



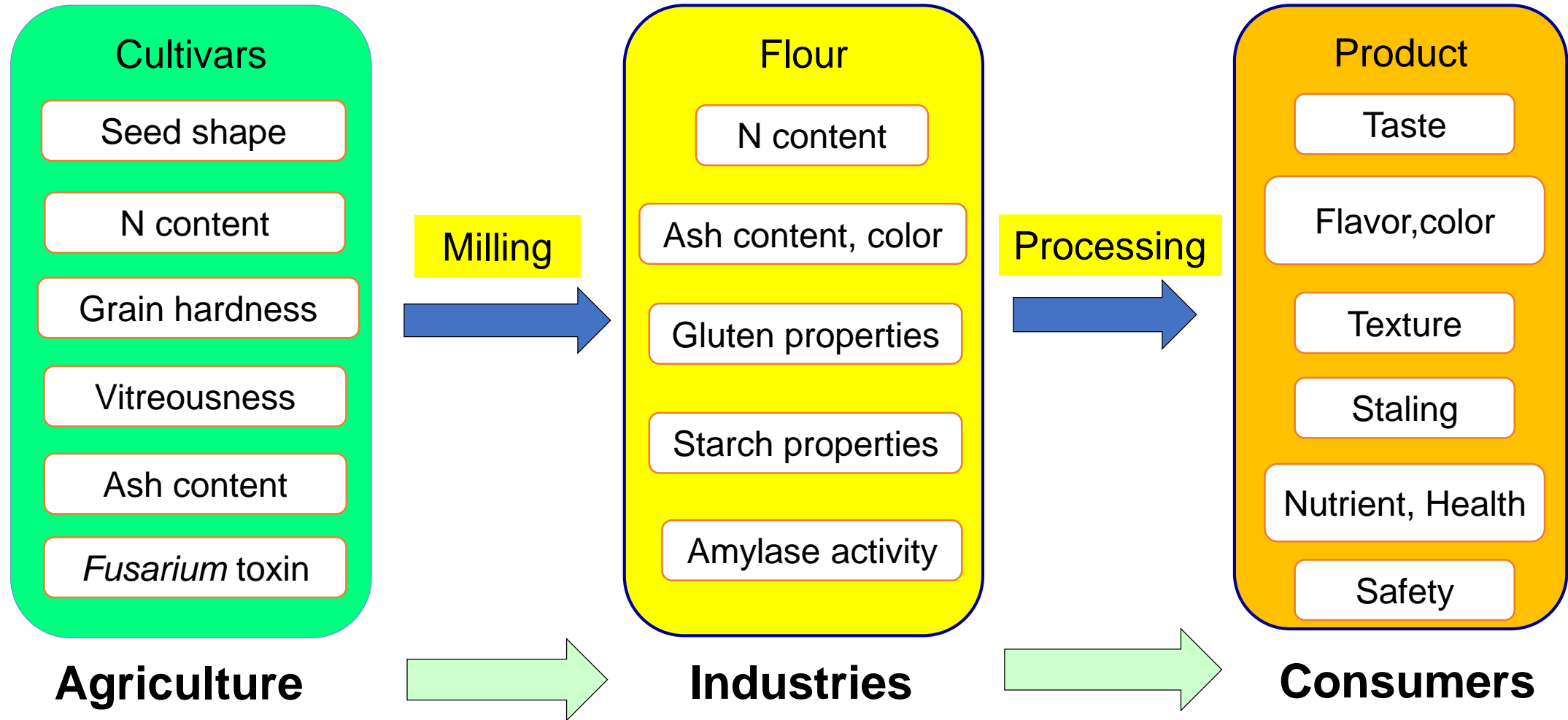
International collaboration on wheat quality and safety

