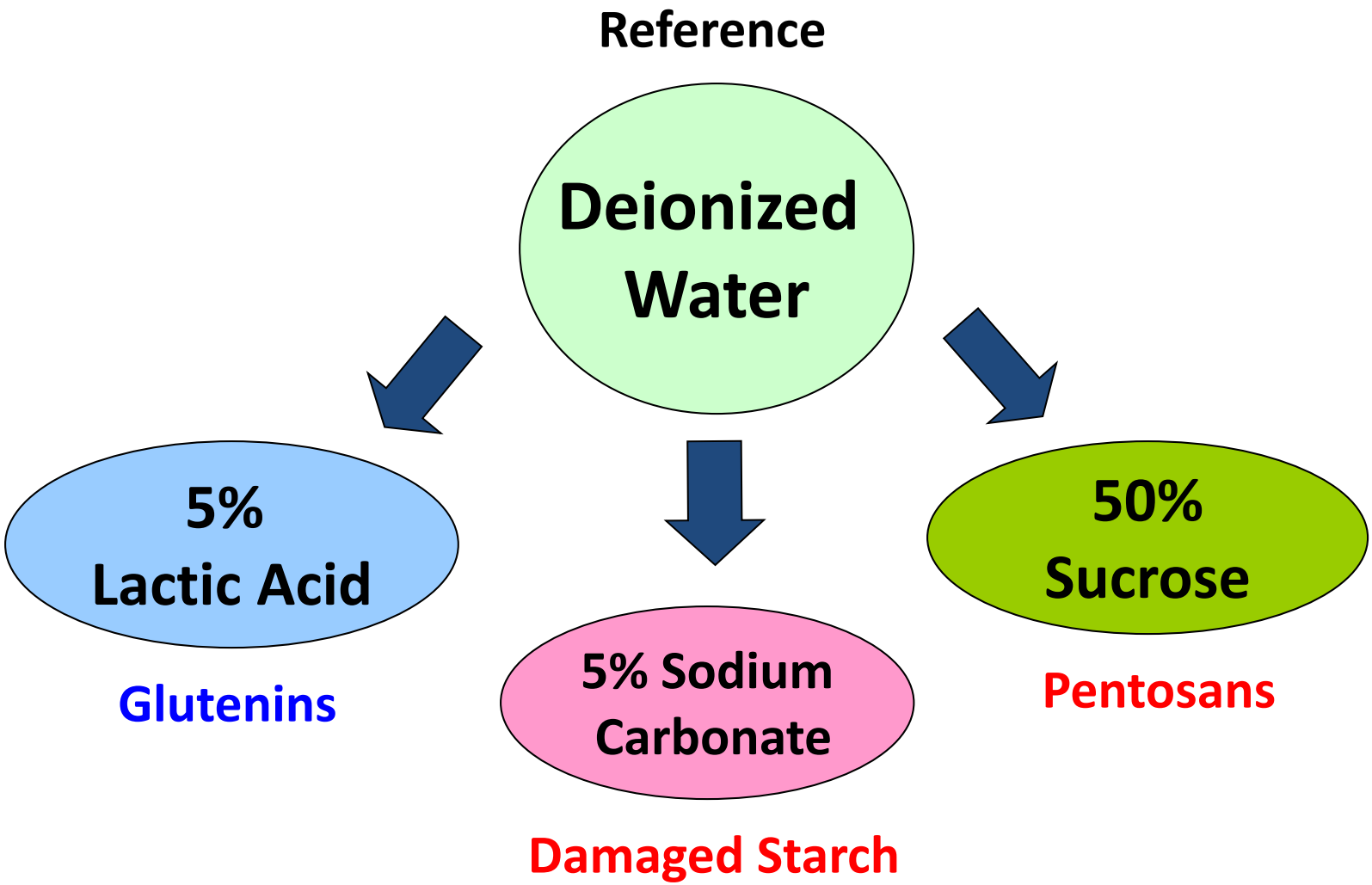
DIAGNOSTIC SOLVENTS

		EXPLORE	MIMIC
PHYSICAL CHEM	WATER *	ALL	SALTINES
	SUCROSE-WATER *	PENTOSANS	RICH CRACKERS SWEET CRACKERS COOKIES
	LACTIC ACID **	GLUTENINS	SPONGE
	Na CARBONATE *	DAMAGED STARCH	~ ALKALINE NOODLES
BIOCHEM	PENTOSANASE	PENTOSANS	
	a-AMYLASE	DAMAGED STARCH	
	PROTEASE	GLUTEN	

* WHITE & WHOLE WHEAT FLOURS FOR RAPID MICRO BREEDERS' SCREENING

** ONLY WHITE FLOURS DUE TO ANOMALOUS ACID SWELLING BRAN

SRC Standard Diagnostic Solvents



SRC PROCEDURE
(AACC Method 56-11)

Selective Solvation

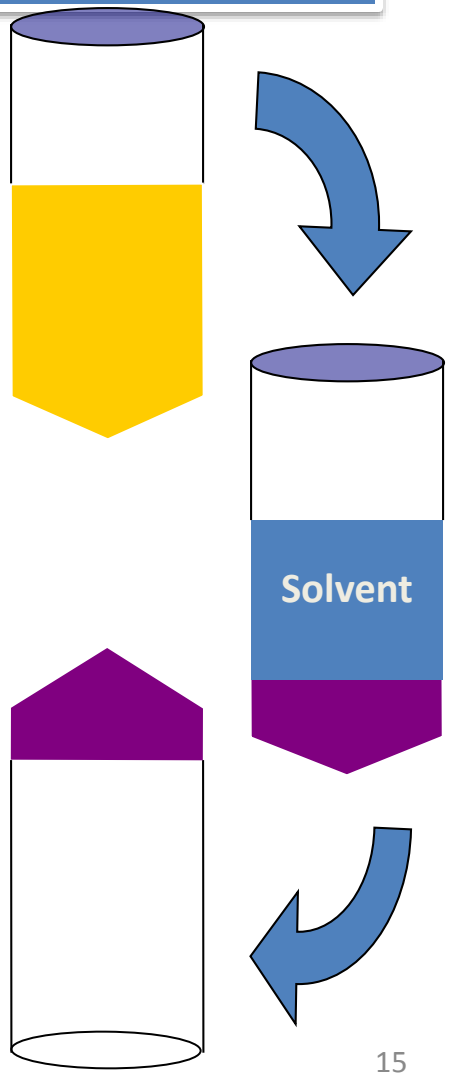
5 g Flour
25 g Solvent
20 min Solvation

Centrifugation

1000 g (Gravity)
15 minutes

Drainage

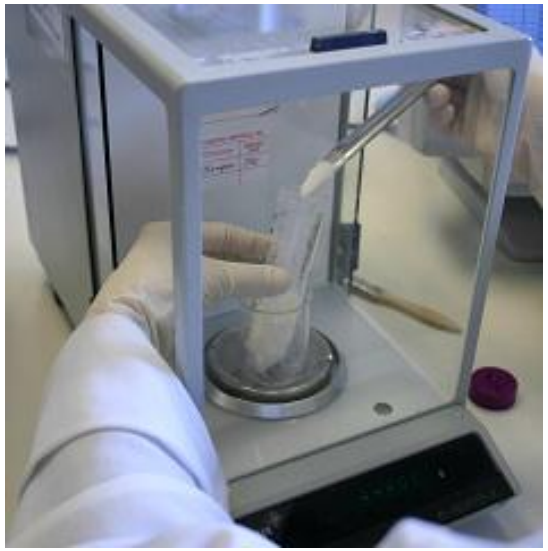
Overturn 180° angle
for 10 minutes

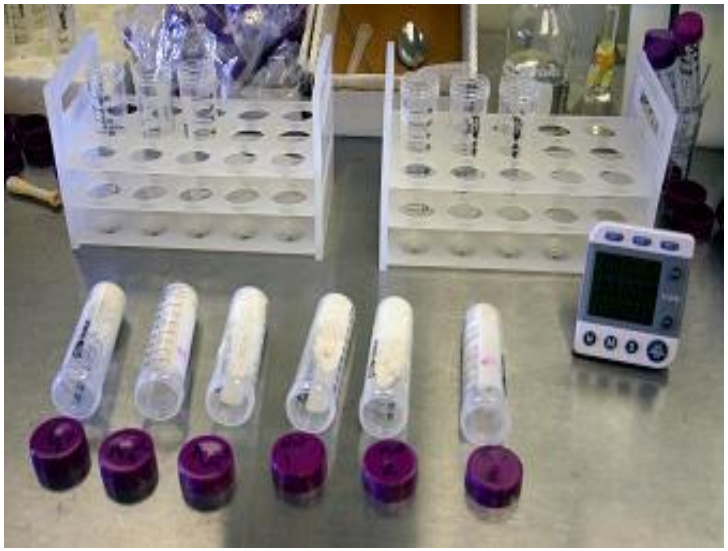


SRC PROCEDURE

Selective Solvation

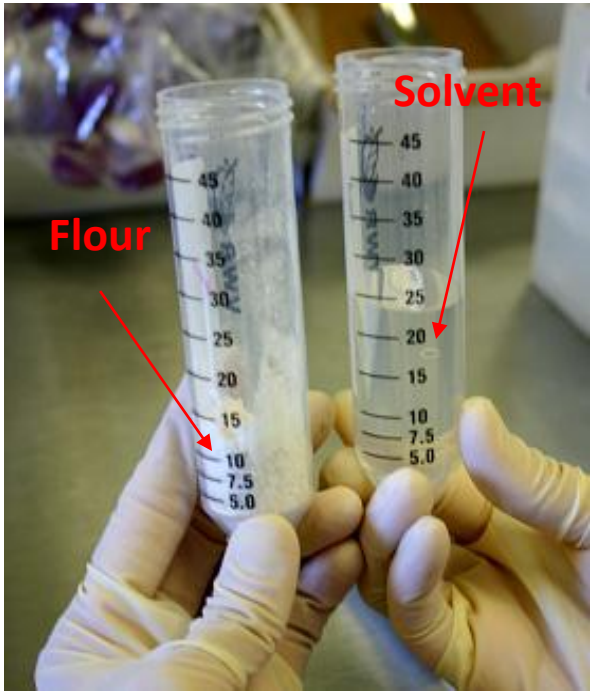
- Weigh 5 g of flour
- Weigh 25 g of each solvent: Water, 50% Sucrose, 5% Lactic Acid and 5% Sodium Carbonate

