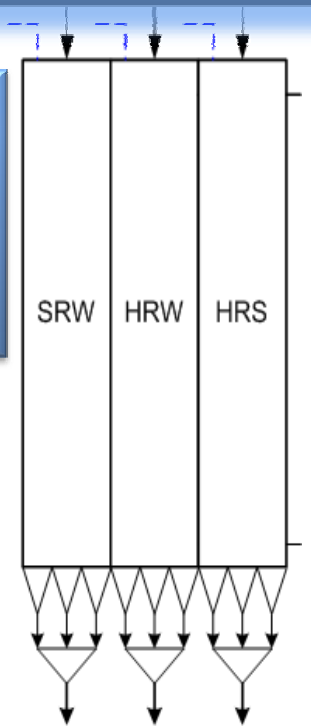
Protein Power - Performance or Price?

IAOM Middle East and Africa Technical Conference

Antalya, Turkey



24 October 2009
10:30-10:50
Peter Lloyd,
USW Middle East, East and North Africa Region

The world's most reliable choice.

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Objectives of this presentation:

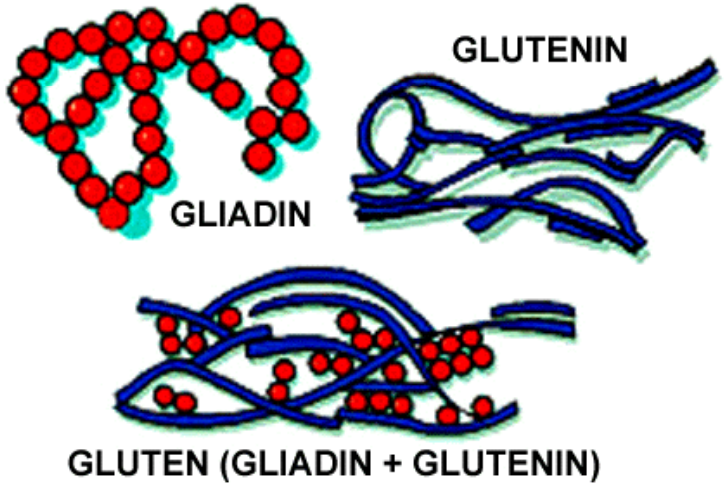
- **Millers worldwide have a fixation with wheat protein quantity, wet gluten and water absorption, test weight and flour ash as amongst the principle determinants of wheat quality at the time of purchase.**
- **Bakers on the other hand value bread volume, flour consistency and yield as their top quality parameters.**
- **The USW presentation will look at the correlation of protein content, wet gluten percentage and other traditional value measures compared to bread volume in a series of baking tests and draw conclusions on the results.**
- **Thanks to all those who generously shared their findings with me for the presentation – most notably Dr. Philip Randall, PhD, Mr Bon Lee of the Wheat Marketing Centre and my colleagues in USW Arlington, Singapore, Cairo, Cape town and Manila.**

So – what are Proteins?

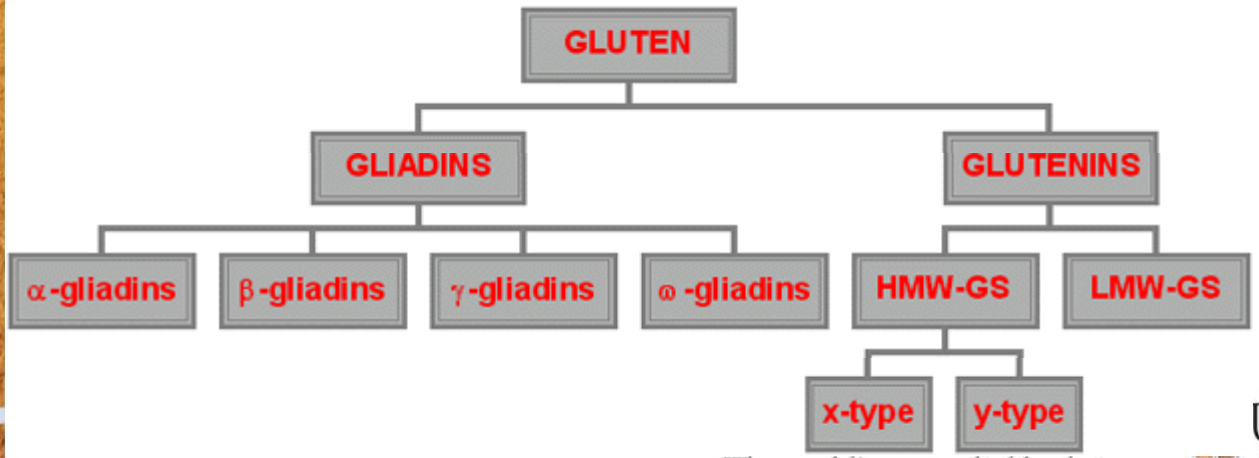
- **Proteins are series of amino acids linked together with peptide bonds.**
- **The major amino acids that are in the wheat flour protein are Glutamic acid and Proline.**
- **The major proteins in wheat flour are Albumins, Globulins, and Gluten (Gliadins and Glutenins) by solubility fractions.**
- **Gluten is the functional protein in wheat flour.**

Building blocks for new wheat plant

Gluten

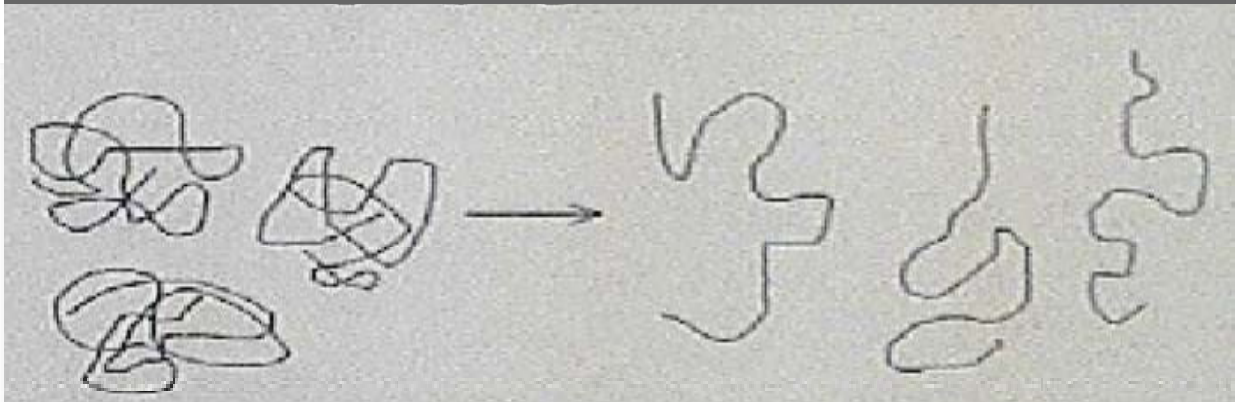


- **Gliadins – Responsible for dough extensibility**
- **Glutenins – Responsible for dough elasticity**



Gluten

Tangled Glutenins and Gliadins	Relaxed Glutenins and Gliadins



Dough mixing --→

What does gluten do?

- **Very simply – gluten provides the skin of the balloons formed during the bread fermentation process.**

The more stronger and elastic the gluten – the bigger the balloon.

Proteins II – enzymes.

- Enzymes are proteins.
- Enzymes work as chemical messengers to bring about changes in the wheat from dormancy through germination to growth.
- Amylases, Proteases, Lipase, Phytase, Lipoxygenase, Polyphenol oxidase (PPO) are some of these messengers.

What factors influence protein?

Protein Quantity:

The three principle factors affecting protein quantity in wheat are;

- **Nitrogen availability – normally through fertilizer**
- **Environmental conditions during growth.**
- **Disease pressure: Especially with relation to fungi such as fusarium which can very adversely impact upon protein content.**

Protein quality :

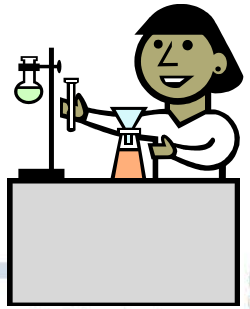
The two important factors are;

- **The Wheat Variety**
- **Environmental conditions**

Many thanks to Dr Bert D'Appolonia for his guidance on this.