T.M.Ikeda

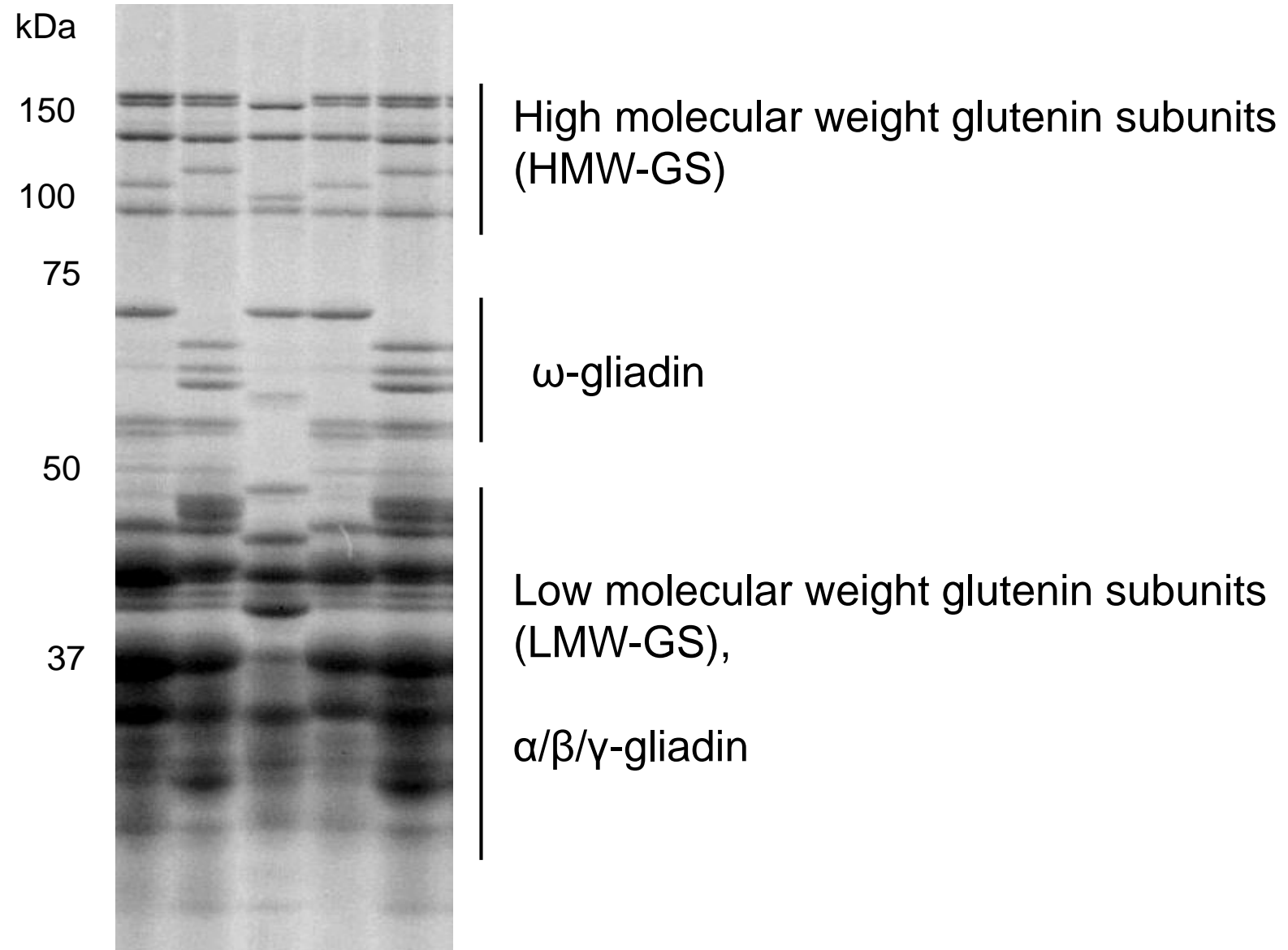
NARO, Fukuyama, Hiroshima, Japan

13th International Gluten Workshop in Mexico, 2018

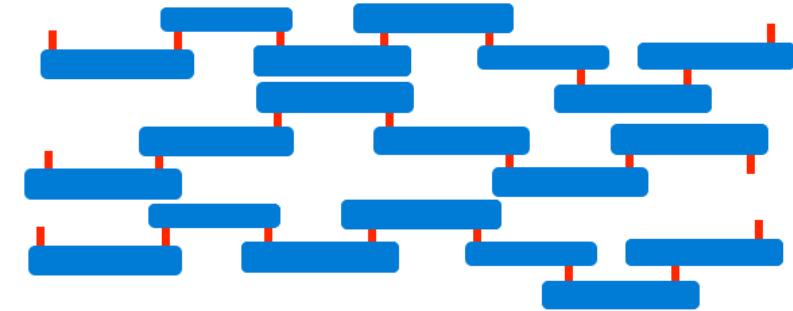
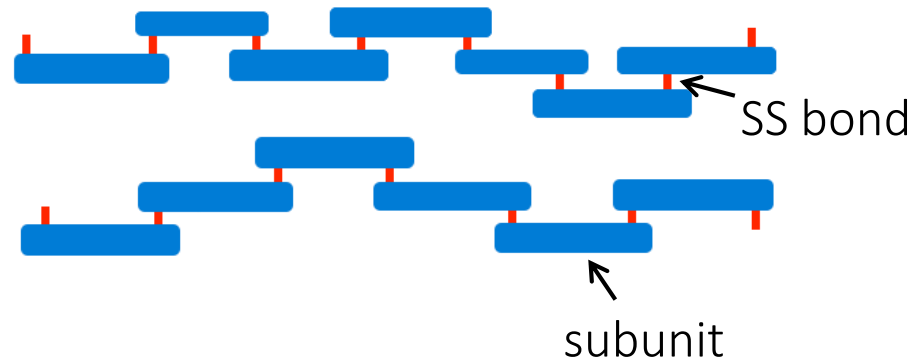
Wheat quality



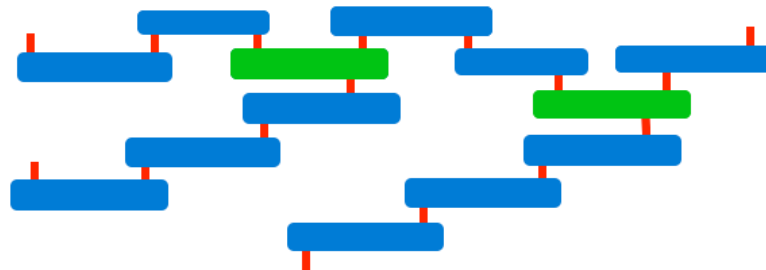
Gluten proteins



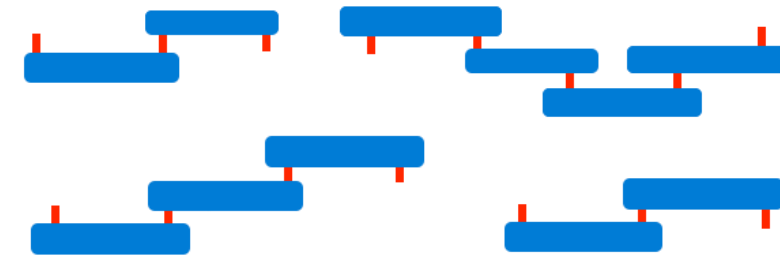
Allelic variation of glutenin subunits



Increasing glutenin polymer
(*Glu-B1a1*, *Glu-A3d*, *Glu-B3g* etc)



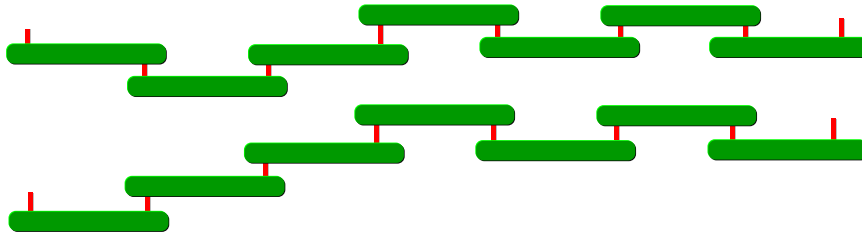
Tightening glutenin polymer
(*Glu-D1d*)