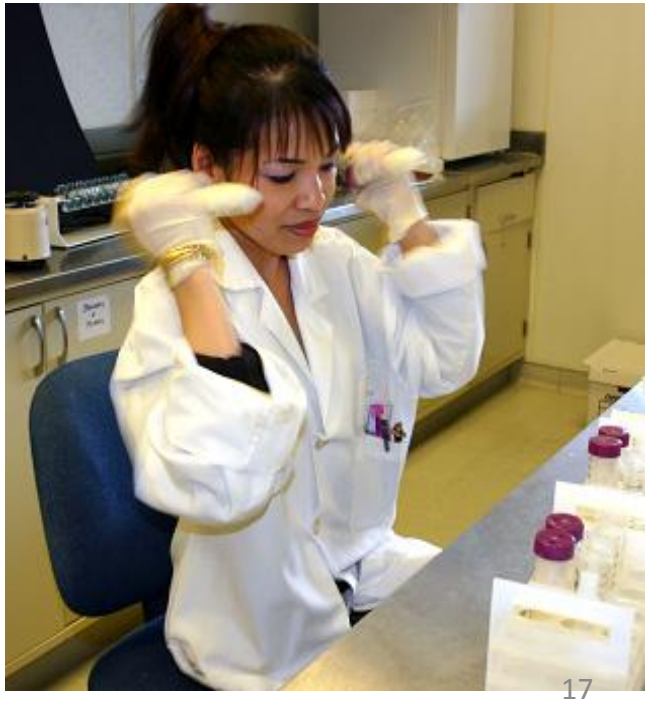




SRC PROCEDURE

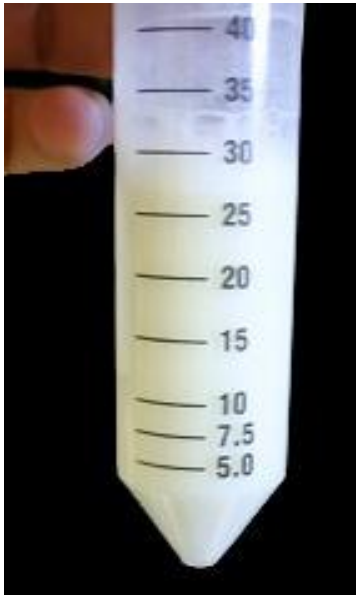
- Start the timer
- Pour the solvent into the flour samples
- Shake the mixture well

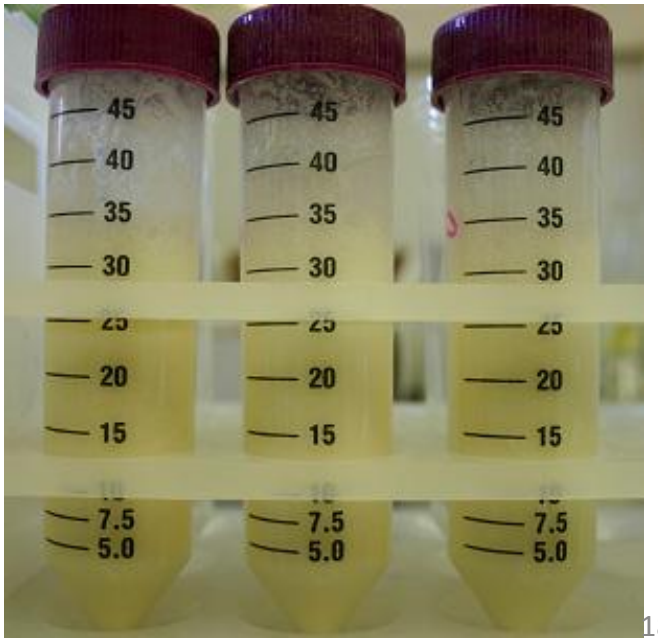




SRC PROCEDURE

- Shake the mixture every 5 minutes
- Shake the mixture for 5 times
- Each time, shake the mixture for 5 seconds

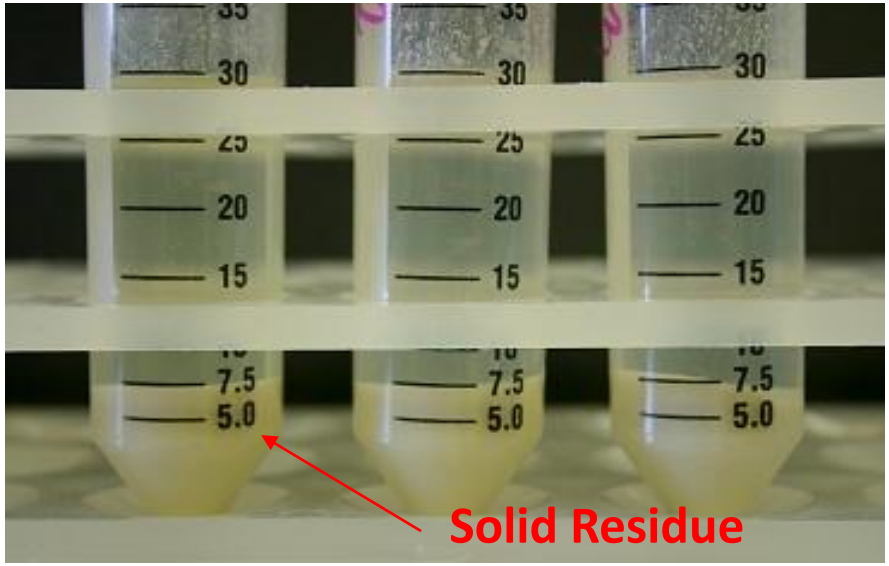




SRC PROCEDURE

Centrifugation

- Place the samples into the Centrifuge
- Centrifuge the samples for 15 minutes at 1000 g



SRC PROCEDURE

Drainage

- Decant supernatant
- Overturn tubes to drain off excessive solvent for 10 minutes
- Cap tubes before weighing

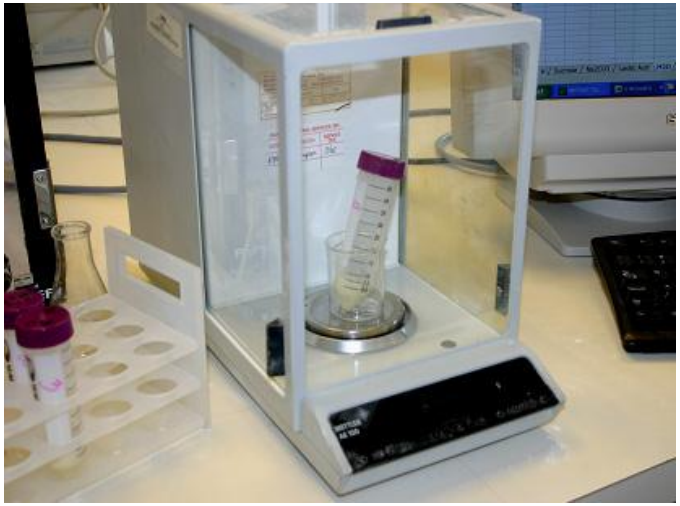
SRC PROCEDURE

- Weigh the drained samples
- Calculate the weight gain - SRC is the weight of solvent held by flour after centrifugation

$$\% \text{ SRC} = \left[\frac{\text{Gel weight}}{\text{Flour weight}} \times \left(\frac{86}{100 - \% \text{ flour moisture}} \right) - 1 \right] \times 100$$

Report:

- SRC Water
- SRC Sucrose
- SRC Lactic Acid
- SRC Sodium Carbonate



Significance of SRC Test Solvents (1)

- When the flour blends are made from mill streams of the SAME WHEAT SOURCE, Water Holding Capacity alone can be predictive of rheology and baking performance
- When the flour blends are made from flours of DIFFERENT WHEAT SOURCES, all diagnostic solvents must be compared by the Swelling Test assays
- Sodium carbonate is the most predictive solvent for measuring flours with variable amounts of damaged starch

Significance of SRC Test Solvents (2)

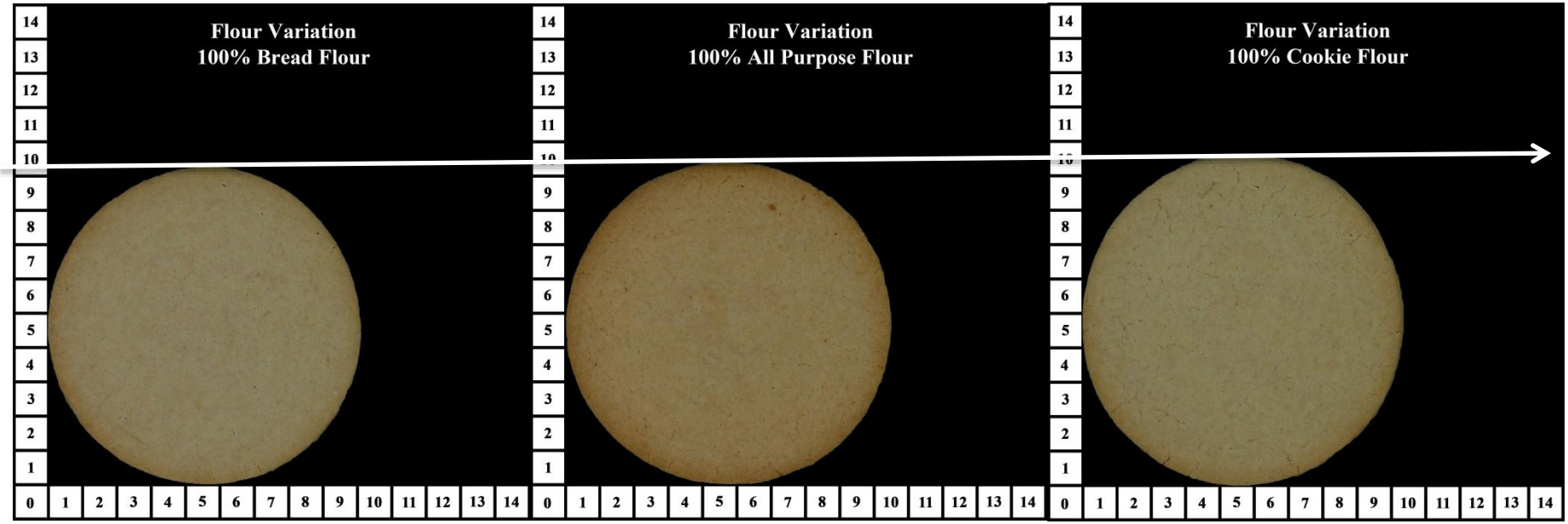
- **Lactic acid is the most predictive solvent for measuring variable gluten quality due to differences in the Glutenin elastic proteins**
- **Sucrose is the most predictive solvent for measuring Pentosan variations in flours**
- **Damaged starch and the water-extractable Pentosans are extremely DETRIMENTAL to cookie and cracker baking; but they are beneficial to bread baking, because of their high water absorbing ability**