Protein Quantity vs Protein Quality

- Both are important and have to be assessed together.
- Quantity easier to test, more important for millers.
- Quality more important for bakers and processors.
- Gluten, test baking and rheological analysis most typical testing formats for protein quality.
- Imperfect measures.



Protein reporting

- **Different in each supplier country.**
  - US uses 12% moisture basis reporting
  - Canada uses 13.5% m.b.
  - Australia uses 11% m.b.
  - Most others use dry basis (0% m.b)

- **Most measures of protein measure nitrogen in the product and measure this by a factor. (N*5.7, some use N*6.3)**
- **Make sure you compare apples with apples when buying wheat.**

Comparing protein.

- **Quantity is easy to compare.**
- **Quality more difficult.**
- **The best analysis is finished product testing using your methods to make your products.**

Typical Regional Purchase Specifications

Class	HRS	HRW	SRW
Grade	#2/OB	#2/OB	#2/OB
SubClass	NS/DNS		
Protein	min. 14.0%	min. 11.0%	min. 9.5%
Moisture	max. 13.0%	max. 13.0%	max. 13.5%
Dockage	max. 1.0%, all deductible	max. 1.0%, all deductible	max. 1.0%, all deductible
FN	min. 350	min. 350	min. 250
Wet gluten		min. 34% wet gluten	min. 23% wet gluten

Will this wheat get to the target?

Too high = loss of VALUE to you.

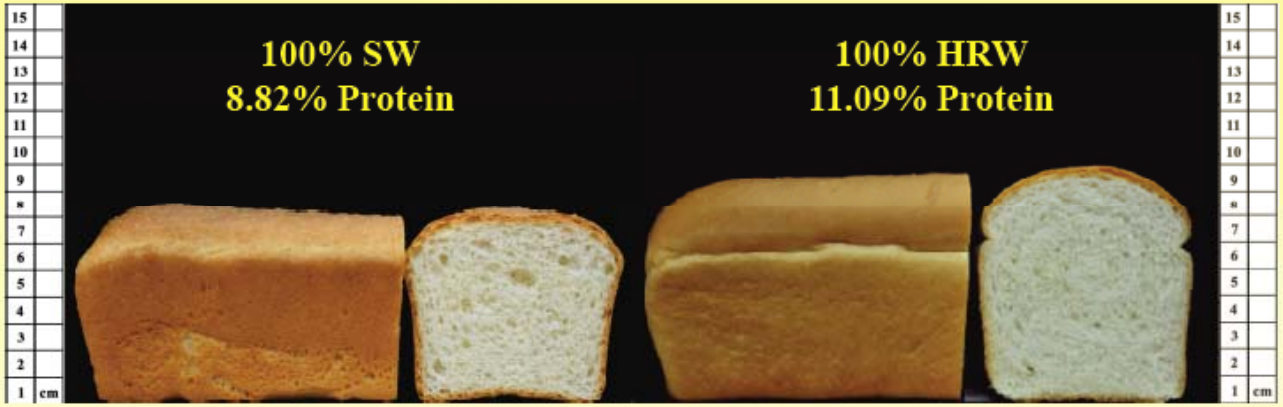
Immediate loss of profit

Profit!!

Too low = loss of VALUE to customer

Eventual loss of profit

Protein Quality vs Quantity



Competitor wheats

South Asian Baking Study 2009

Flour Analytical Result

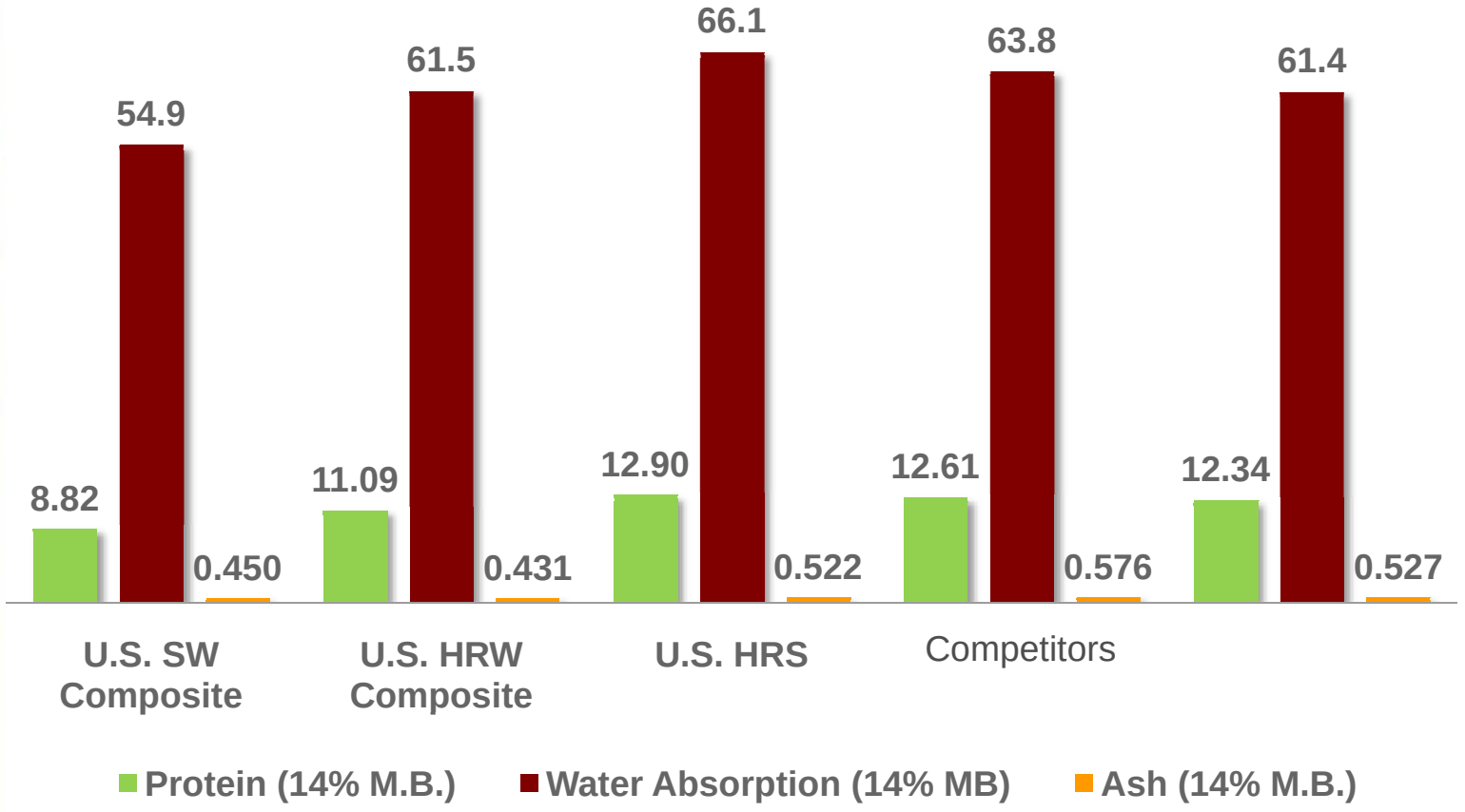
Type& Origin Of Flour Sample	U.S. SW Composite	U.S. HRW Composite	U.S. HRS	Competitor 1	Competitor 2
	OVA 2009 811 - 820 Blend	OVA 2009 801 - 808 Blend	Commercial Sample	Commercial Sample	Commercial Sample
Chemical Tests					
Moisture (%)	12.50	9.80	12.60	13.10	13.45
Ash (%)	0.458	0.452	0.530	0.582	0.530
Ash (14% M.B.)	0.450	0.431	0.522	0.576	0.527
Protein (%, as is)	8.97	11.63	13.11	12.74	12.42
Protein (14% M.B.)	8.82	11.09	12.90	12.61	12.34
Wet Gluten (%, as is)	26.40	33.00	37.00	36.80	35.99
Wet Gluten (14% M.B.)	25.95	31.46	36.41	36.42	35.76