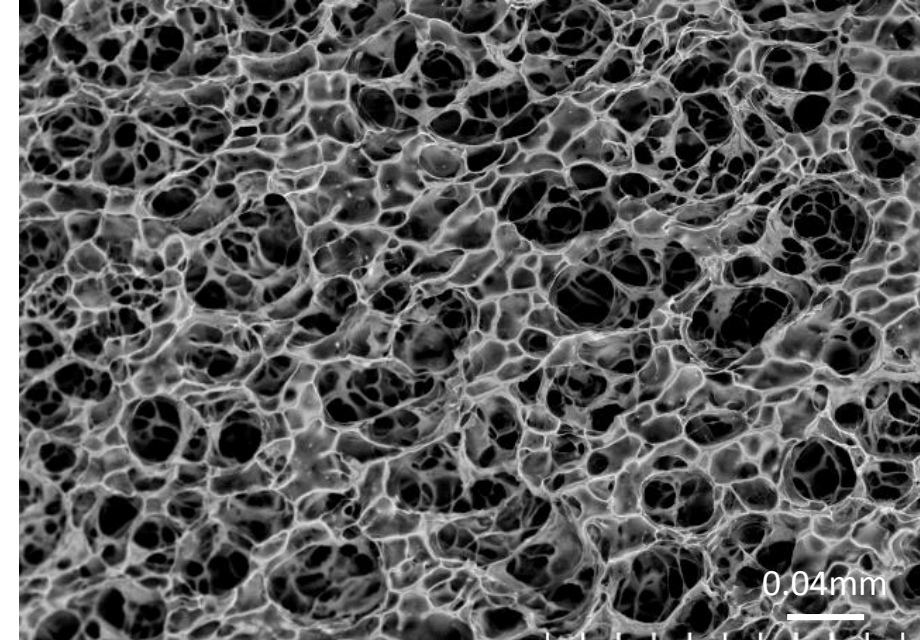
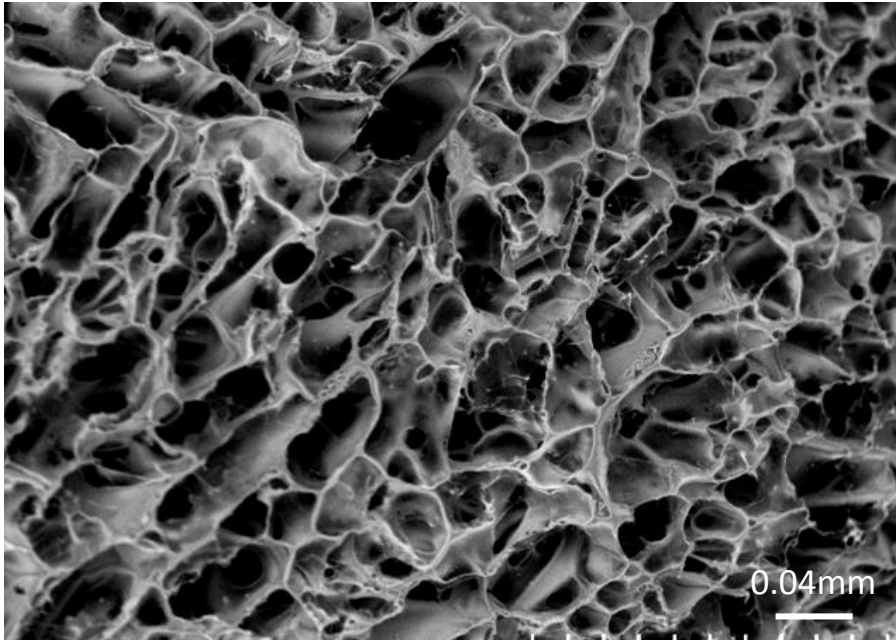
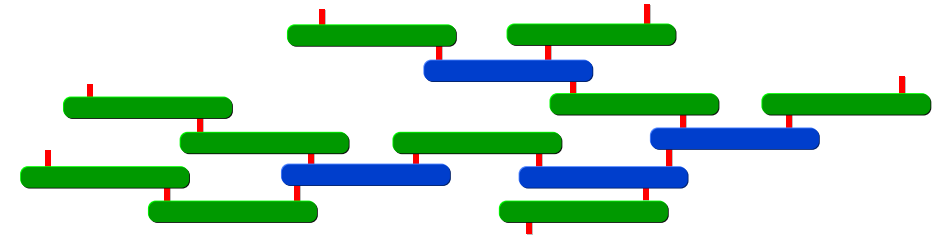
Decreasing glutenin polymer
(*Glu-A1c*, *Glu-A3e*, *Glu-B3j* etc)