Flour Functionality = PATTERN of SRC Values

SRC Behavior Patterns

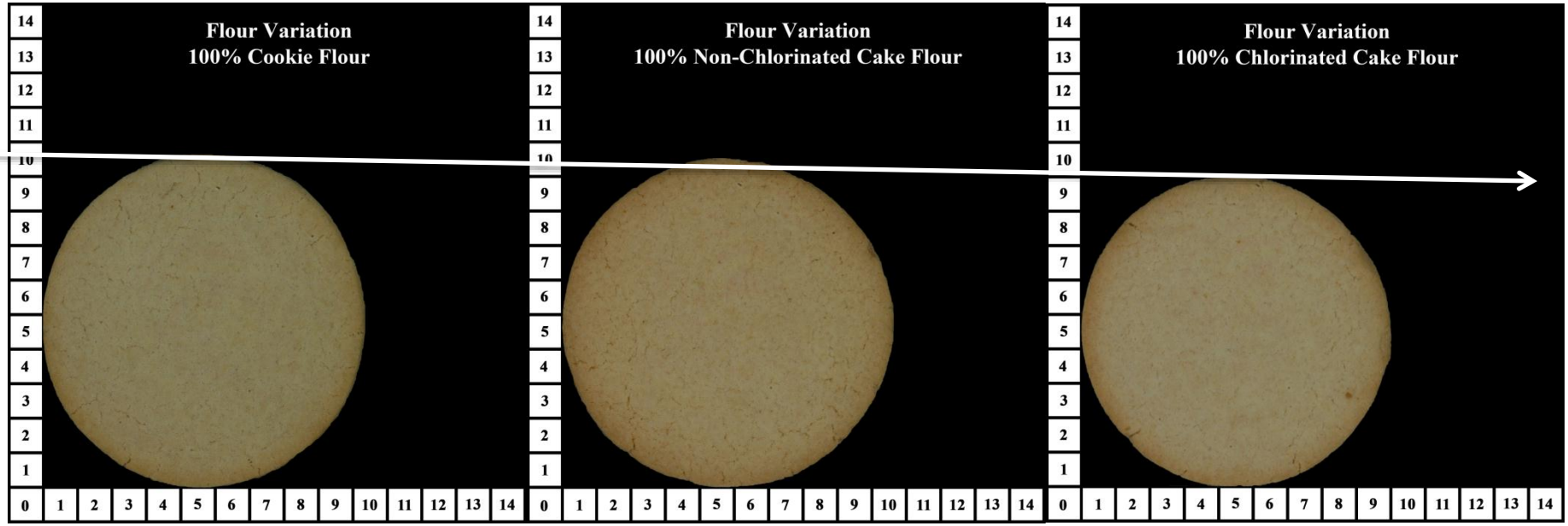
- Serve as a fingerprint
- Predict end-product performance
- Recommend to satisfy end-use requirements

Protein Based Behavior



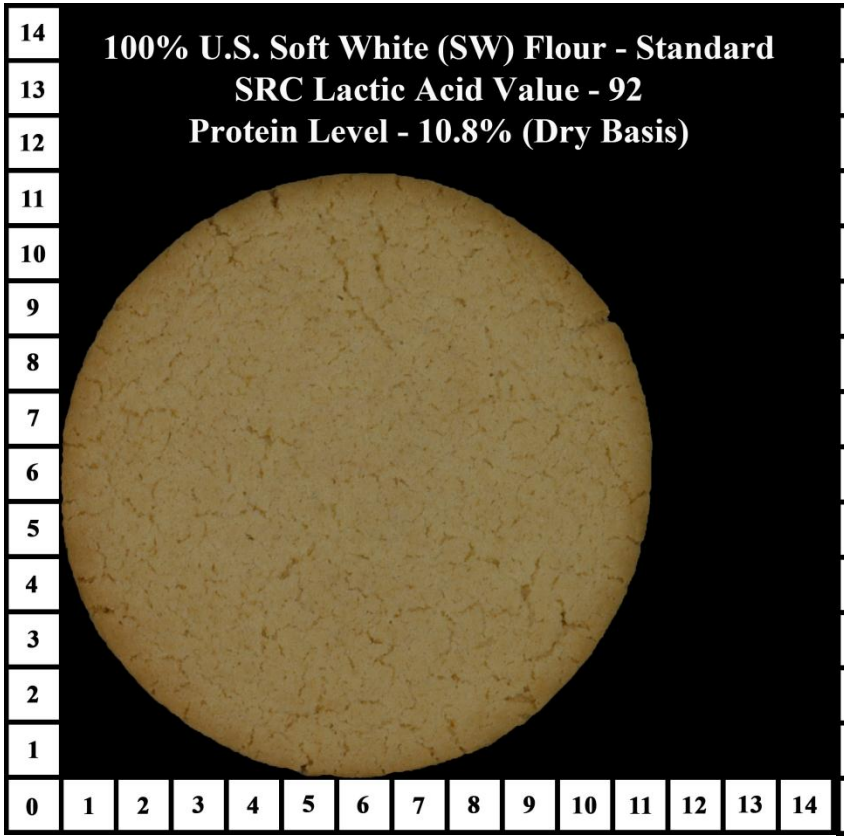
As protein decreases, cookie spread increases

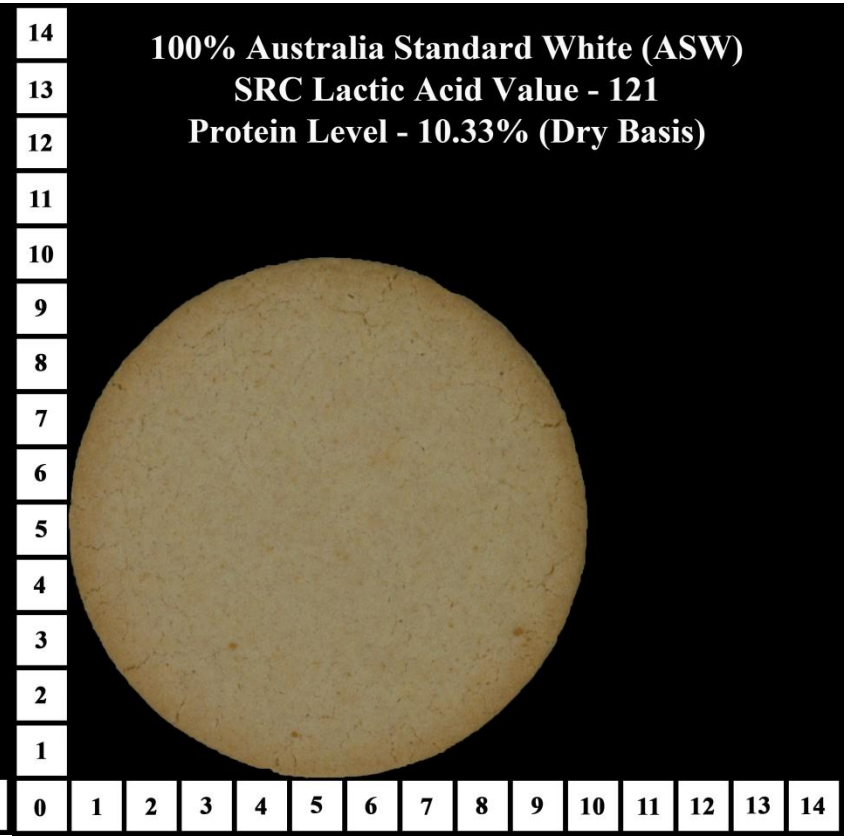
Protein Based Behavior – not always true



As protein decreases, cookie spread also decreases

SRC Based Behavior





Protein does not count, SRC Lactic Acid Value does

COOKIE SPREAD TEST

Cookie Diameter : 8.6 cm
Top Grain Score : 4.0
SRC Lactic Acid : 96%
SRC Na2CO3 : 93%
Flour Protein : 9.4%

Cookie Diameter : 8.2 cm
Top Grain Score : 1.5
SRC Lactic Acid : 107%
SRC Na2CO3 : 85%
Flour Protein : 9.8%

Cookie Diameter : 8.2 cm
Top Grain Score : 0.0
SRC Lactic Acid : 118%
SRC Na2CO3 : 84%
Flour Protein : 11.4%

Cookie Diameter : 8.4 cm
Top Grain Score : 3.0
SRC Lactic Acid : 111%
SRC Na2CO3 : 83%
Flour Protein : 10.3%

Cookie Diameter : 8.8 cm
Top Grain Score : 5.0
SRC Lactic Acid : 80%
SRC Na2CO3 : 78%
Flour Protein: 10.0%

So – how to use SRC in your mill?

SRC Reference Guide – soft wheat products

Absorption: 100% Distilled Water
Pentosan: 50% Sucrose Solution
Damage Starch: 5% Sodium Carbonate Solution
Glutenin: 5% Lactic Acid Solution

Type of SRC Solvents	Weight of Solvent @ 14% Moisture Basis		
	Cracker Flour	*Cookie Flour*	*Wafer Flour*
100% Water	50 to 70	50 to 70	50 to 70
50% Sucrose	80 to 110	80 to 110	80 to 110
5% Sodium Carbonate (pH 11)	60 to 85	60 to 85	60 to 85
5% Lactic Acid (pH 2)	100 to 120	85 to 100	80 to 100

SRC values for Water, Sucrose, and Sodium Carbonate solvents are preferred to be at the lower end of the range listed in the table for weakness

SRC value of Lactic Acid solvent in return requires slightly at the higher end of the range in the table to provide some strength to the end products.

SRC Reference Guide – Hard Wheat Flour

Absorption: 100% Distilled Water
Pentosan: 50% Sucrose Solution
Damage Starch: 5% Sodium Carbonate Solution
Glutenin: 5% Lactic Acid Solution