No Time Dough Formulation

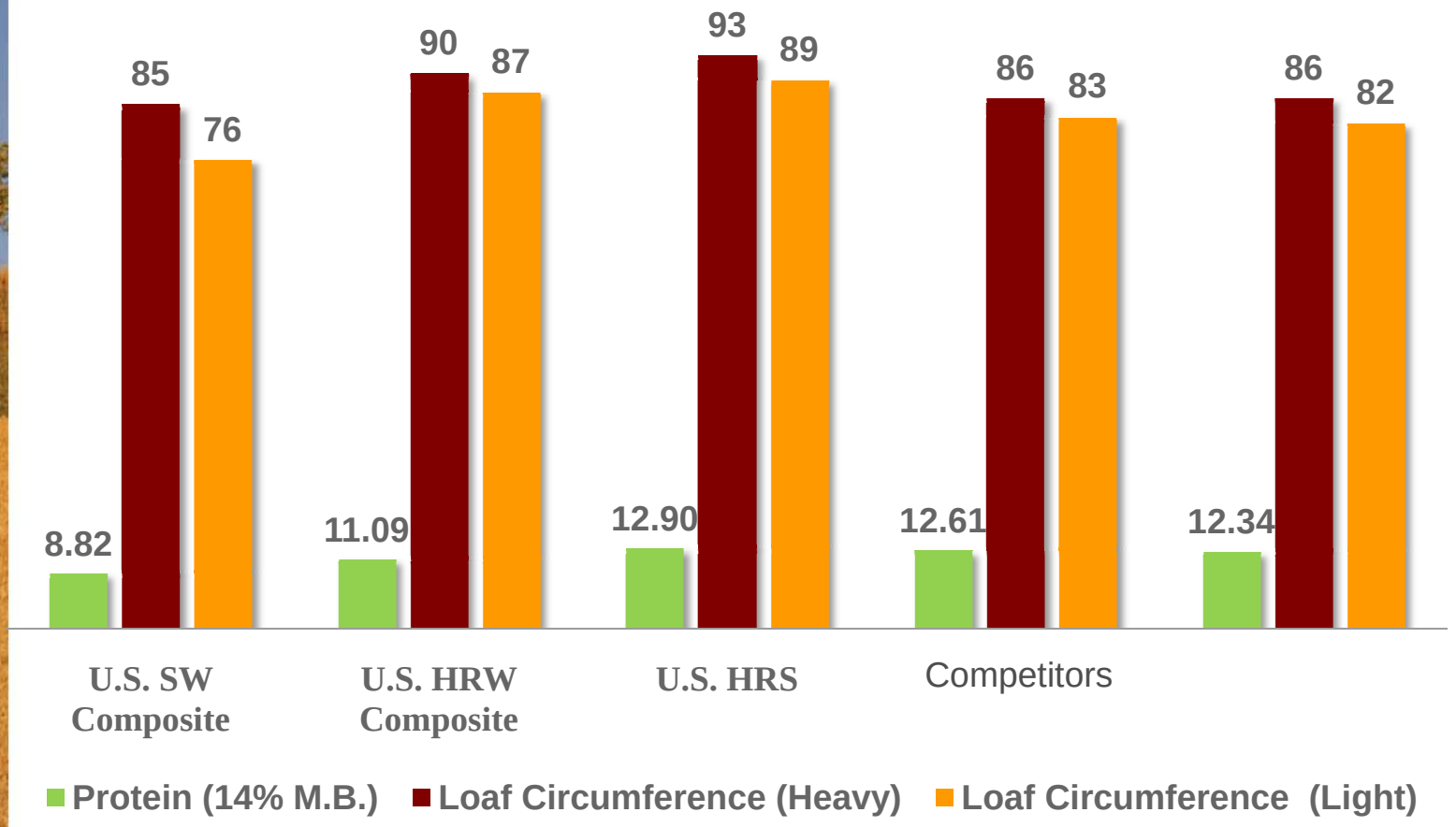
Ingredients	Baker %
Flour	100
Water	*Vary
Instant Yeast (Type: High Sugar)	1.5
Salt	1.5
Sugar	6.0
Shortening	4.0
Improver (Type: SAF Magimix Green)	0.5

*Amount used is based on 105% of Farinograph absorption.

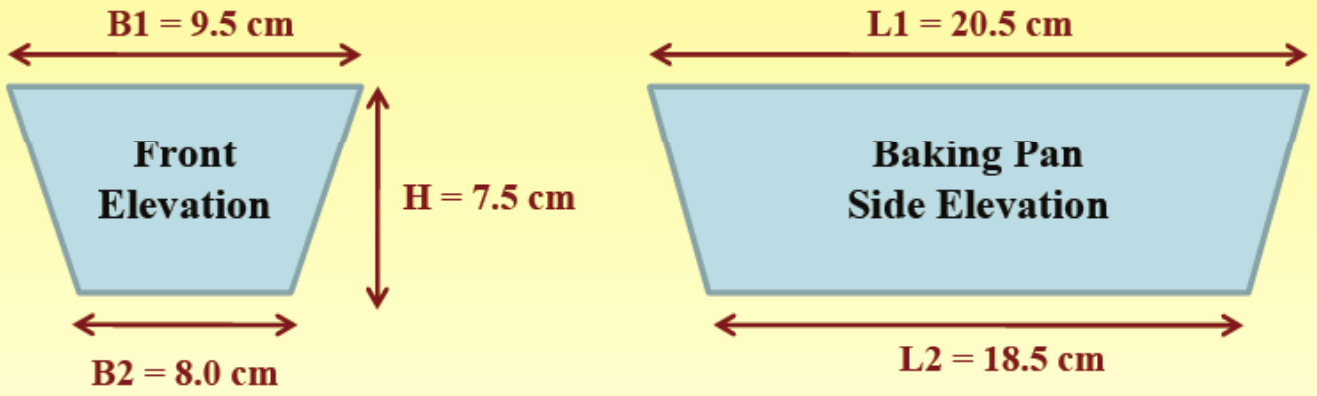
Protein, Absorption & Ash Level



Protein & Loaf Circumference



Pan Size & Scaling Weight



$$\text{Pan Volume} = \frac{(L1 + L2)}{2} \times \frac{(B1 + B2)}{2} \times \text{Height}$$

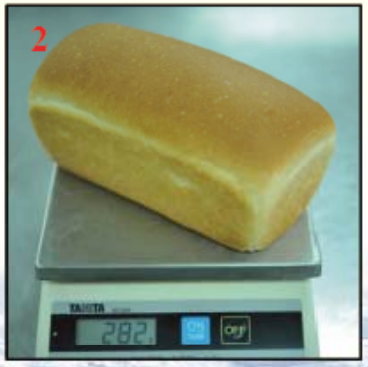
Calculated Pan Volume = 1280 cm^3

Heavy Weight Scale Factor (4 cm^3 /gm of dough) = 1280 ÷ 4 = 320gm scaling weight