Effect of *Glu-D1d* (5+10) on gluten network

Without *Glu-D1d*



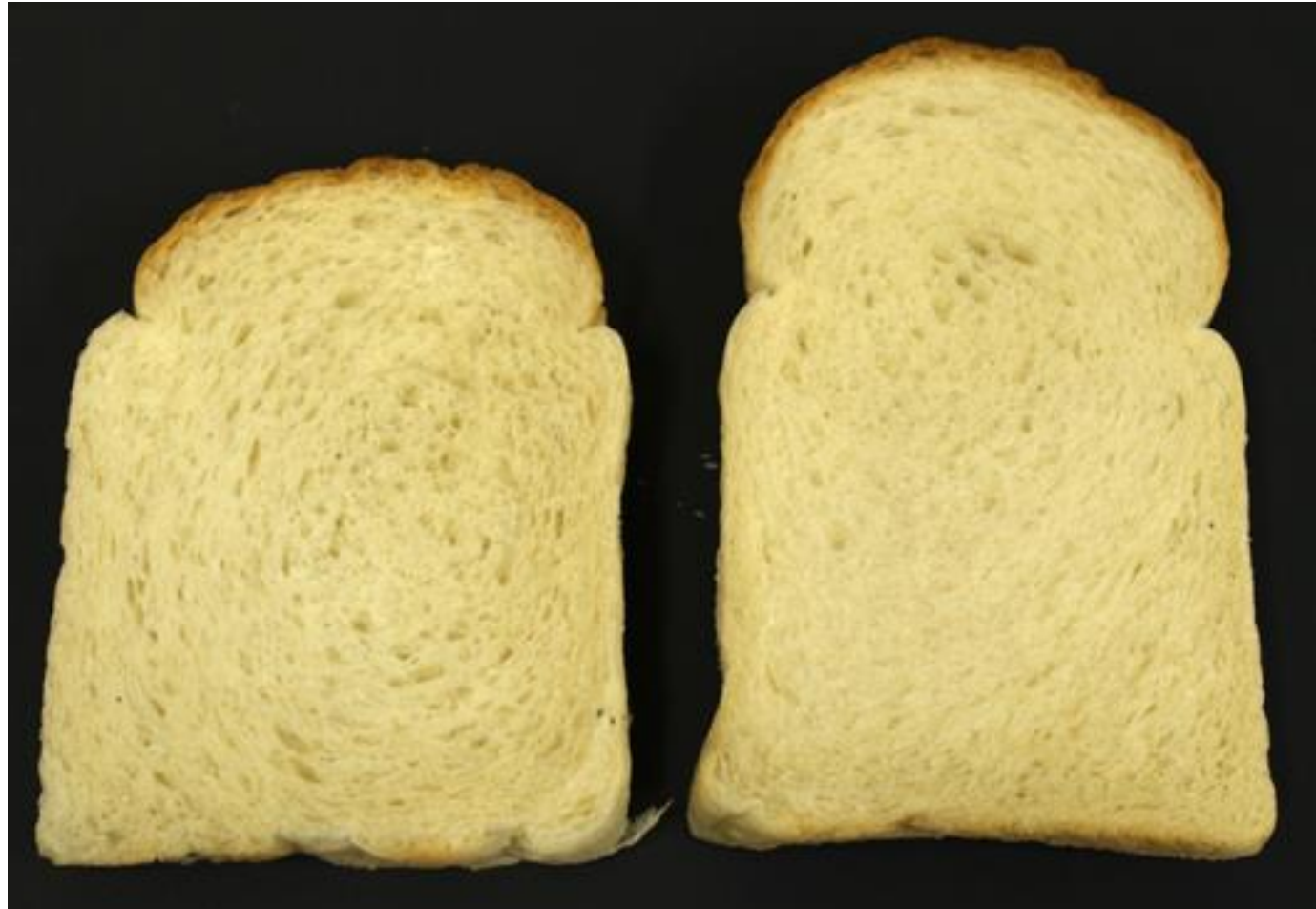
With *Glu-D1d*



***Glu-D1d* improves bread volume**

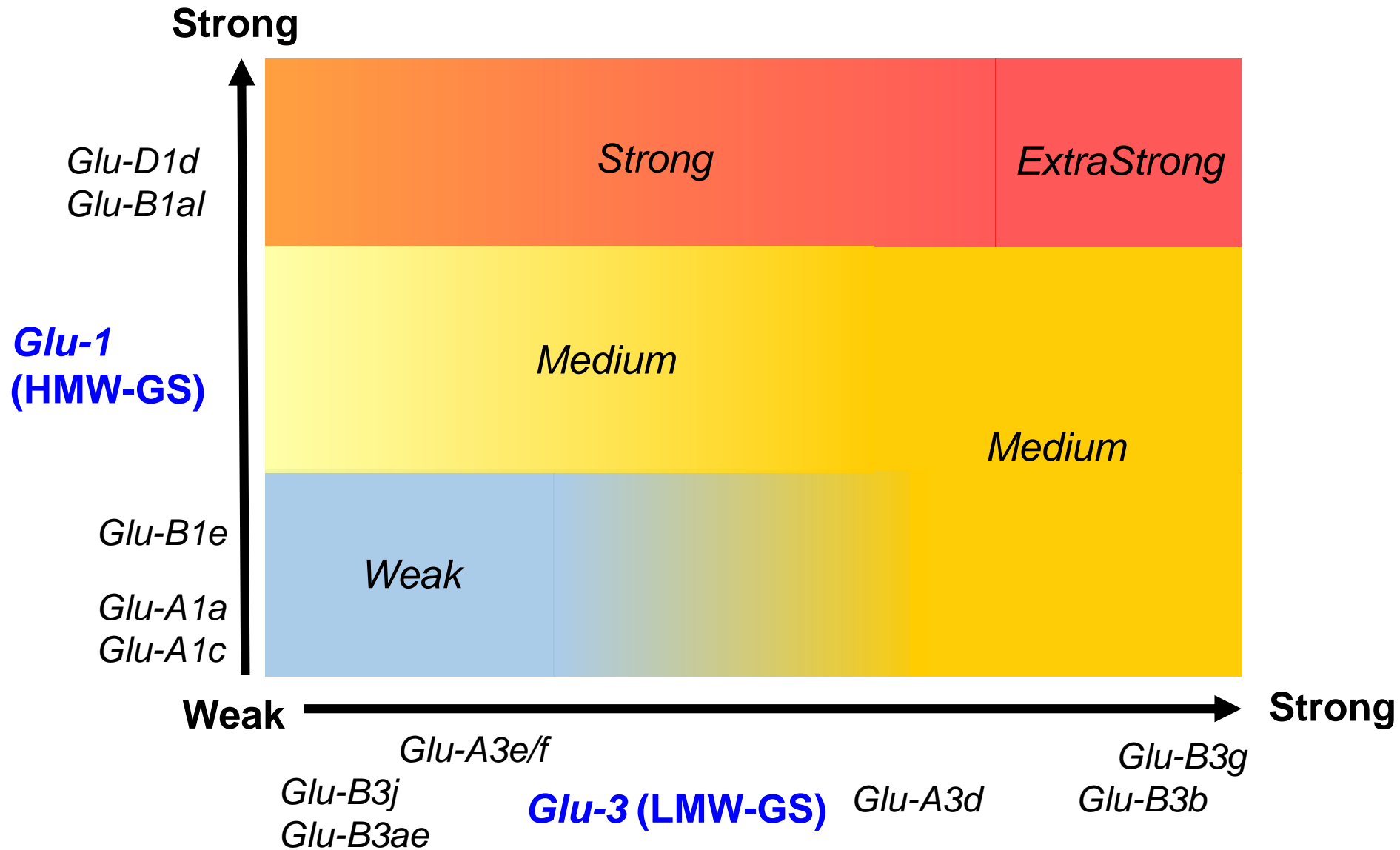
Without *Glu-D1d*

With *Glu-D1d*



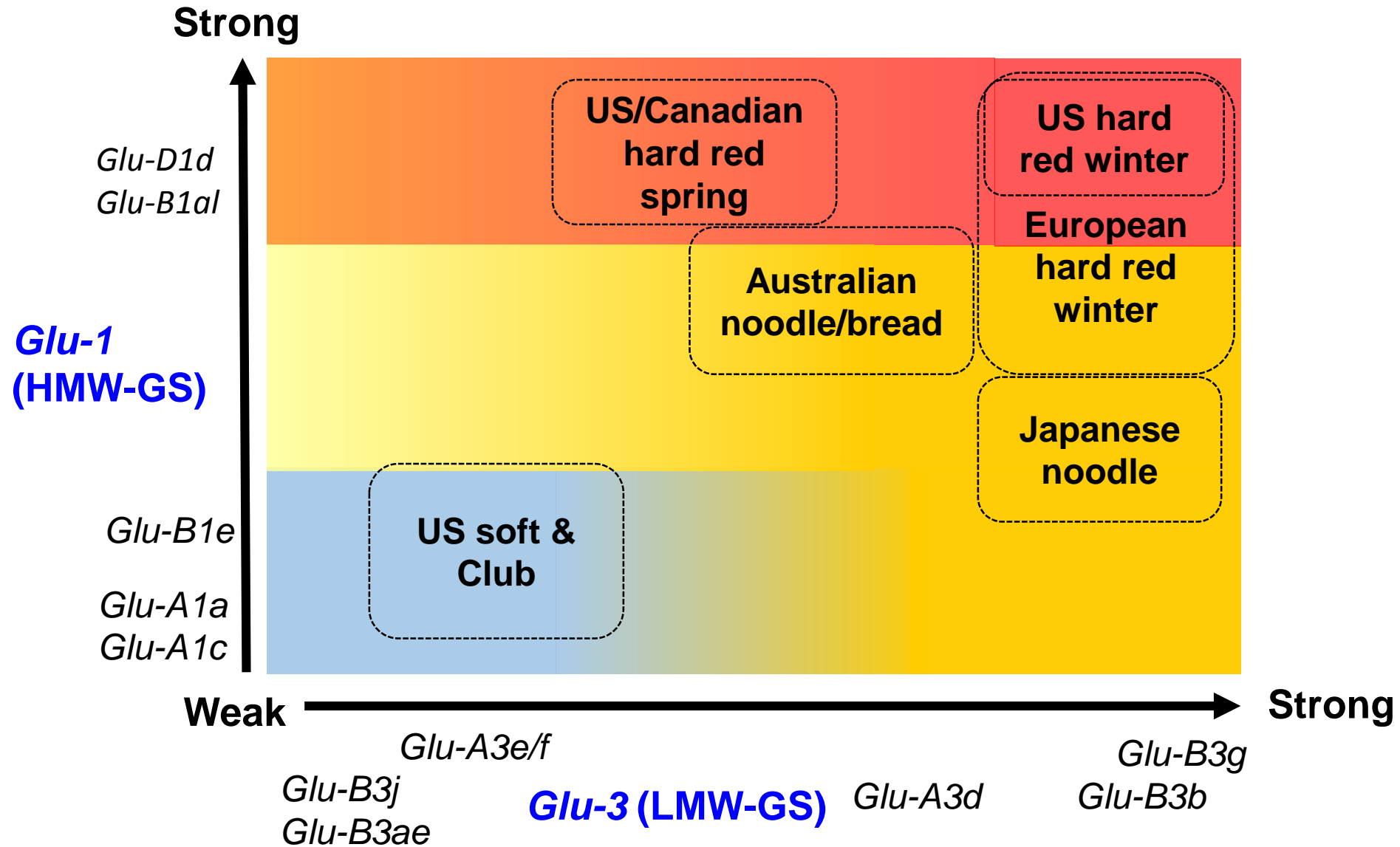
Larger loaf volume

Glutenin allele and gluten strength



Ikeda et al, Cereal Chem 2014

Glutenin allele and gluten strength



Our Expert Working Group

Seed components

- Seed proteins
- Carbohydrates
- Nutrients

G
x
E

Functionality