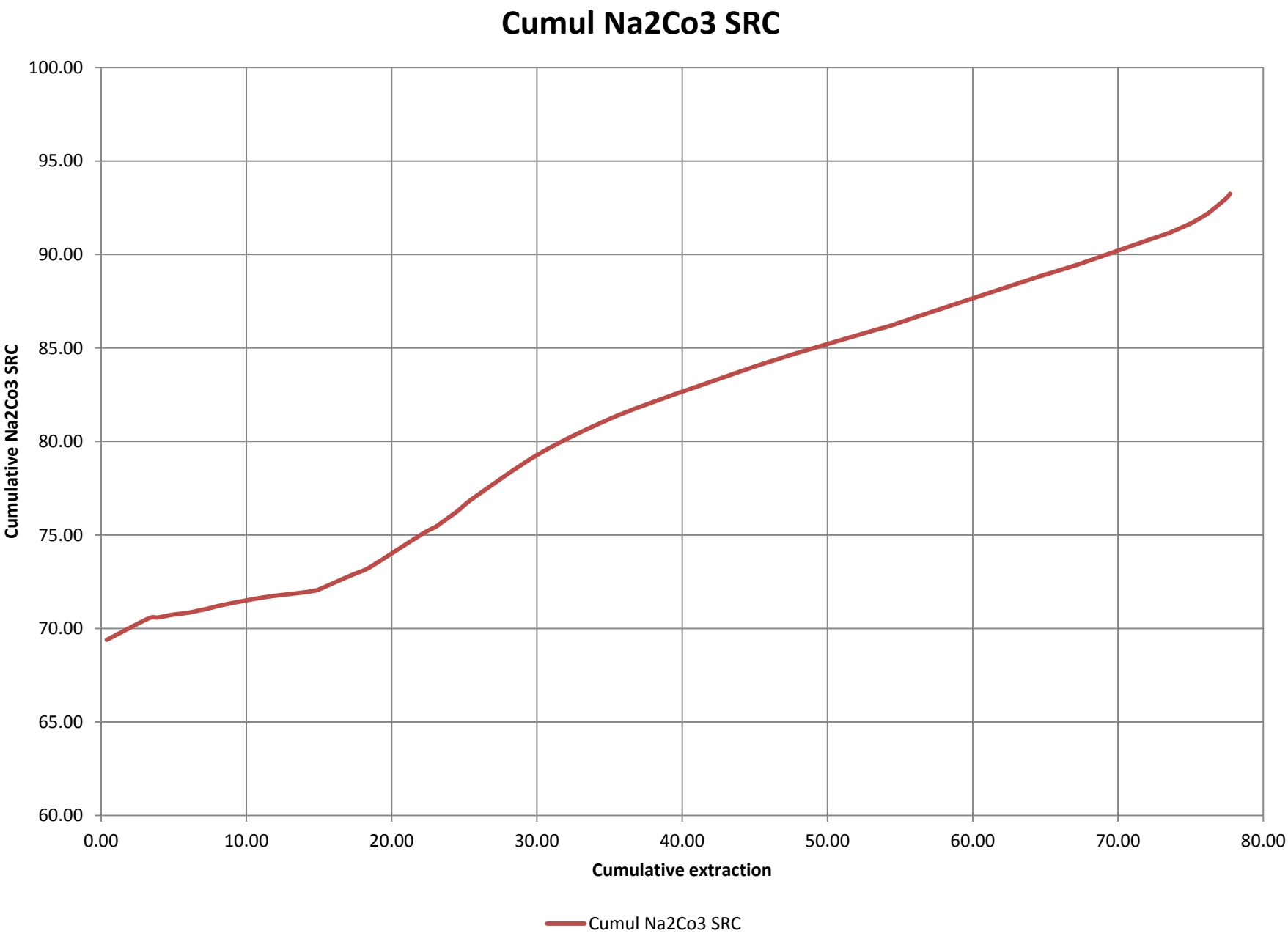
Type of SRC Solvents	Weight of Solvent @ 14% Moisture Basis	
	Bakers Flour Range	**Target**
100% Water	65-70	70
50% Sucrose	105-115	110
5% Sodium Carbonate (pH 11)	80-90	Max 88
5% Lactic Acid (pH 2)	>140	150
Gluten Performance Index (GPI)	0.75	

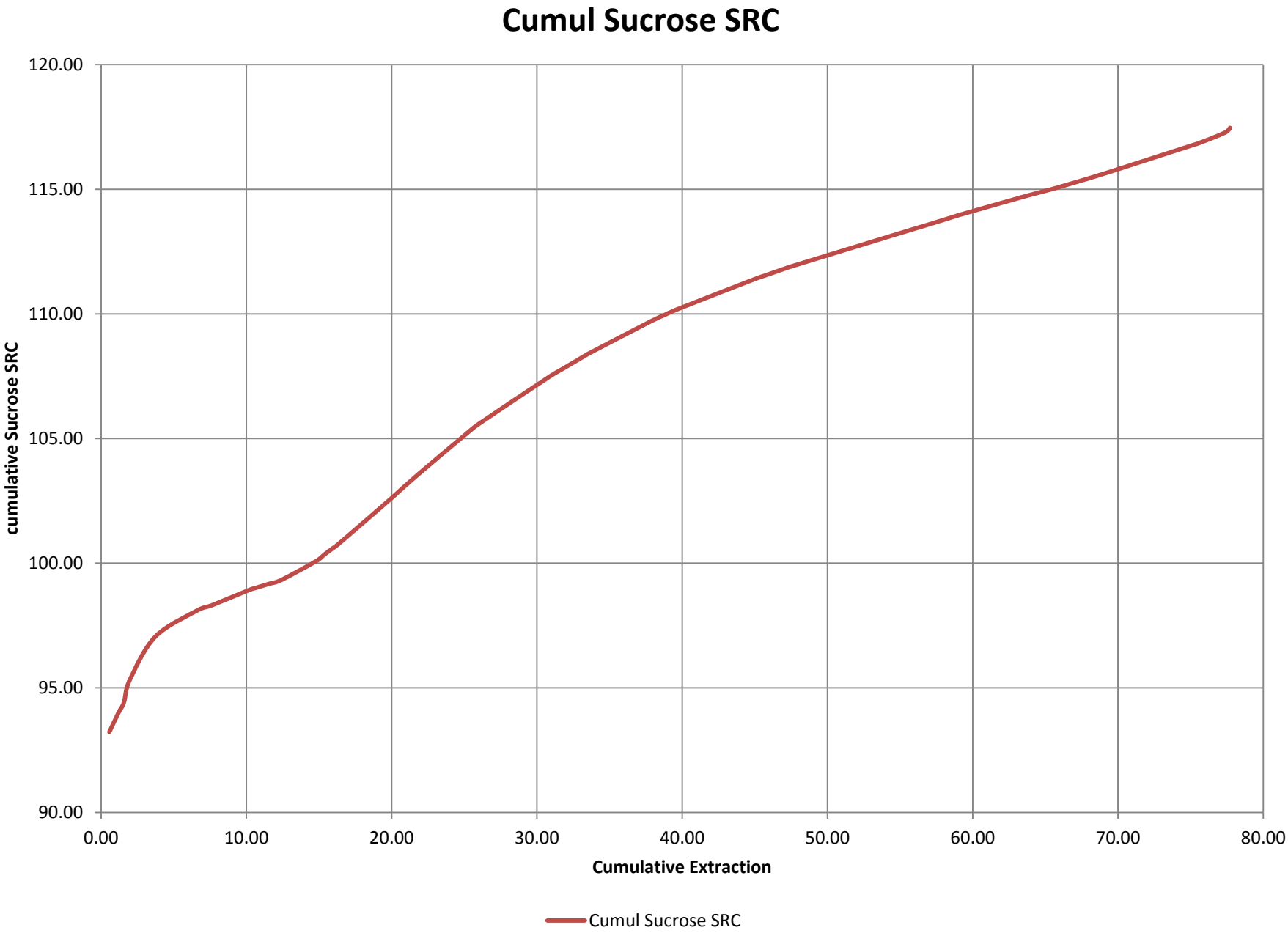
PART 2 – a real world implementation of SRC.

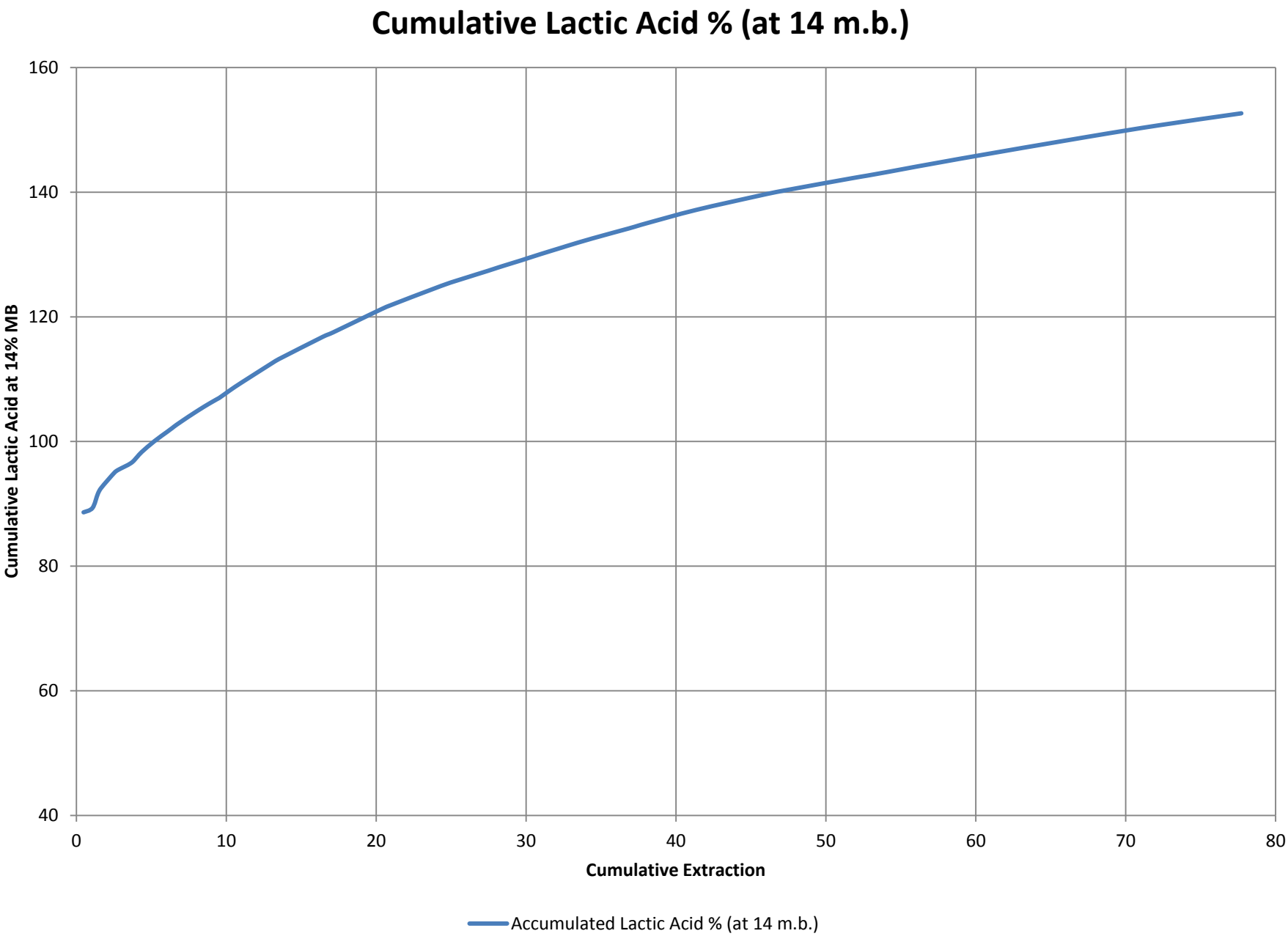
	Protein As is	*SRC Water*	*SRC Sucrose*	*SRC Lactic Acid*	*SRC Na2CO3*	*Gluten performance Index*	*Water Absorption*	*Dev. Time*	*Stability*	*Dept. Time*	*MTI*	*Height NW (cm)*	*Height LW (cm)*	*Volume NW (cc)*	*Volume LW (cc)*
Protein As is	1.000														
SRC Water	-0.238	1.000													
SRC Sucrose	-0.214	0.917	1.000												
SRC Lactic Acid	-0.403	-0.235	-0.039	1.000											
SRC Na2CO3	-0.255	0.975	0.923	-0.216	1.000										
Gluten performance Index	-0.083	-0.775	-0.645	0.775	-0.773	1.000									
Water Absorption	0.139	0.871	0.827	-0.463	0.874	-0.857	1.000								
Dev. Time	0.116	-0.608	-0.471	0.518	-0.580	0.707	-0.622	1.000							
Stability	0.027	-0.777	-0.668	0.421	-0.773	0.755	-0.805	0.786	1.000						
Dept. Time	0.009	-0.787	-0.648	0.602	-0.749	0.867	-0.801	0.759	0.782	1.000					
MTI	0.122	0.555	0.403	-0.447	0.559	-0.609	0.637	-0.549	-0.864	-0.605	1.000				
Height NW (cm)	-0.179	-0.552	-0.460	0.643	-0.620	**0.778**	-0.709	0.535	0.623	0.625	-0.609	1.000			
height LW (cm)	-0.261	-0.567	-0.447	0.699	-0.620	**0.813**	-0.739	0.538	0.647	0.643	-0.636	0.970	1.000		
Volume NW (cc)	-0.136	-0.585	-0.490	0.620	-0.654	**0.784**	-0.727	0.552	0.640	0.637	-0.613	0.997	0.966	1.000	
Volume LW (cc)	-0.218	-0.595	-0.473	0.680	-0.649	**0.821**	-0.755	0.553	0.668	0.658	-0.650	0.969	0.997	0.969	1.000