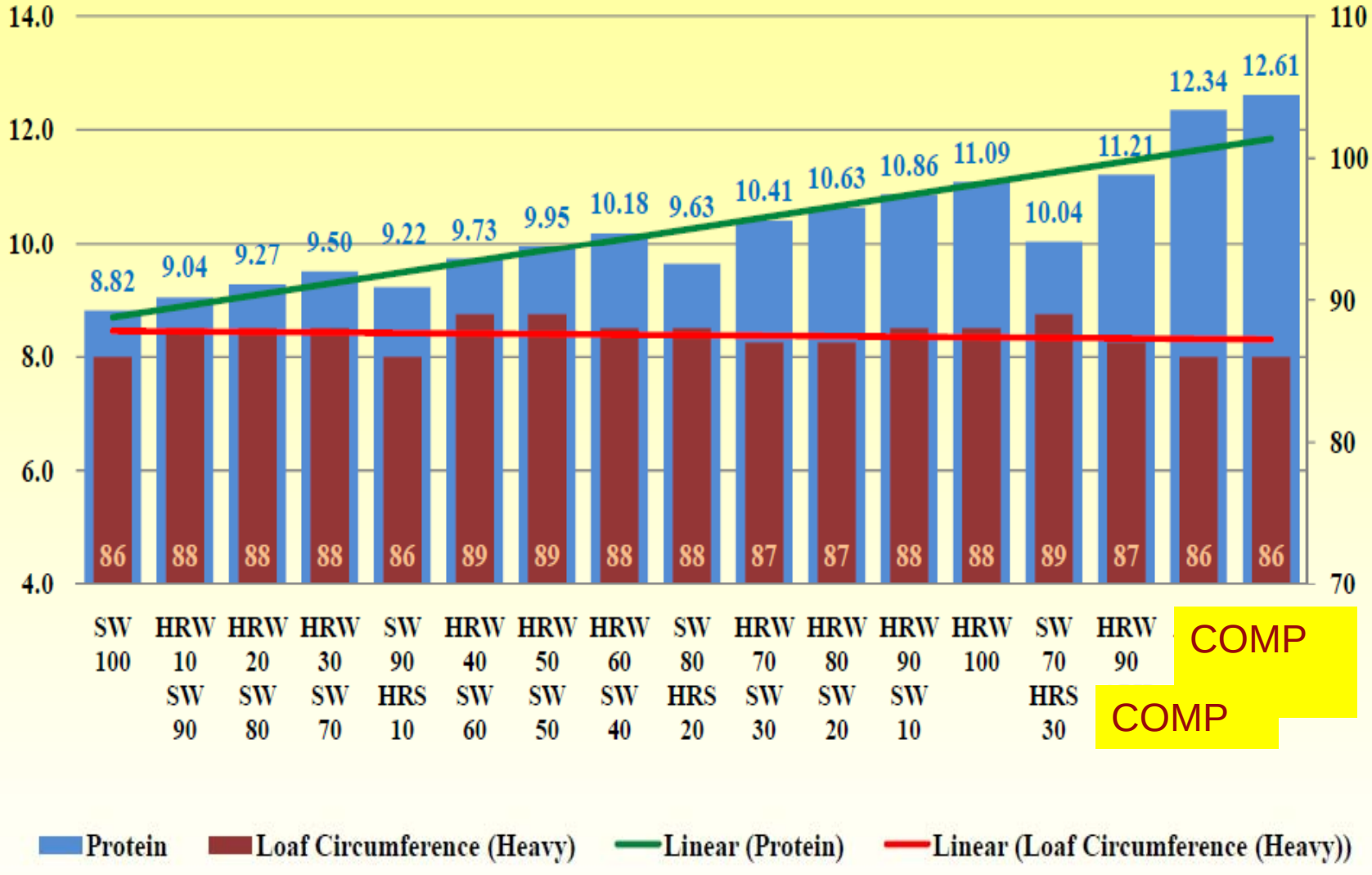
Light Weight Scale Factor (6.12 cm^3 /gm of dough) = 1280 ÷ 6.12 = 210gm scaling weight

Post Baking Product Evaluation

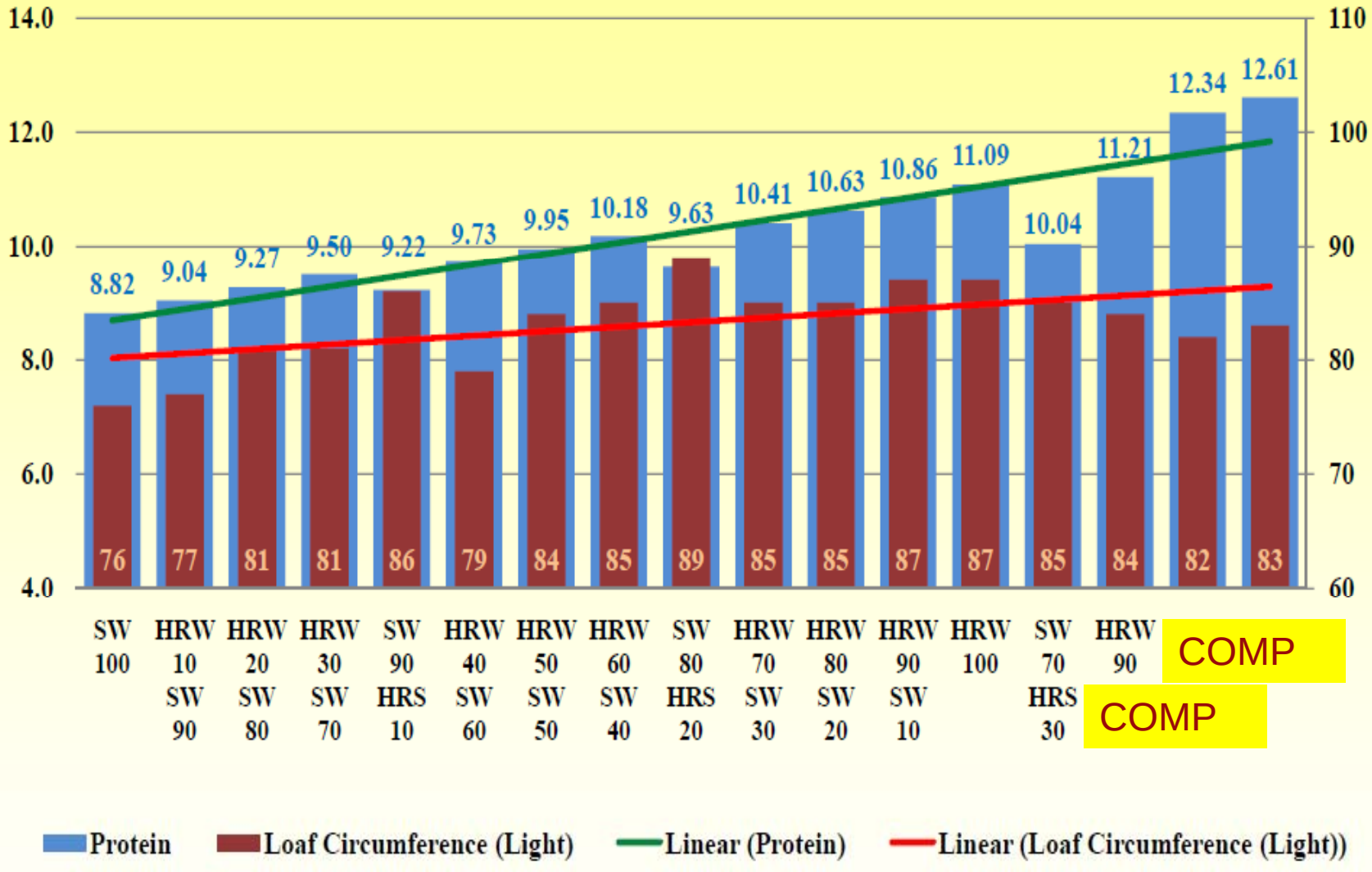
1. Identify the 2 loaf samples from each variation
2. Individually note down the weight of each loaf sample
3. Average the 2 obtained weights to determine the "Average Weight"
4. Individually measure & note down the width & length of each loaf sample
5. Sum width & length together to determine the circumference of each sample
6. Repeat the same procedure for another sample in the same variation & average the 2 measurements to determine the "Average Circumference"
7. Divide average circumference with average weight to determine "Specific Circumference"