- Allergy
- Food safety
- Processing

Resources

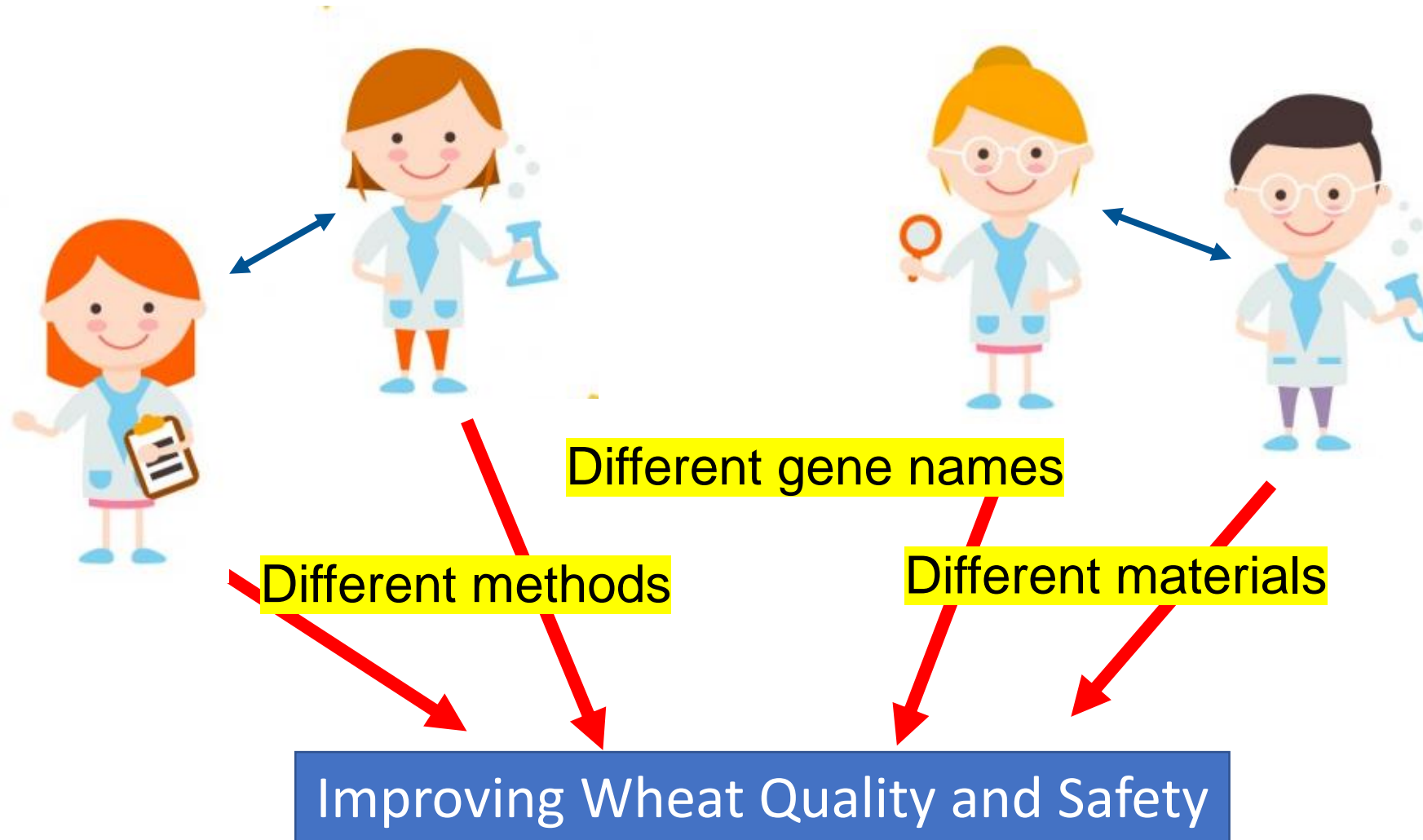
- Genetic resources
- Gene nomenclature

EWG for Improving wheat quality for processing and health

Subgroups	Organizers
Seed proteins	Tatsuya M. Ikeda (Japan)
Allergy	Angela Juhasz (Hungary)
Carbohydrates	Regina Ahmed (Australia)
Nutrition	Peter Shewry (UK)
Processing	Valérie Lullien-Pellerin (France)
Food safety	Sofia Chulze (Argentina)
Genetic resources and gene nomenclature	John W. Rogers (Argentina) & Carlos Guzmán (CIMMYT)