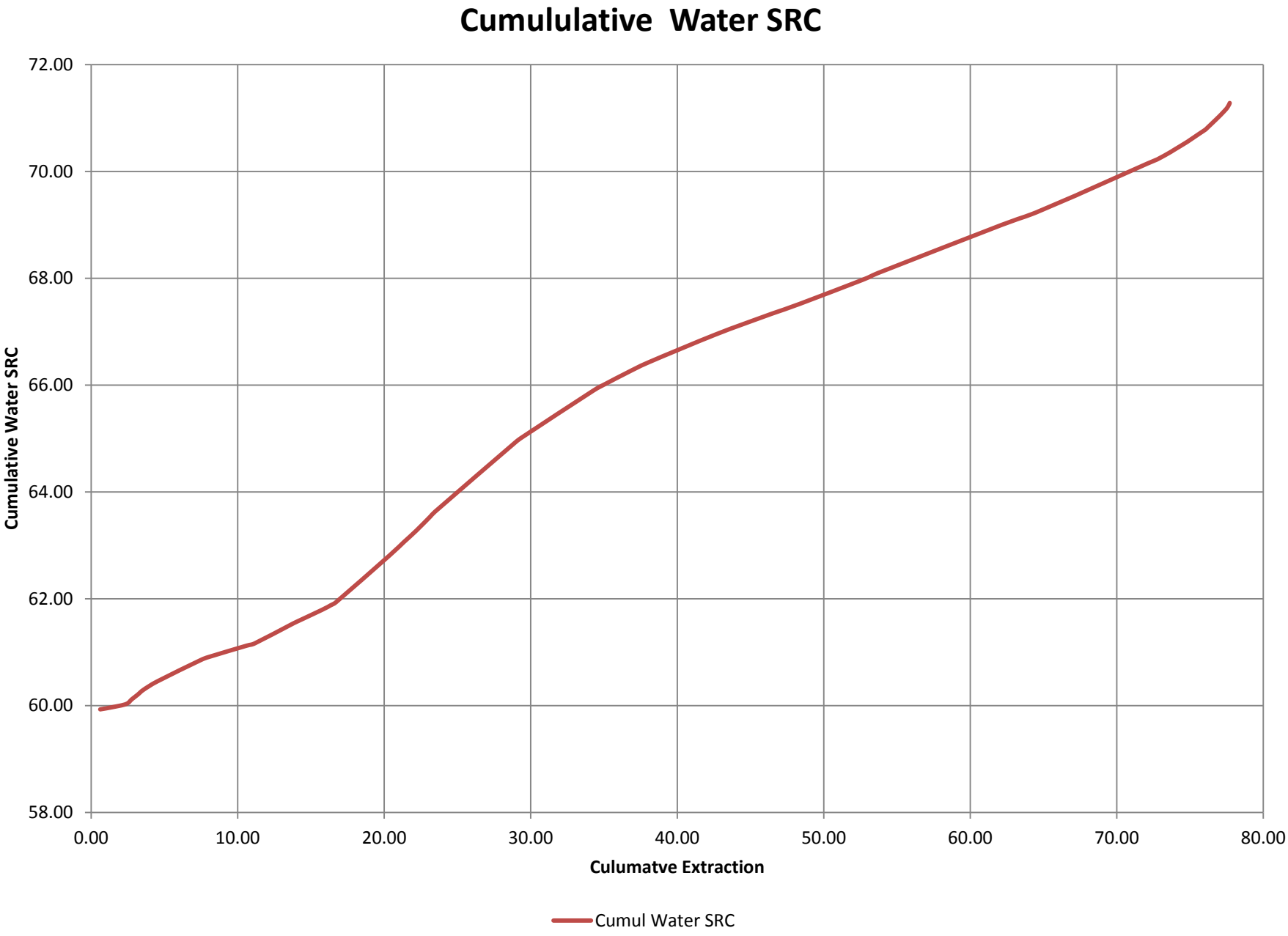
Mill Stream Analysis

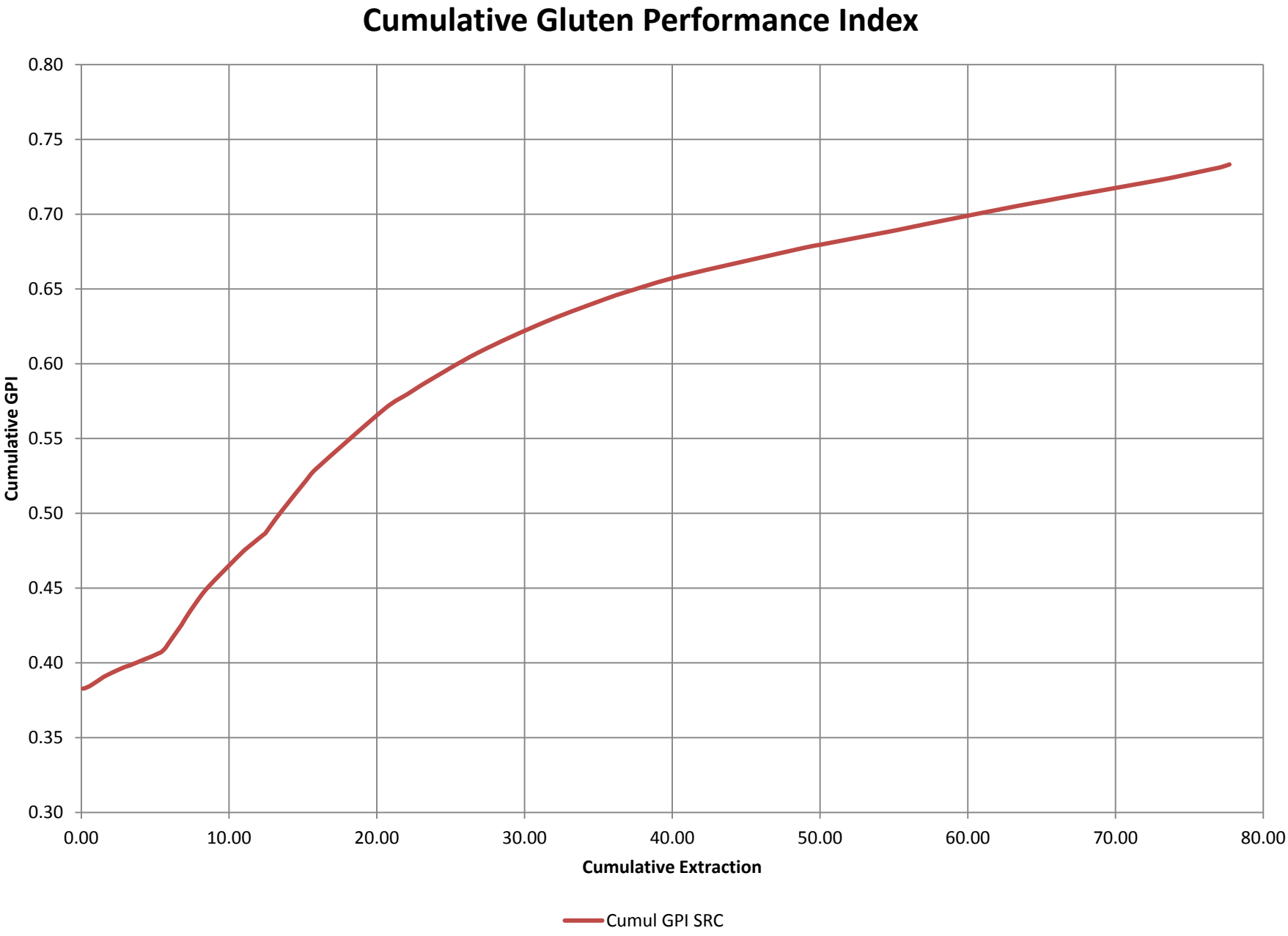
Reduction stages	Yield in %	Moisture (%)	Ash db (%)	SRC			
				Water	Sucrose	Lactic Acid	Na_2CO_3
C3A G (I)	**8.44**	13.08	0.35	74.73	121.83	**173.20**	103.23
C1/2A F (I)	**4.86**	14.80	0.38	71.19	117.62	**177.00**	92.79
C3A H (I)	**4.71**	12.93	0.38	78.38	129.94	**169.18**	109.20
C1/2A H (I)	**5.48**	14.24	0.38	70.48	120.42	**177.94**	96.95
C1/2A F (II)	**0.97**	14.13	0.40	69.66	120.13	**163.80**	92.69
C1/2AH (II)	**1.48**	14.21	0.40	71.22	114.12	**166.05**	95.48
C1/2A G (II)	**1.63**	14.13	0.41	72.06	119.33	**162.80**	93.68
C1/2A G (I)	**3.31**	14.19	0.41	71.62	115.93	**161.78**	95.28
C5 H (I)	**4.25**	13.32	0.43	73.03	119.86	**161.93**	92.80
C5 G (I)	**4.57**	13.44	0.44	71.28	124.54	**162.89**	92.74
C3 B (II)	**1.76**	14.00	0.44	63.60	99.00	**145.60**	77.80
C3 B (I)	**3.65**	14.04	0.47	66.82	110.82	**144.03**	84.22
C1/2B K (I)	**1.58**	13.90	0.48	75.20	124.34	**155.90**	101.17
C3A G (II)	**0.11**	12.41	0.50	78.11	119.34	**130.34**	104.03
C1/2B J (I)	**1.44**	14.04	0.52	71.28	121.10	**154.12**	96.29
C5 H (II)	**0.50**	12.68	0.53	74.72	123.57	**146.61**	96.98
C5 G (II)	**0.71**	13.09	0.53	75.74	123.24	**149.56**	99.29
DIV 1 F (II)	**0.61**	14.39	0.54	59.93	94.68	**117.59**	71.98
DIV 1 E (I)	**2.59**	14.84	0.55	61.78	100.76	**140.35**	72.89
DIV 1 E (II)	**0.57**	14.37	0.56	61.70	93.23	**161.12**	70.73
B2 A (I)	**0.81**	14.75	0.57	60.00	101.36	**147.36**	71.29
B2 C (I)	**0.95**	14.88	0.58	61.05	101.06	**149.76**	71.35
B2 B (I)	**0.97**	18.74	0.58	68.27	118.44	**153.36**	79.28
DIV 3 (II)	**0.36**	14.17	0.58	64.53	107.61	**152.30**	74.95
DIV 1 F (I)	**2.93**	14.46	0.58	61.46	99.47	**133.25**	70.71
B2 D (I)	**0.96**	15.14	0.60	60.12	99.65	**143.83**	72.69
DIV 3 (I)	**2.44**	14.58	0.62	63.10	103.98	**156.93**	72.97
C3A H (II)	**0.04**	11.45	0.62	93.27	148.82	**143.97**	133.28
B1 C (I)	**0.40**	15.39	0.66	60.80	100.85	**125.44**	71.98
B3 C (I)	**0.59**	15.03	0.67	64.17	107.28	**160.72**	72.47
B1 D (I)	**0.40**	14.87	0.68	61.03	98.81	**123.86**	71.33
B3 D (I)	**0.40**	14.76	0.69	63.44	113.28	**155.86**	73.74
B3 B (I)	**0.56**	14.85	0.69	62.00	107.25	**150.68**	73.31
B1 E (I)	**0.39**	15.11	0.70	60.67	95.73	**119.23**	69.39
C4 (I)	**0.68**	13.37	0.74	84.65	124.95	**134.48**	110.46
C6 (I)	**2.25**	13.17	0.84	77.19	126.81	**129.78**	104.82
C6 (II)	**0.67**	12.94	0.88	78.60	124.63	**126.01**	107.05
DF (II)	**0.30**	13.61	1.05	70..23	123.79	**114.43**	87.95