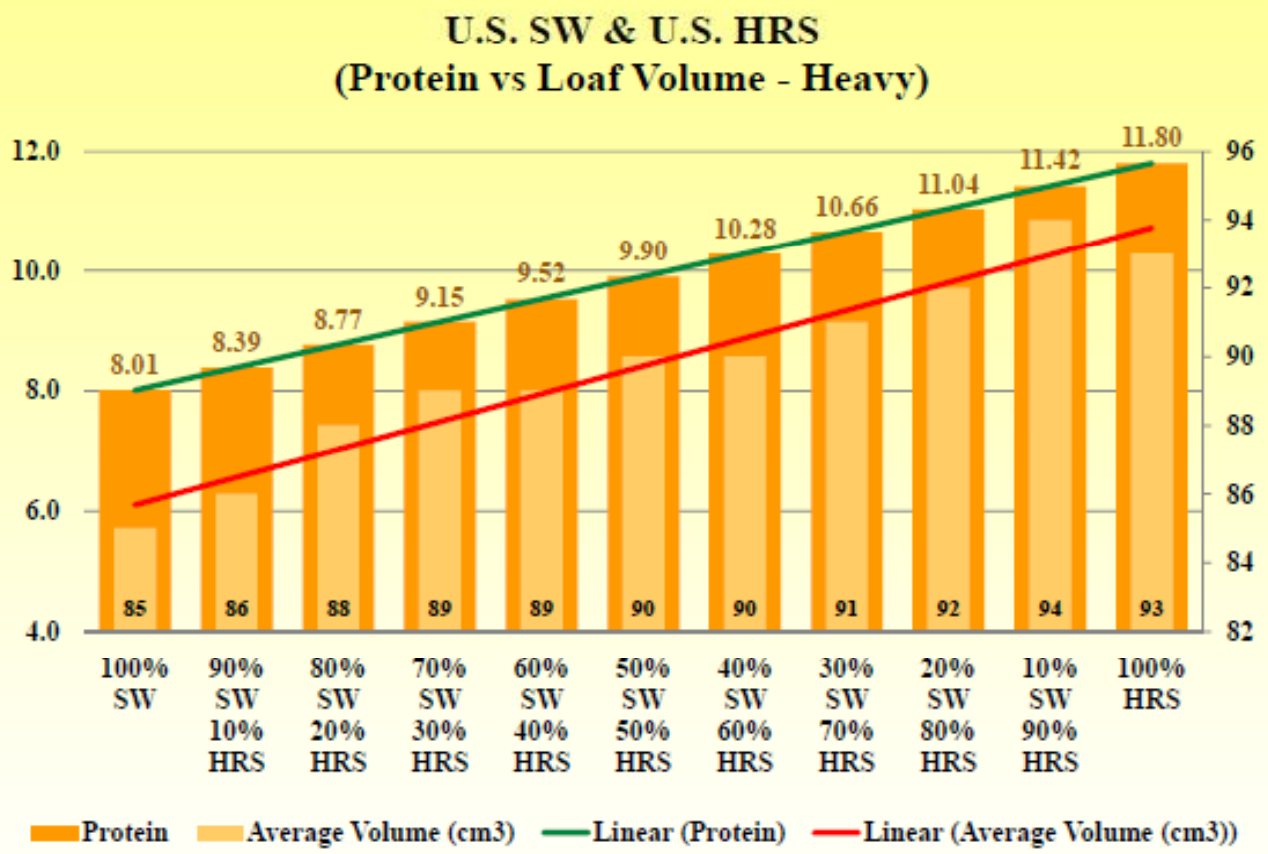
Flour Protein & Loaf Circumference
(Heavy Weight Factor)

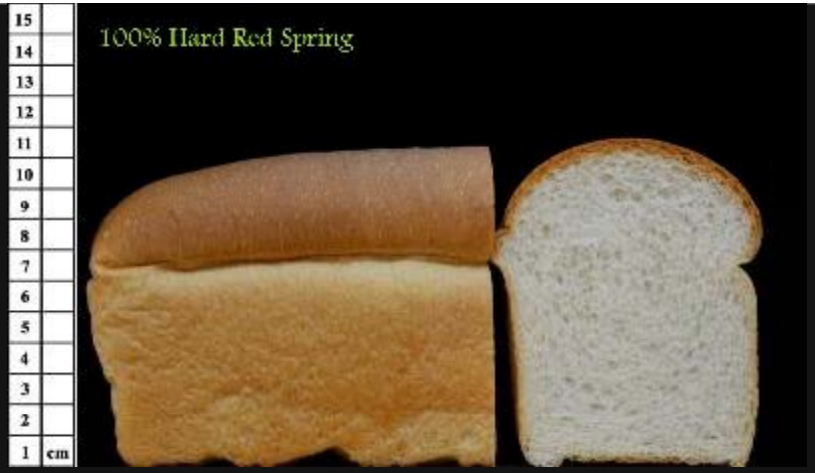


Flour Protein & Loaf Circumference
(Light Weight Factor)



US Soft White and Hard Red Spring Blends




100% Hard Red Spring
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
cm


30% Soft White / 70% Hard Red Spring
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
cm


10% Soft White / 90% Hard Red Spring
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
cm


40% Soft White / 60% Hard Red Spring
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
cm


20% Soft White / 80% Hard Red Spring
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
cm


50% Soft White / 50% Hard Red Spring
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
cm


60% Soft White / 40% Hard Red Spring
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
cm


90% Soft White / 10% Hard Red Spring (HRS)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
cm


70% Soft White/ 30% Hard Red Spring
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
cm

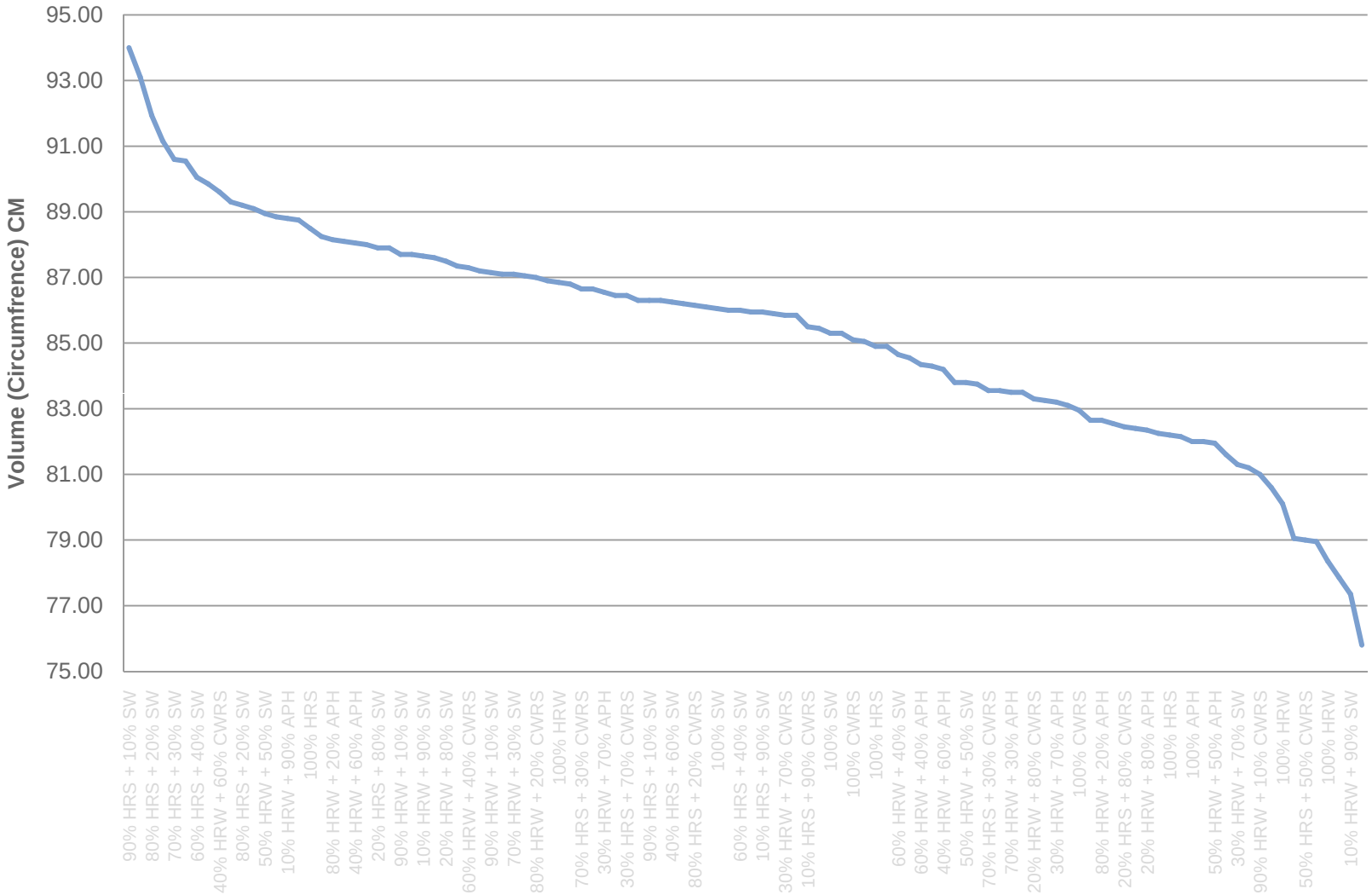

100% Soft White Wheat (SWW)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
cm