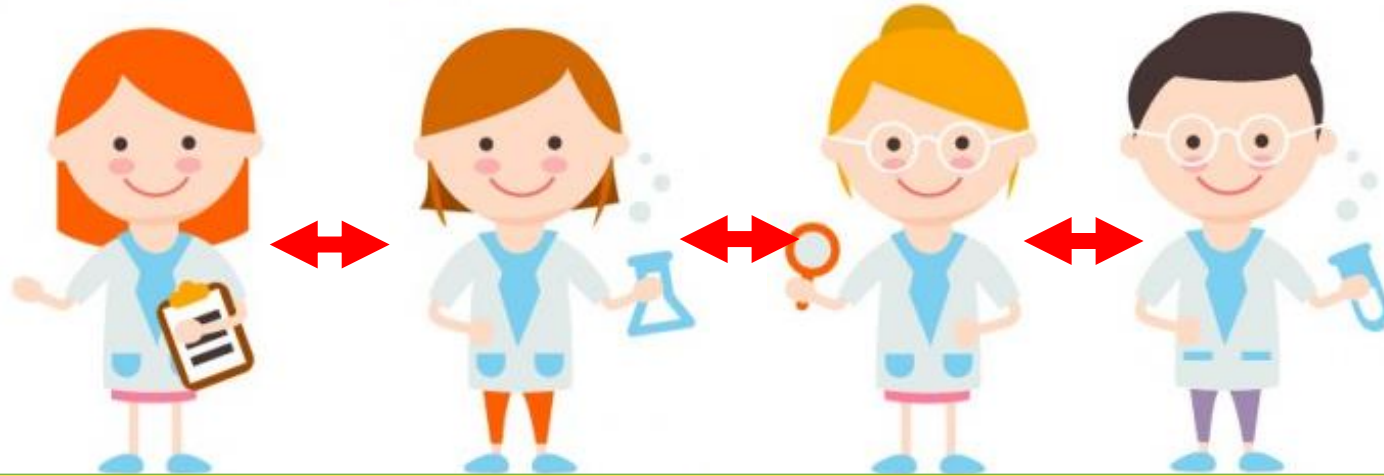
7 subgroups, 71 members from 23 countries. Only one member from industry. Some subgroups have a few members.

We studied independently



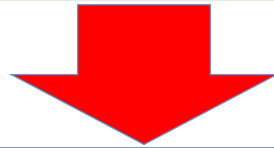
Not efficient and not friendly to newcomers

Important to share a research platform



Sharing a same platform

Same gene names, same materials and same methods



Improving Wheat Quality and Safety

The bread wheat *Glu-3* master set representing *Glu-3* alleles

Locus	Allele	Cultivar	Locus	Allele	Cultivar
<i>Glu-A3</i>	a	Chinese Spring	<i>Glu-B3</i>	ad	AC Vista, Heilo, Opata85, Ruso
	b	Gabo, Pavon76		ae (<u>h'</u>)	CA9722, Huaimai16,
	c	Thesee, Seri82, Cheyene		af (<u>ht</u>)	Spear, Neepawa
	d	Cappelle-Desprez, Wilgoyne		ag (<u>h1</u>)	Shinchunaga,
	e	Marquis, Neepawa		ah (<u>h2</u>)	Jing411
	f	Clément, Insignia, Heilo	<i>Glu-D3</i>	a	Chinese Spring
	g	Glenlea, Klein Proteo		b	Gabo, Wilgoyne, Seri
<i>Glu-B3</i>	a	Chinese Spring		c	Cappelle-Desprez, Insignia,
	b	Gabo, Marquis		d	Brimstone, Buck Brasil
	c	Insignia, Halberd		d*	Jufy-1
	d	Pepital, Eshimashinriki		e	Orca, Thatcher
	e	Cheyene		f	Cheyenne
	f	Magali Blondeau		g	Hartog, PavonF76
	g	Brimstone, Cappelle-Desprez		h	India115
	h	Petrel, Pavon76		i	Bolac, Bullet
	i	Demai3, Norin61, AC Vista		j	Brevor, Penjamo62
	j	Clément, Seri82		k	Lincoln, Otane
	m	Soissons		l	Heilo, Pepital, Thesee
	ab	Hope, Nanbukomugi		m	Darius
	ac	Thesee, Acta801, Klein Proteo		n	Fengmai27

Selection durum *Glu-2/Glu-3* Master Set

Magdalena Ruiz and Patricia Giraldo (Spain)

STANDARD VARIETY	genotype	Glu-A3	Glu-B3	Glu-B2
Alaga	1+3+6+11+14+18	6+11	1+3+14+18	null
Alcala la Real	2+4+6+12*+15+19	6	2+4+15+19	12*
Andalucía 344	5+7+8+14+18	5	7+8+14+18	null
Ardente	2+4+11+12+15+17	11	2+4+15+17	12
BGE13077	1+3+6+13*+19	6	1+3+13*+19	null
BGE13089	5*+6*+8a*+11+12+14*+16+22	5*+11+22	6*+8a*+14*+16	12
BGE47507	7+8+11+15+17	11	7+8+15+17	null
BGE47513	6*+13**+14+19	null	6*+13**+14+19	null
BGE47535	5+ (6*)+8a*+11+14*+16+21	5+11	(6*)+8a*+14*+16+21	null
BGE48494	2+4+12+15+17+21	null	2+4+15+17+21	12
Blancal de Nules	1+3+6+13*+16	6	1+3+13*+16	null
Buck cristal	2+4+6.1+12+15+19	6.1	2+4+15+19	12
Claro de Balazote	2+4+6+12+15+16+20	6	2+4+15+16+20	12
Cocorit	2+4+6+10+12+15+19	6	2+4+10+15+19	12
Fanfarrón	5+8+9+13+16+20	5+20	8+9+13+16	null
Langdon	5+8+9+13+16	5	8+9+13+16	null
Mexicali	2+4+6+12+15+19	6	2+4+15+19	12
Mundial	2+4+11+12+15+17+19	11	2+4+15+17+19	12
Mourisco Fino	4+6*+8*+11+15+19	8*+11	4+6*+15+19	null
PI 273985 turanicum	8*+9*+12+14+18	8*	9*+14+18	12