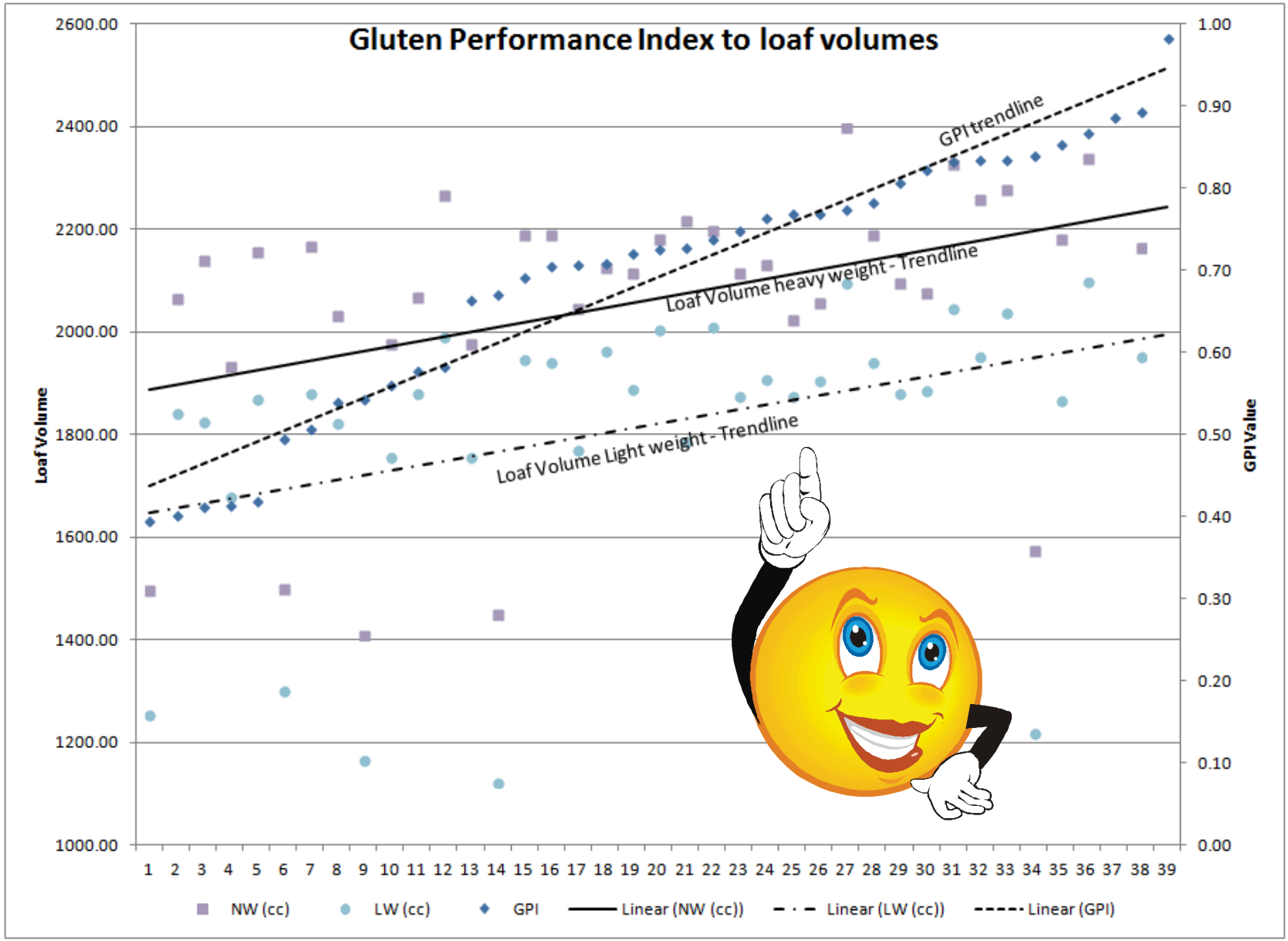

Cumul Na2Co3 SRC
100.00
95.00
90.00
85.00
80.00
75.00
70.00
65.00
60.00
Cumulative Na2Co3 SRC
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Cumulative extraction
Cumul Na2Co3 SRC


Cumul Sucrose SRC
120.00
115.00
110.00
105.00
100.00
95.00
90.00
cumulative Sucrose SRC
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Cumulative Extraction
Cumul Sucrose SRC


Cumulative Lactic Acid % (at 14 m.b.)
160
140
120
100
80
60
40
Cumulative Lactic Acid at 14% MB
0
10
20
30
40
50
60
70
80
Cumulative Extraction
Accumulated Lactic Acid % (at 14 m.b.)

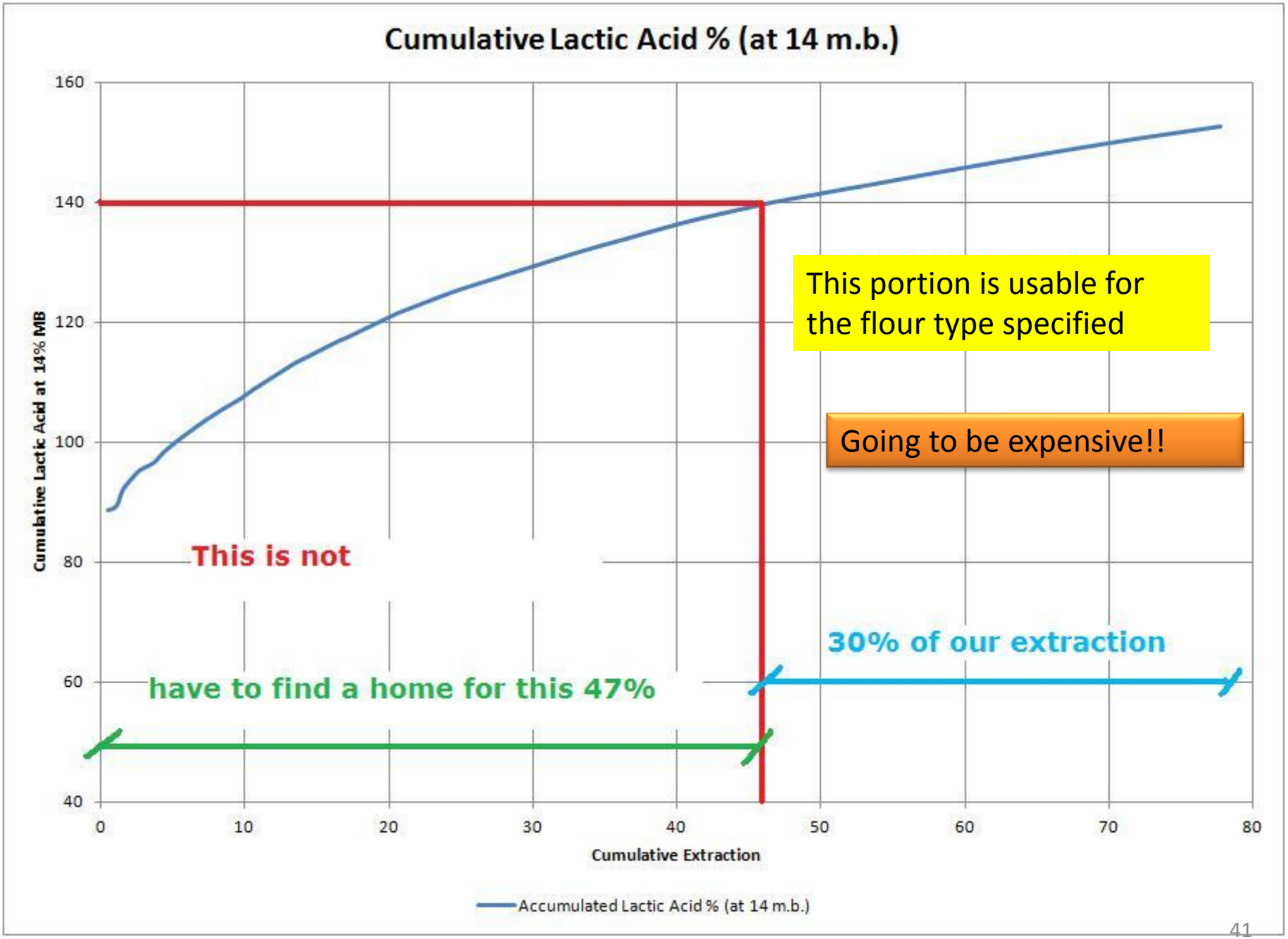

Cumululative Water SRC
72.00
70.00
68.00
66.00
64.00
62.00
60.00
58.00
Cumulative Water SRC
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Culumatve Extraction
Cumul Water SRC