80% Soft White / 20% Hard Red Spring
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
cm

Selection of blends with Circ.>88 / Sp.Circ>0.32

Blend	Volume Avg	Specific Volume	Scaling	Weight Avg
90% HRS + 10% SW	94.00	0.353	Heavy	266
100% HRS	93.10	0.349	Heavy	267
80% HRS + 20% SW	91.95	0.343	Heavy	268
60% HRW + 40% SW	91.15	0.330	Heavy	276
70% HRS + 30% SW	90.60	0.337	Heavy	269
30% HRS + 70% SW	90.55	0.328	Heavy	276
60% HRS + 40% SW	90.05	0.327	Heavy	275
50% HRS + 50% SW	89.85	0.330	Heavy	272
40% HRW + 60% Comp 2	89.60	0.320	Heavy	280
40% HRS + 60% SW	89.30	0.324	Heavy	276
80% HRS + 20% SW	89.20	0.531	Light	168
10% HRW + 90% Comp 2	89.10	0.318	Heavy	280
50% HRW + 50% SW	88.95	0.319	Heavy	279
60% HRW + 40% Comp 1	88.85	0.328	Heavy	271
10% HRW + 90% Comp 1	88.80	0.329	Heavy	270
40% HRW + 60% SW	88.75	0.320	Heavy	277
30% HRW + 70% Comp	88.25	0.313	Heavy	282
80% HRW + 20% Comp 1	88.15	0.329	Heavy	268
70% HRW + 30% Comp 1	88.10	0.325	Heavy	271
40% HRW + 60% Comp 1	88.05	0.325	Heavy	271
100% HRW	88.00	0.322	Heavy	273

Bread volume



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So – what else is impacting on bread volume?

Extensograph

	Area 45	R Max 45	Extent 45	Area 90	R Max 90	Extent 90	Area 135	R Max 135	Extent 135
Control	163	565	20.6	185	650	20.1	192	765	18.8
Fat 1%	153	540	20.3	185	635	21.3	175	705	18.5
Fat 3%	164	525	22.7	191	700	19.8	192	810	18.1
Ascorbic Acid 50ppm	202	905	17.1		1000	11.5		1000	10.1
Fat 1% + Ascorbic Acid 50 ppm	158	760	16.0		1000	11.6		1000	10.1

Farinograph

CONDITION	Absorption	Valorimeter	Develop Time	Stability
Control	63.7	73	8.0	12.9
Fat 1%	63.6	72	7.7	11.4
Fat 3%	63.0	72	7.9	9.3
Salt 2%	61.9	90	12.2	20.0
Ascorbic Acid 50ppm	63.8	74	8.9	15.1
Fat 1% + Salt 2%	60.8	94	16.0	20.0
Fat 3% + Salt 2%	60.2	95	17.0	20.0
Fat 1% + Ascorbic Acid 50 ppm	63.6	80	11.0	11.3
Fat 3% + Ascorbic Acid 50ppm	62.8	76	9.5	10.4
Fat 1% + Salt 2% + Ascorbic Acid 50ppm	61.5	96	20.0	20.0
Fat 3% + Salt 2% + Ascorbic Acid 50ppm	60.8	96	19.5	20.0
Salt 2% + Ascorbic 50 ppm	61.8	97	20.5	20.0

Alveograph

CONDITION	Strength	Stability	Disten	PL Value	P
Control	50	77.6	128.8	0.60	70.5
Fat 1%	45	69.9	131.0	0.53	63.5
Fat 3%	35	65.7	105.8	0.62	59.8
Ascorbic Acid 50ppm	46	88.0	89.3	0.99	80.0
Fat 1% + Ascorbic Acid 50 ppm	52	93.1	91.5	1.02	84.6
Fat 3% + Ascorbic Acid 50ppm	45	85.5	82.7	1.03	77.8

AND THE SECRET INGREDIENT WE HAVE ALL FORGOTTEN ABOUT?
Same flour, same lab, same equipment and same technician.

	1	2	3	4
P	99	100	98	118
L	102	101	97	68
G	22.5	22.4	21.9	18.4
W	341	345	316	298
S	52.1	52.8	48.3	45.6
P/L	0.97	0.99	1.01	1.72

AND THE SECRET INGREDIENT WE HAVE ALL FORGOTTEN ABOUT - TIME

	Mill	Mill + 24hrs	Mill + 72 hrs	3 weeks
P	99	100	98	118
L	102	101	97	68
G	22.5	22.4	21.9	18.4
W	341	345	316	298
S	52.1	52.8	48.3	45.6
P/L	0.97	0.99	1.01	1.72

TIME

- **All of the above are exactly the same wheat flour, run on the same instrument by the same technician.**
- **Samples 1, 2 and 3 would all have been under direct mill control – sample 4 is what was delivered 3 weeks after milling.**
- **And what the baker would be dealing with.**

Table of correlations – S. African study

	WhPro	W_Glu	D_Glu	F_Abs	F_Val	F_D_T	F_Stab	E_Area	E_R_Max	E_Ext	A_Str	A_Stab	A_Dist	VOLUME
WhPro	1.000													
W_Glu	0.883	1.000												
D_Glu	0.906	0.978	1.000											
F_Abs	0.409	0.488	0.478	1.000										
F_Val	0.512	0.406	0.473	0.452	1.000									
F_D_T	0.556	0.437	0.499	0.478	0.923	1.000								
F_Stab	0.352	0.191	0.265	0.286	0.872	0.820	1.000							
E_Area	0.397	0.263	0.339	0.184	0.713	0.648	0.746	1.000						
E_R_Max	0.138	0.015	0.083	0.111	0.650	0.549	0.719	0.912	1.000					
E_Ext	0.639	0.568	0.623	0.168	0.499	0.496	0.432	0.690	0.388	1.000				
A_Str	0.421	0.363	0.424	0.443	0.814	0.782	0.741	0.785	0.732	0.525	1.000			
A_Stab	-0.136	-0.056	-0.050	0.576	0.404	0.331	0.343	0.273	0.447	-0.133	0.564	1.000		
A_Dist	0.628	0.490	0.543	-0.037	0.447	0.464	0.418	0.628	0.403	0.748	0.531	-0.282	1.000	
Volume	0.521	0.562	0.582	0.122	0.408	0.387	0.253	0.350	0.180	0.537	0.464	0.005	0.531	1

Table of Correlations greater than 70%

	WhPro	W_Glu	D_Glu	F_Abs	F_Val	F_D_T	F_Stab	E_Area	E_R_Max	E_Ext	A_Str	A_Stab	A_Dist	VOLUME
WhPro	1.000													
W_Glu	0.883	1.000												
D_Glu	0.906	0.978	1.000											
F_Abs				1.000										
F_Val					1.000									
F_D_T					0.923	1.000								
F_Stab					0.872	0.820	1.000							
E_Area					0.713		0.746	1.000						
E_R_Max							0.719	0.912	1.000					
E_Ext										1.000				
A_Str					0.814	0.782	0.741	0.785	0.732		1.000			
A_Stab												1.000		
A_Dist										0.748			1.000	
Volume														1.000

Protein:volume 52.1%
W.Gluten:Volume 56.2%
D.Gluten:Volume 58.2%
Extenso Ext: 53.7%

N=547 samples

Correlation Table

A 'BEST CASE' SCENARIO!

	Wheat protein	*Flour Protein*	*Wet Gluten*	*Gluten Index*	*Bake volume*
Wheat protein	100.0%				
Flour Protein	98.0%	100.0%			
Wet Gluten	93.1%	94.7%	100.0%		
Gluten Index	38.3%	40.7%	30.3%	100.0%	
VOLUME	**73.0%**	**73.7%**	**75.4%**	**37.0%**	**100.0%**

N= 16,670

What does this tell us?