The best standard for some subunits are indicated in red

The test varieties BGE047511 for 7**, and Güero-1 or Joric 69 for 15* are not included

Standards in Nieto-Taladriz et al 1997

Standards added after WI Meeting in Austria 2017

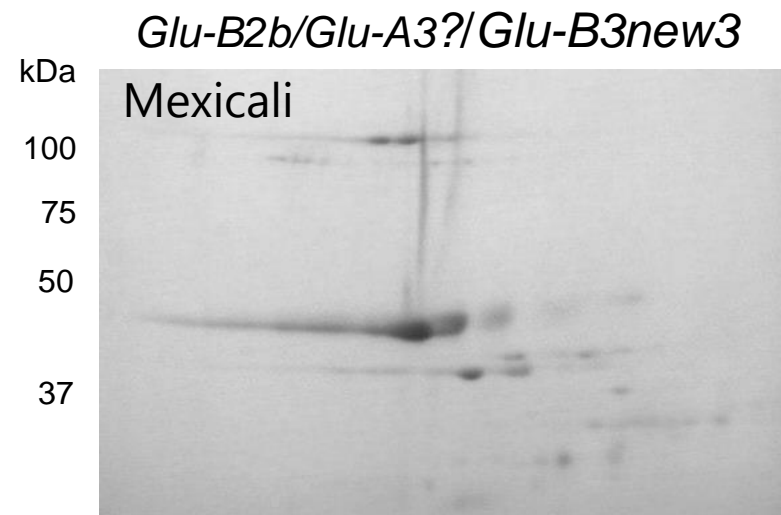
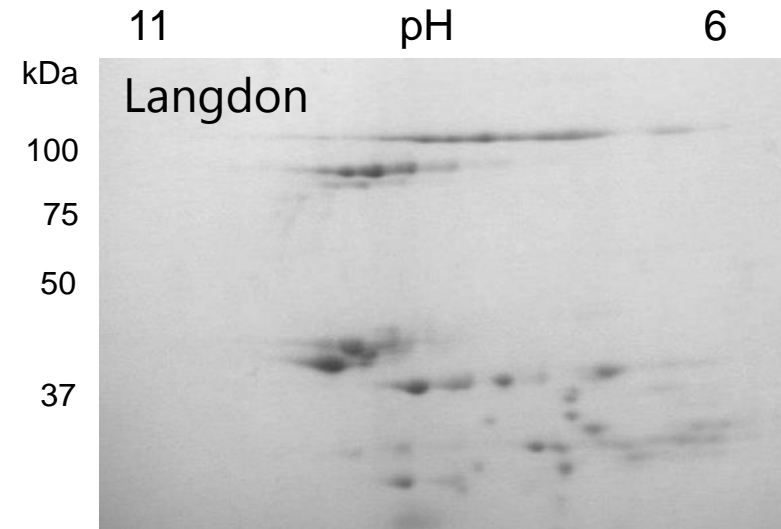


Unifying nomenclature with durum alleles

	<i>Glu-A3</i>	<i>Glu-B3</i>	<i>Glu-B2</i>	<i>Gli-B1</i>
'Alaga'	(m) new	(y) ad	(b) b	(44)
'Andalucia 344'	(-) new2	(-) new	(b) b	(null)
'Ardente'	d*	(w) d	(a) a	(45)
'Blancal de Nules'	(-) ?	(aa) h	(-) b	(-)
'Clarofino'	(o) d	d	(a) a	(45)
'Cocorit'	(l) ?	d	(a) a	(45)
'Fanfarrón'	(q) d	c?	(-) b	n.a.
'Granja Badajoz'	d*	(v) i	(a) a	(45)
'Jiloca'	(p) e	(t) d	(b) b	(45)
'Langdon'	(k) new2	(s) c?	(b) b	(42)
'Mexicali'	(j) ?	(r) d	(a) a	(45)
'Mourisco Fino'	(i) d*	i	(-) b	(-)
'Mundial'	(n) d*	(u) d	(a) a	(45)

Collaboration with P. Giraldo (Spain)
and G. Igrejas (Portugal).

20 alleles were found so far.



Glu-B2b/Glu-A3?/Glu-B3new3

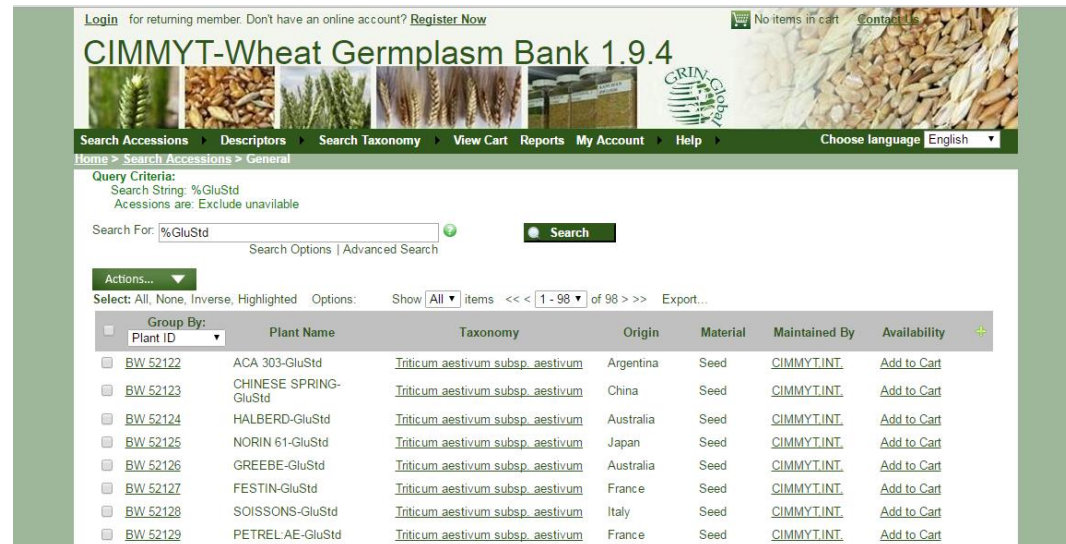
Glu-B2a/Glu-A3?/Glu-B3d

Useful alleles should be found for durum and bread wheat for each other.