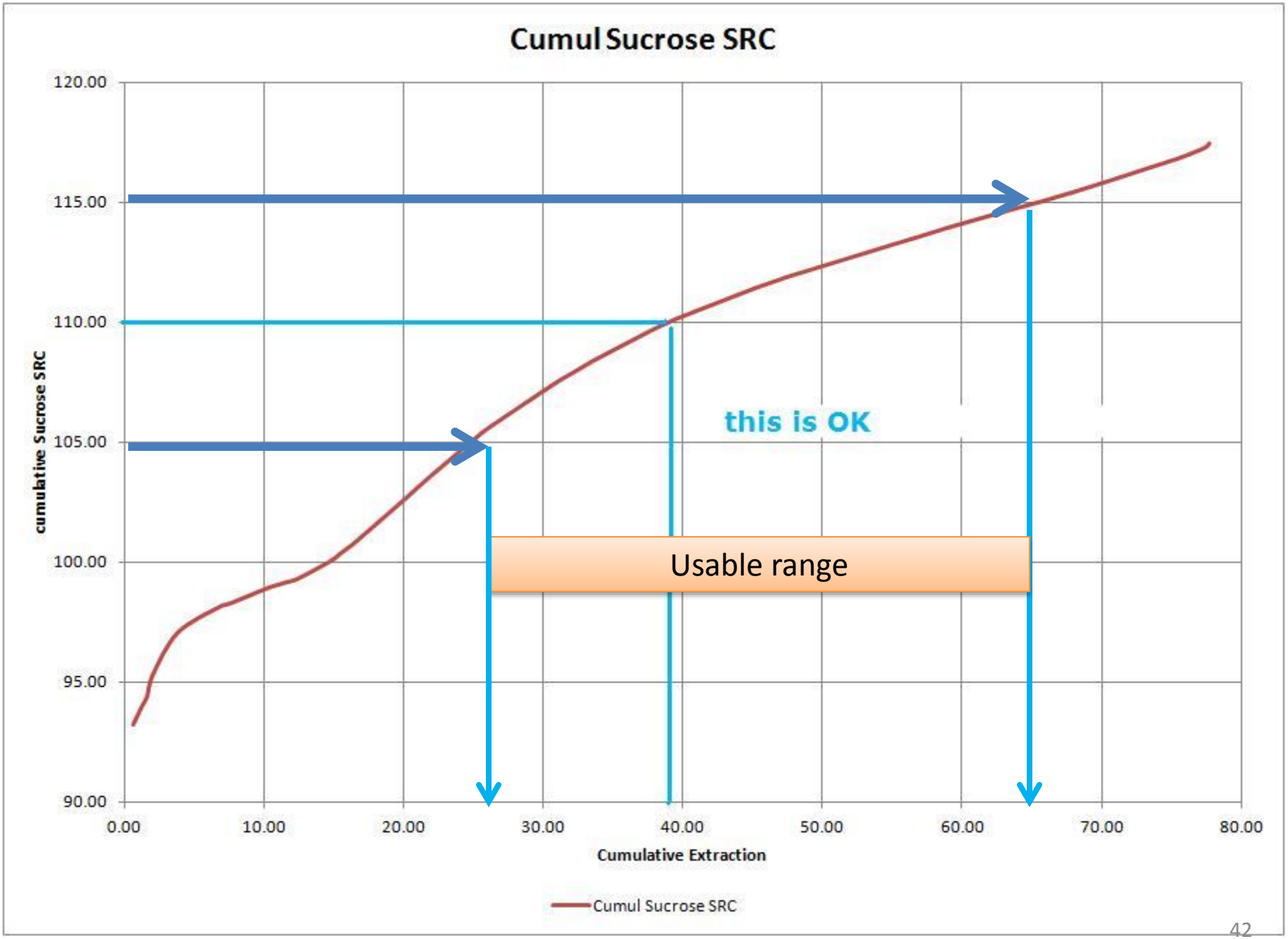

Cumulative Gluten Performance Index
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
Cumulative GPI
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Cumulative Extraction
Cumul GPI SRC

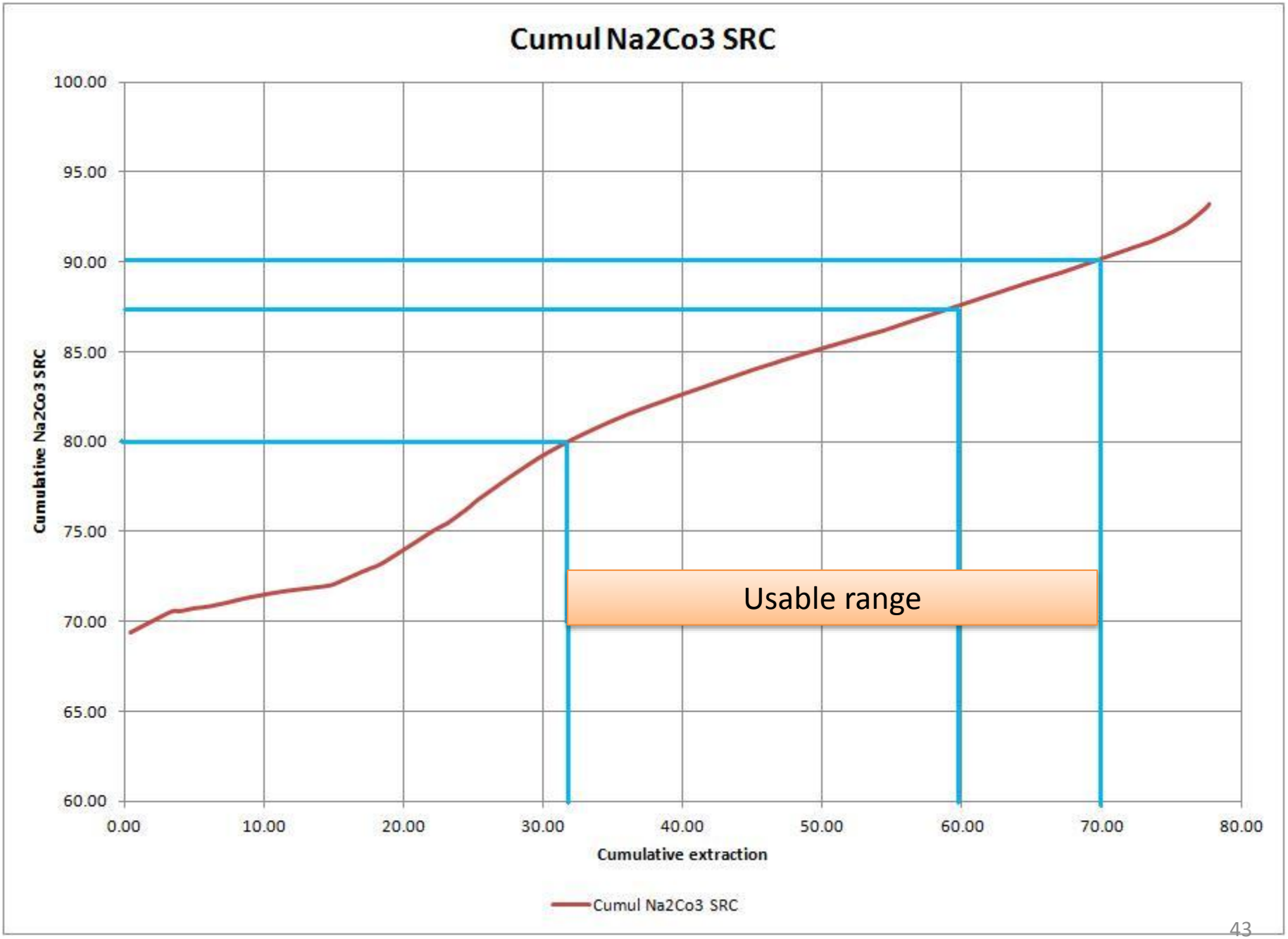

Gluten Performance Index to loaf volumes
Loaf Volume
GPI Value
2600.00
2400.00
2200.00
2000.00
1800.00
1600.00
1400.00
1200.00
1000.00
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39
GPI trendline
Loaf Volume heavy weight - Trendline
Loaf Volume Light weight - Trendline
NW (cc)
LW (cc)
GPI
Linear (NW (cc))
Linear (LW (cc))
Linear (GPI)

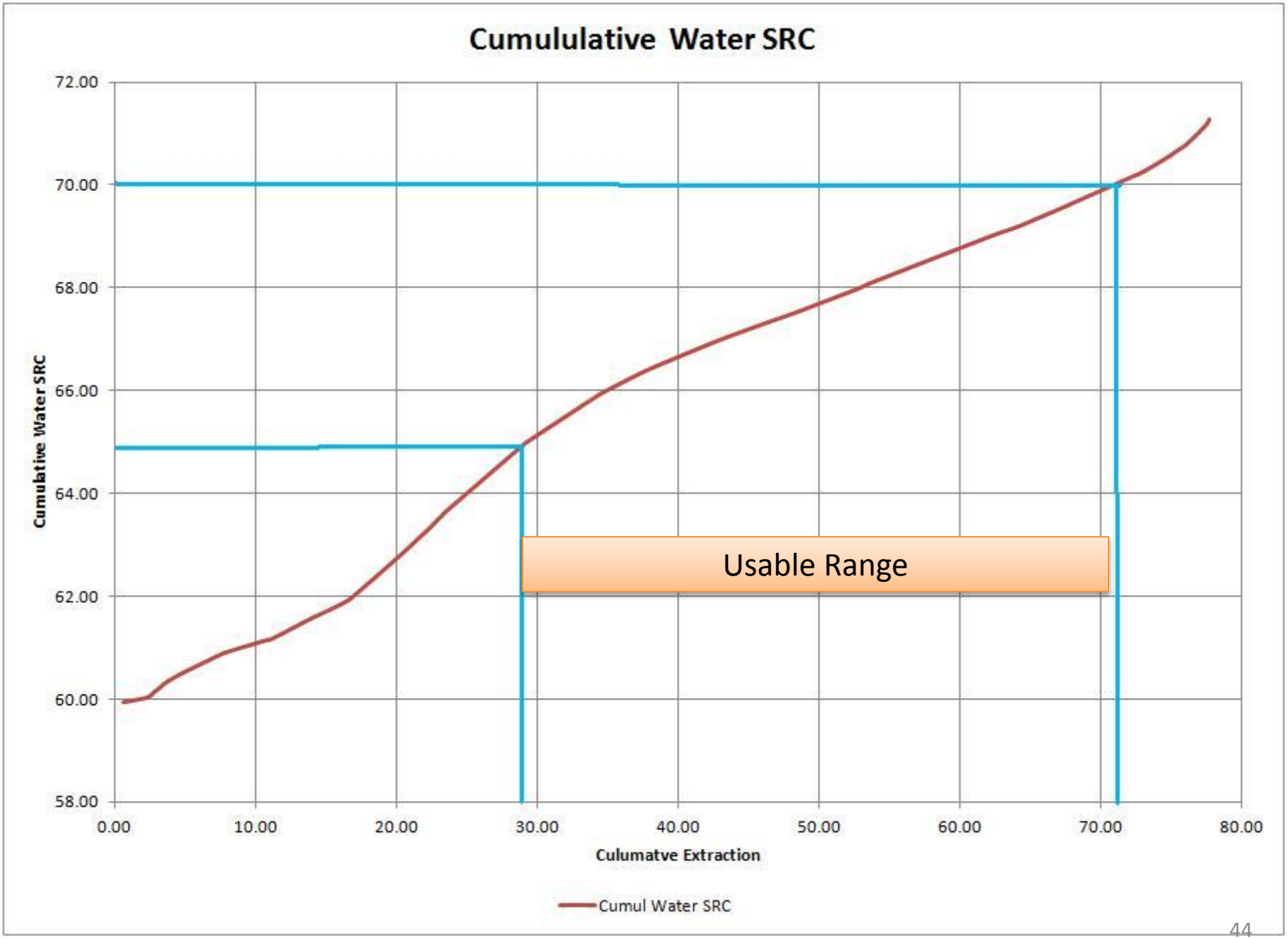
Can I make this type of flour?