1. **The big surprise was we got better volumes with soft/hard blends.**
2. **Protein quantity is only part of the story.**
3. **The correlation to bread volume is best with protein and gluten content among the existing tests.**
4. **That correlation is at best only 70% and that is within single classes of hard wheat.**
5. **We badly need another functional test with better correlation to the finished product.**

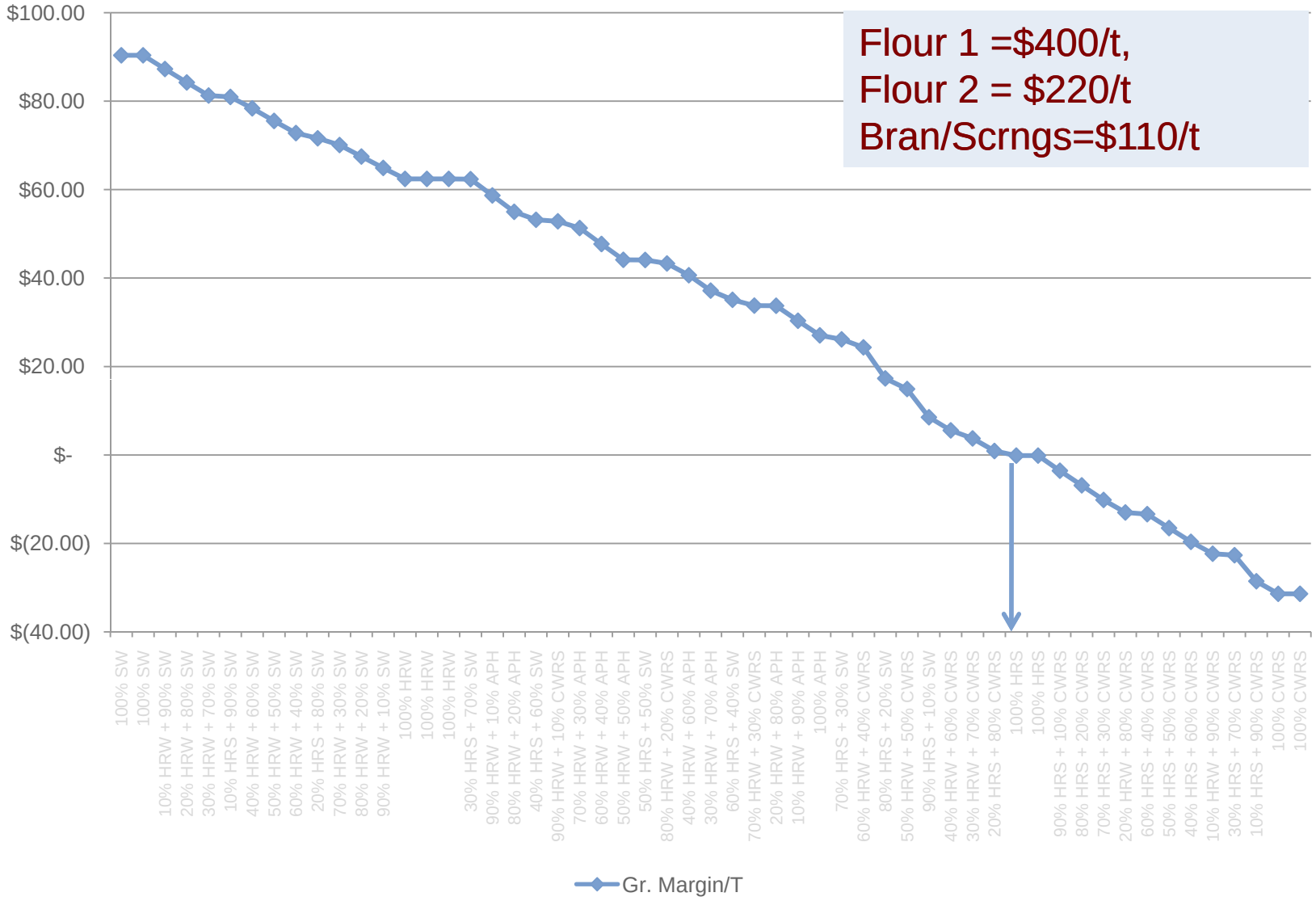
An historical note

- **A classic study was published in the 1940's by Dr. Karl Finney on the relationship of protein content and loaf volume.**
- **This study showed, that for a particular variety, there is a very good correlation between protein content and loaf volume. As the protein content increased for a particular variety so did loaf volume.**
- **Within a range of varieties and protein qualities and contents, it is less linear.**

Moving back to the South Asian Study…

- **Which of the tested blends suit my customer best?**
- **Can we afford to produce this flour at the current market price of $400/t?**
- **Following is the profitability of the blends in the South Asia study from highest to lowest. (Gross margin only). You have to take your fixed and non-wheat variable costs from this amount.**

Gross Margin/Ton of wheat Milled



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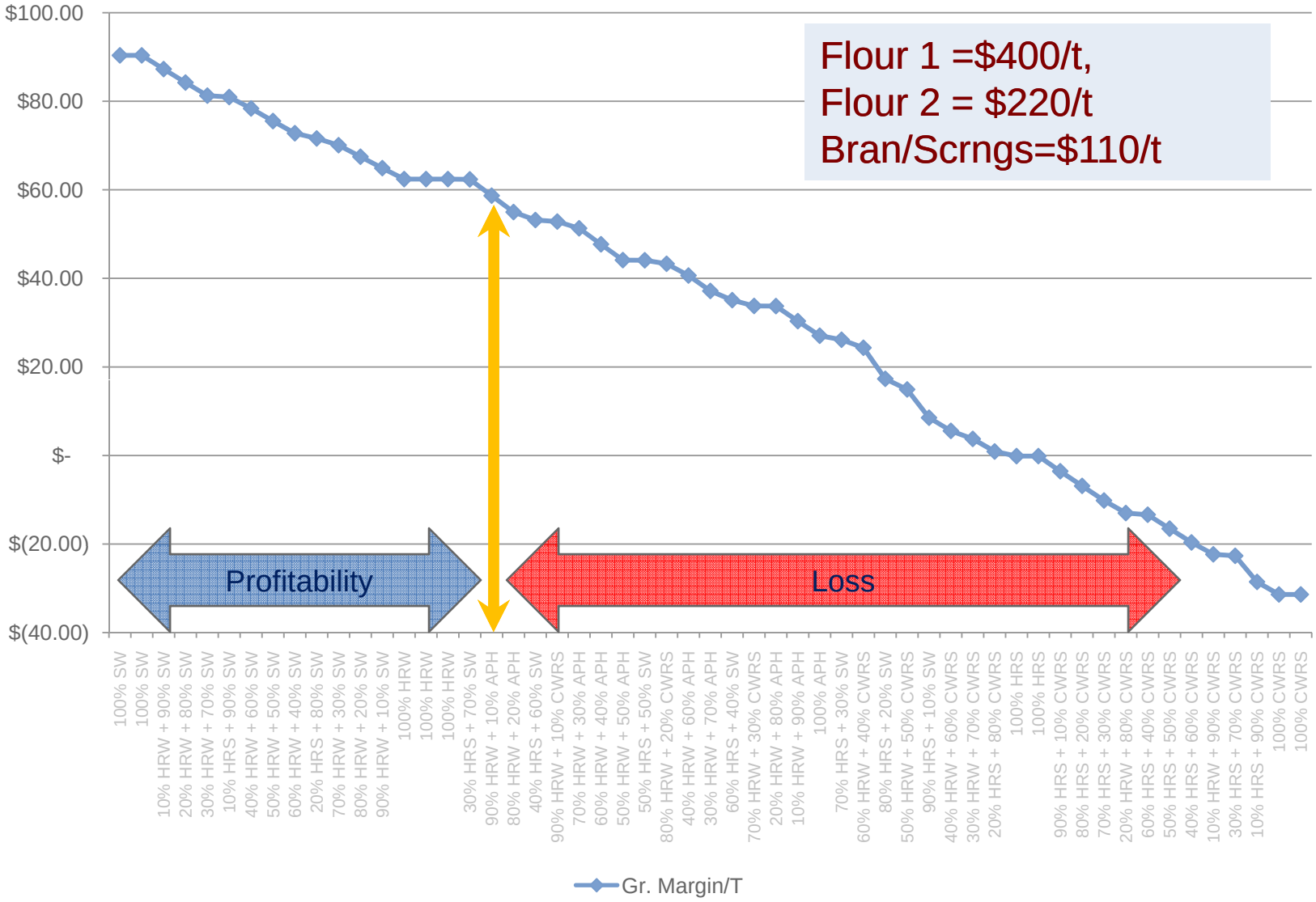
Getting to the bottom line…

- I cannot tell you what your non-wheat variable and fixed costs are.
- In my example, non-wheat variable and fixed costs total $58 per ton.
- We therefore have to have a minimum Gross Margin of $58/t of wheat milled in order to cover our fixed and variable costs.