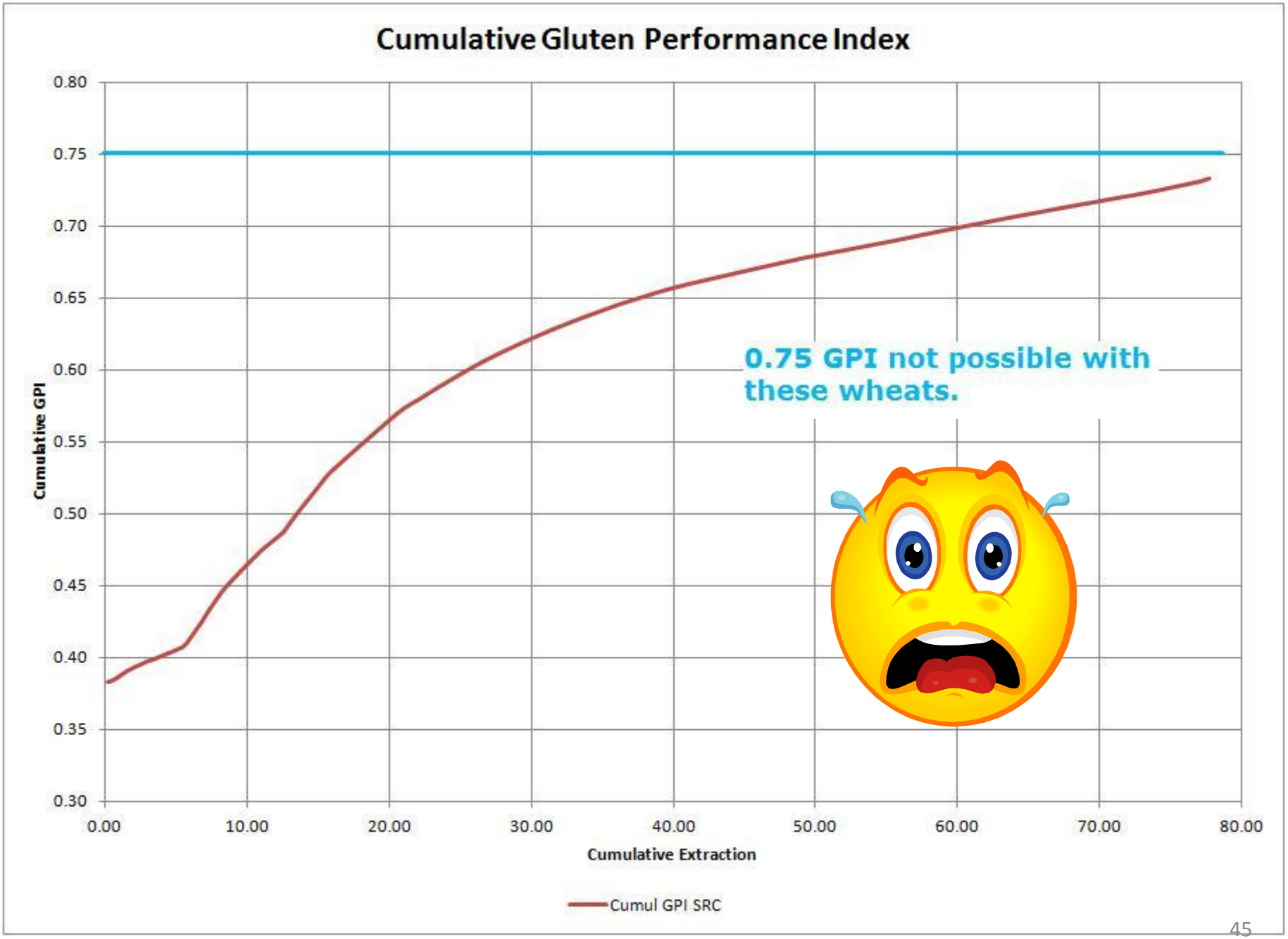
Type of SRC Solvents	Weight of Solvent @ 14% Moisture Basis	
	Bakers Flour Range	**Target**
100% Water	65-70	70
50% Sucrose	105-115	110
5% Sodium Carbonate (pH 11)	80-90	Max 88
5% Lactic Acid (pH 2)	>140	150
Gluten Performance index	0.75	


Cumulative Lactic Acid % (at 14 m.b.)
160
140
120
100
80
60
40
Cumulative Lactic Acid at 14% MB
0
10
20
30
40
50
60
70
80
Cumulative Extraction
This portion is usable for the flour type specified
Going to be expensive!!
This is not
have to find a home for this 47%
30% of our extraction
Accumulated Lactic Acid % (at 14 m.b.)


Cumul Sucrose SRC
120.00
115.00
110.00
105.00
100.00
95.00
90.00
cumulative Sucrose SRC
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Cumulative Extraction
this is OK
Usable range
Cumul Sucrose SRC


Cumul Na2Co3 SRC
100.00
95.00
90.00
85.00
80.00
75.00
70.00
65.00
60.00
Cumulative Na2Co3 SRC
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Cumulative extraction
Usable range
Cumul Na2Co3 SRC


Cumululative Water SRC
72.00
70.00
68.00
66.00
64.00
62.00
60.00
58.00
Cumulative Water SRC
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Culumatve Extraction
Usable Range
Cumul Water SRC


Cumulative Gluten Performance Index
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
Cumulative GPI
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Cumulative Extraction
0.75 GPI not possible with these wheats.
Cumul GPI SRC

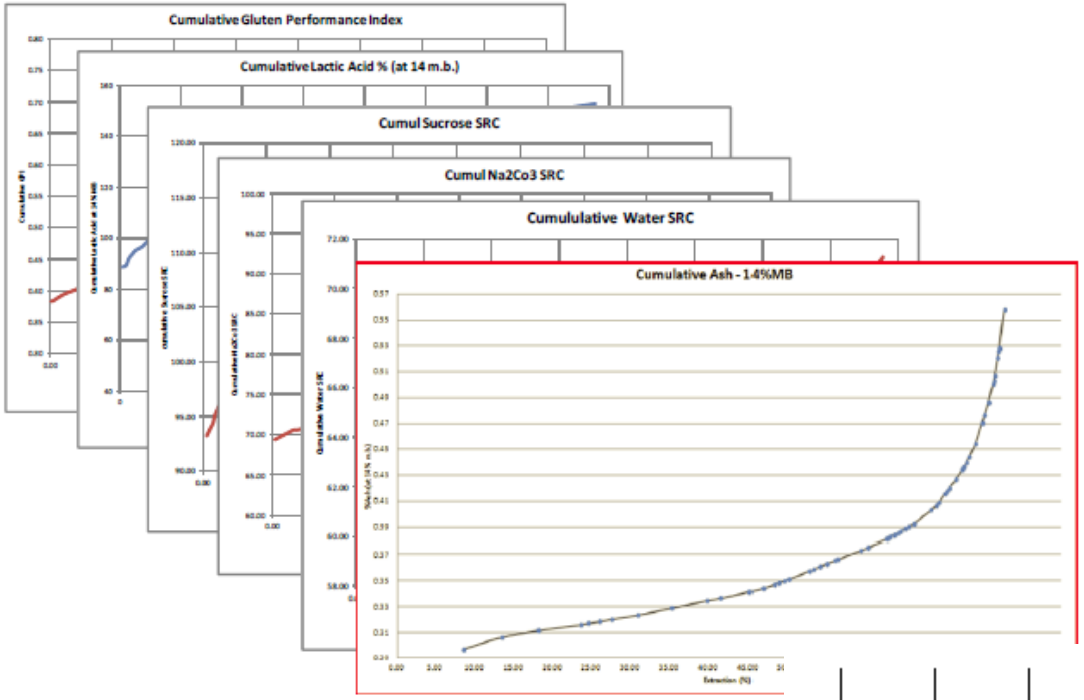
Conclusions

1. The type of flour specified cannot be made with and streams of the type of wheat we had on the mill!

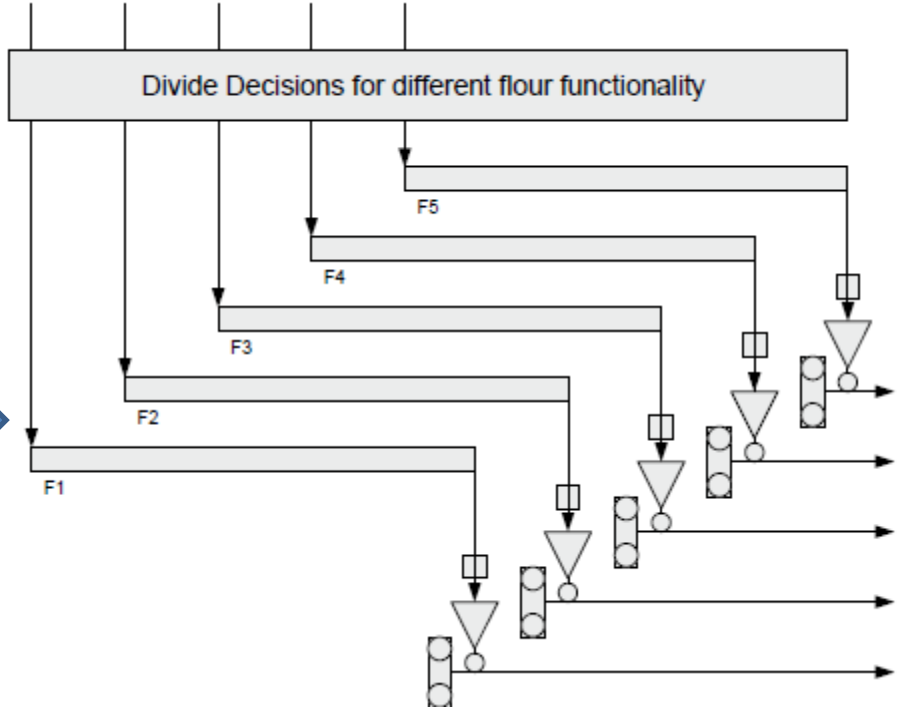
2. If we were able to make the GPI, then the flour price would be very high due to only 30% extraction.

3. Better to find this out before we supply the customer than afterwards!

Back to the drawing board!



Knowing these



Will enable you to optimize each of your flour types, your production divide and/or base flours used in blending.

This means giving the customer what he or she values most!

Further Reading

OPTIMIZING WHEAT BLENDS FOR
CUSTOMER VALUE CREATION:
A SPECIAL CASE OF SOLVENT RETENTION CAPACITY
by
NIKOLAS C HAAS
B.S., Kansas State University, 2006

Thank You for your valued business, and for your attention today.
We wish you every success for the future!