Gross Margin/Ton of wheat Milled



Profitable Blends @ $400/t flour price

Blend	Gr. Margin/T
100% SW	$ 90.37
10% HRW + 90% SW	$ 87.26
20% HRW + 80% SW	$ 84.22
30% HRW + 70% SW	$ 81.27
10% HRS + 90% SW	$ 80.94
40% HRW + 60% SW	$ 78.37
50% HRW + 50% SW	$ 75.53
60% HRW + 40% SW	$ 72.78
20% HRS + 80% SW	$ 71.61
70% HRW + 30% SW	$ 70.08
80% HRW + 20% SW	$ 67.47
90% HRW + 10% SW	$ 64.91
100% HRW	$ 62.43
30% HRS + 70% SW	$ 62.36
90% HRW + 10% COMP2	$ 58.67

HEAVY

Blend	Gr. Margin/T	Volume
60% HRW + 40% SW	$72.78	91
30% HRS + 70% SW	$62.36	91
40% HRW + 60% SW	$78.37	89
50% HRW + 50% SW	$75.53	89
10% HRW + 90% SW	$87.26	88
20% HRW + 80% SW	$84.22	88
30% HRW + 70% SW	$81.27	88
20% HRS + 80% SW	$71.61	88
90% HRW + 10% SW	$64.91	88
100% HRW	$62.43	88
90% HRW + 10% COMP2	$58.67	88
70% HRW + 30% SW	$70.08	87
80% HRW + 20% SW	$67.47	87
10% HRS + 90% SW	$80.94	86
100% SW	$90.37	85

LIGHT

Blend	Gr. Margin/T	Volume
90% HRW + 10% SW	$64.91	87
100% HRW	$62.43	87
30% HRS + 70% SW	$62.36	86
60% HRW + 40% SW	$72.78	85
70% HRW + 30% SW	$70.08	85
80% HRW + 20% SW	$67.47	85
50% HRW + 50% SW	$75.53	84
20% HRS + 80% SW	$71.61	84
90% HRW + 10% COMP2	$58.67	84
20% HRW + 80% SW	$84.22	81
30% HRW + 70% SW	$81.27	81
10% HRS + 90% SW	$80.94	81
40% HRW + 60% SW	$78.37	79
10% HRW + 90% SW	$87.26	77
100% SW	$90.37	76

Blends acceptable to our Bakery customer

Getting to the target

Blend	Gr. Margin/T	Volume
60% HRW + 40% SW	**$72.78**	**H91/L85**
30% HRS + 70% SW	$62.36	H91/L87

Miller & Baker

In conclusion of the Study…

- We could make a blend of either 60% HRW + 40% SW or 30% HRS + 70% SW which would satisfy our bakery customer and make us between $62- $73/t of wheat Gross Margin.

OR

- We could use a canon and use 100% HRS at at a Gross Margin of minus ($0.39) per ton.
- I know which one my Board would have me use!!

$60 per ton difference in Margin

To a 500t/day mill

Per day = $30,000 / day

Per week = $180,000 / week

Per month = $756,000 / month

Per year = $9,072,000 / year.

6 days/wk
4.2 wks/month
12 mths/yr

My observations;

- **Basing your flour specifications purely on protein and gluten content could lead to significant erosions in margin.**
- **Prudent to consider other factors with a better correlation to loaf volume as well.**
- **Test baking may yield some very surprising results for you.**
- **If your customer is purely focused on protein and gluten – could it be he is buying your flour for blending with cheap flour from somewhere else?**

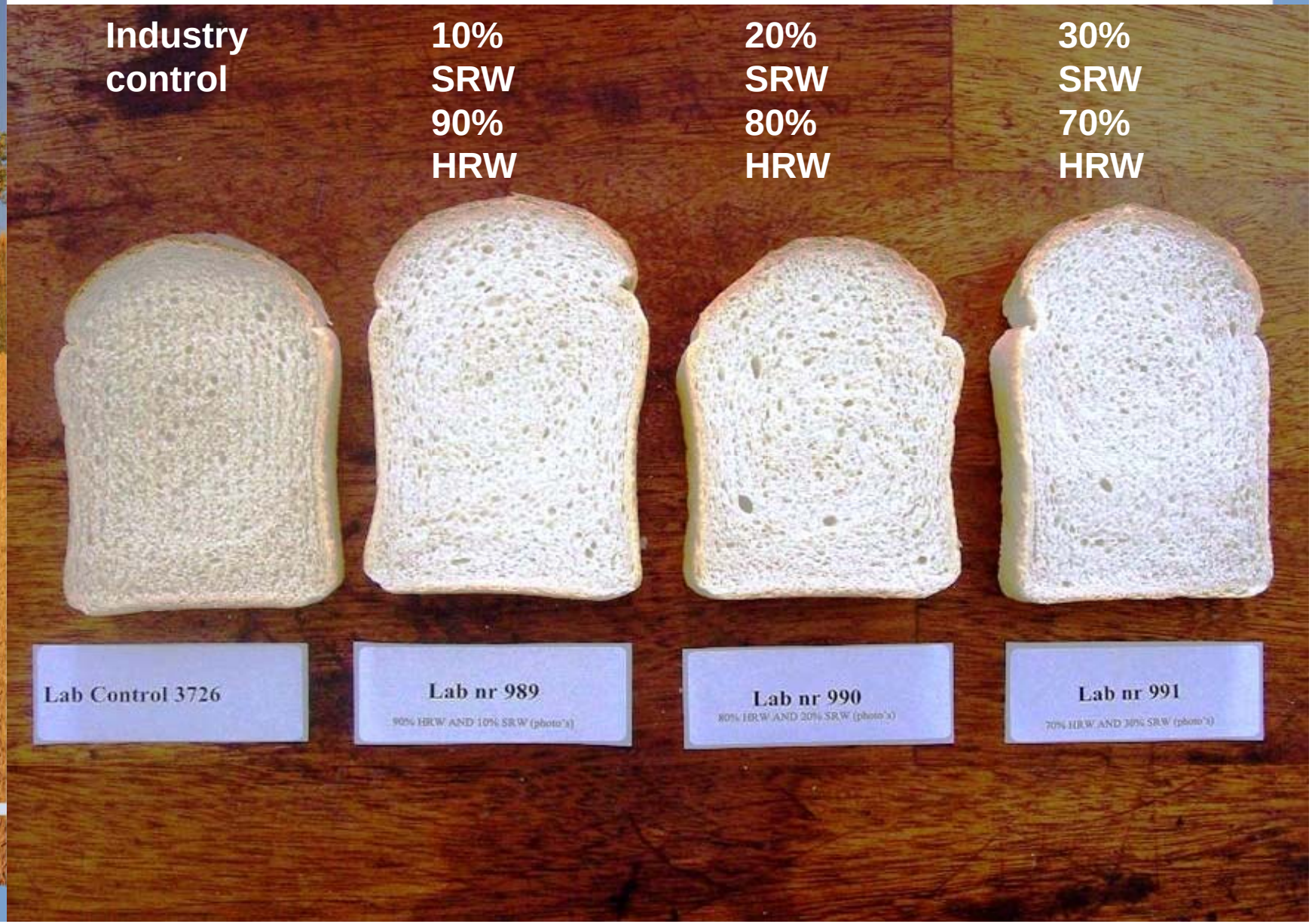
Stop Press – latest news

Blending tests done in October 2009 – no improvers or correctors

Blending tests of HRW and SRW Wheat done at the SA Grain Labs. Chorleywood (No Time Dough) process.

HRW/SRW blends

SAGL testing – SRW/HRW blends



US Wheat Classes

- **A lot of work has gone into the varietal development of our six wheat classes to bring you wheats of distinct protein FUNCTIONALITY.**
- **Please exploit this to maximize the efficiency of your products.**
- **Your success is our success.**

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