Sharing the glutenin master sets

❖ Go to CIMMYT Germplasm Bank web:
<http://wgb.cimmyt.org/gringlobal/search.aspx>

❖ Search for: %GluStd



Search Results for: %GluStd

Plant ID	Plant Name	Taxonomy	Origin	Material	Maintained By	Availability
BW 52122	ACA 303-GluStd	Triticum aestivum subsp. aestivum	Argentina	Seed	CIMMYT.INT.	Add to Cart
BW 52123	CHINESE SPRING-GluStd	Triticum aestivum subsp. aestivum	China	Seed	CIMMYT.INT.	Add to Cart
BW 52124	HALBERD-GluStd	Triticum aestivum subsp. aestivum	Australia	Seed	CIMMYT.INT.	Add to Cart
BW 52125	NORIN 61-GluStd	Triticum aestivum subsp. aestivum	Japan	Seed	CIMMYT.INT.	Add to Cart
BW 52126	GREEBE-GluStd	Triticum aestivum subsp. aestivum	Australia	Seed	CIMMYT.INT.	Add to Cart
BW 52127	FESTIN-GluStd	Triticum aestivum subsp. aestivum	France	Seed	CIMMYT.INT.	Add to Cart
BW 52128	SOISSONS-GluStd	Triticum aestivum subsp. aestivum	Italy	Seed	CIMMYT.INT.	Add to Cart
BW 52129	PETREL-AE-GluStd	Triticum aestivum subsp. aestivum	France	Seed	CIMMYT.INT.	Add to Cart

❖ Advantages of Master Sets:

- ❖ Different groups can work with the same materials.
- ❖ Promote the use of more genetic diversity

Gliadin standard set (69 cultivars)

Gerard Branlard (France)/E.Metakovsky

Variety	Country	Gli-A1	Gli-B1	Gli-D1	Gli-A2	Gli-B2	Gli-D2
Magnif 27	Argentina	b	k	b	b	ap	a
Javelin	Australia	f	b	o	a	at	w
Mokoan	Australia	f	c	b	a	ao	q
Insignia	Australia	f	i	i	a	i	i
Gabo	Australia	g	b	f	c	c	t
Bungulla	Australia	m	b	h	a	an	w
Spear	Australia	m	d	i	m	aq	w
Giurgana	Azerbaijan	o	b	a	v	h	b
251/83-89	Bulgaria	b	b	b	b	x	b
Leader	Canada	m	d	j	f	ak	h
Chinese-Spring	China	a	a	a	a	a	a
Open	France	e	b	g	n	m	e
Orepi	France	f	f	b	r	ab	a
Balthasar	France	f	f	j	l	ad	a
Genial	France	k	f	b	r	r	n
Heurtebise	France	m	b	m	l	g	g
Roazon	France	o	b	b	g	ar	v
Darius	France	o	f	Null	l	g	g
Albatros	France	o	g	b	g	l	ac
Japhet	France	v	h	d	j	n	n
Floreal	Germany	a	h	l	j	au	a
Solo	Germany	f	e	d	x	n	a
Basalt	Germany	f	f	j	h	f	g
New Pusa	India	a*	p	a	t	New	p
Fiorello	Italy	a	e	f	g	v	u
Centauro	Italy	a	e	k	g	y	j
Granarolo	Italy	a	g	k	g	j	r
Ardito (Sample 3)	Italy	f	k	d	e	e	j

Wheat allergy analysis

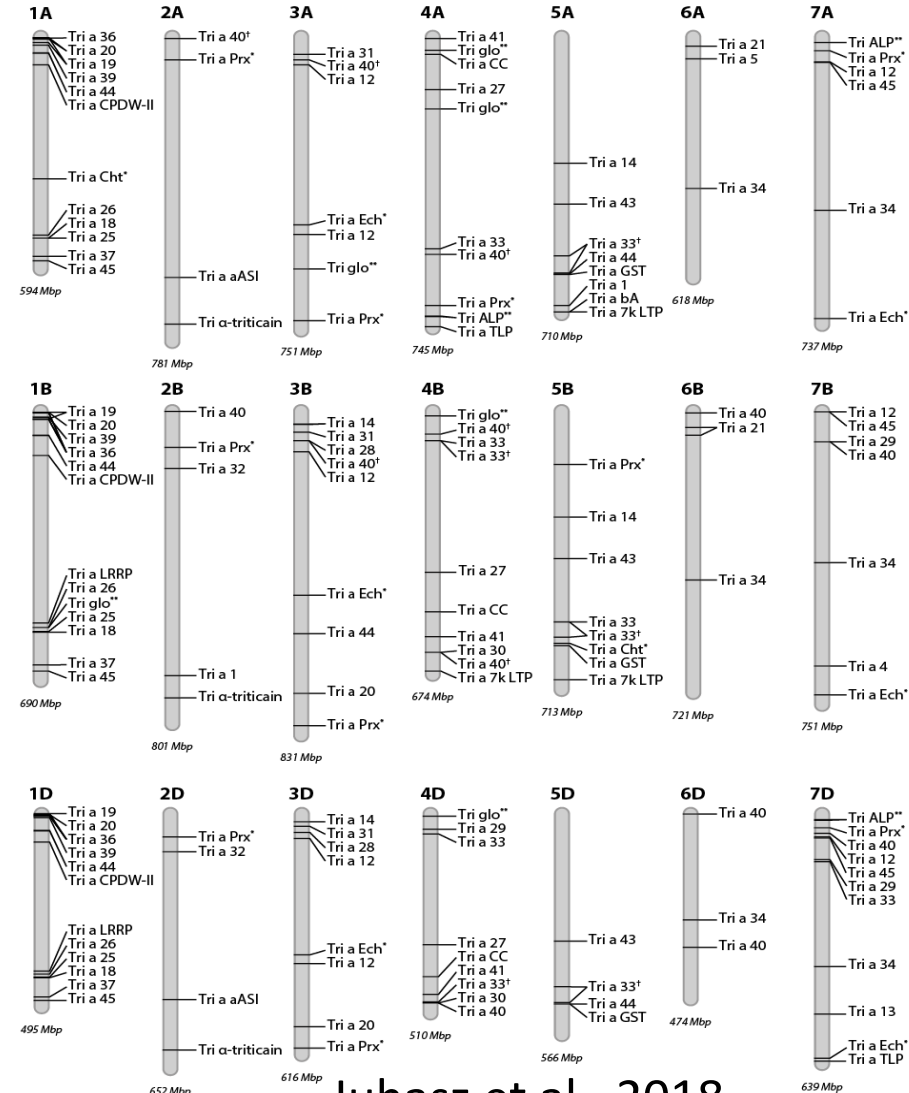
Angela Juhasz (Australia)

Collaboration with IWGSC

Reference map of wheat allergens

Wheat genome: 69 allergen protein families are represented

- More than 17000 genes
- 6500 genes are expressed in the grain
- 350 genes show high sequence homology to known reference allergens
- Presence of conserved allergen clusters



Juhasz et al., 2018

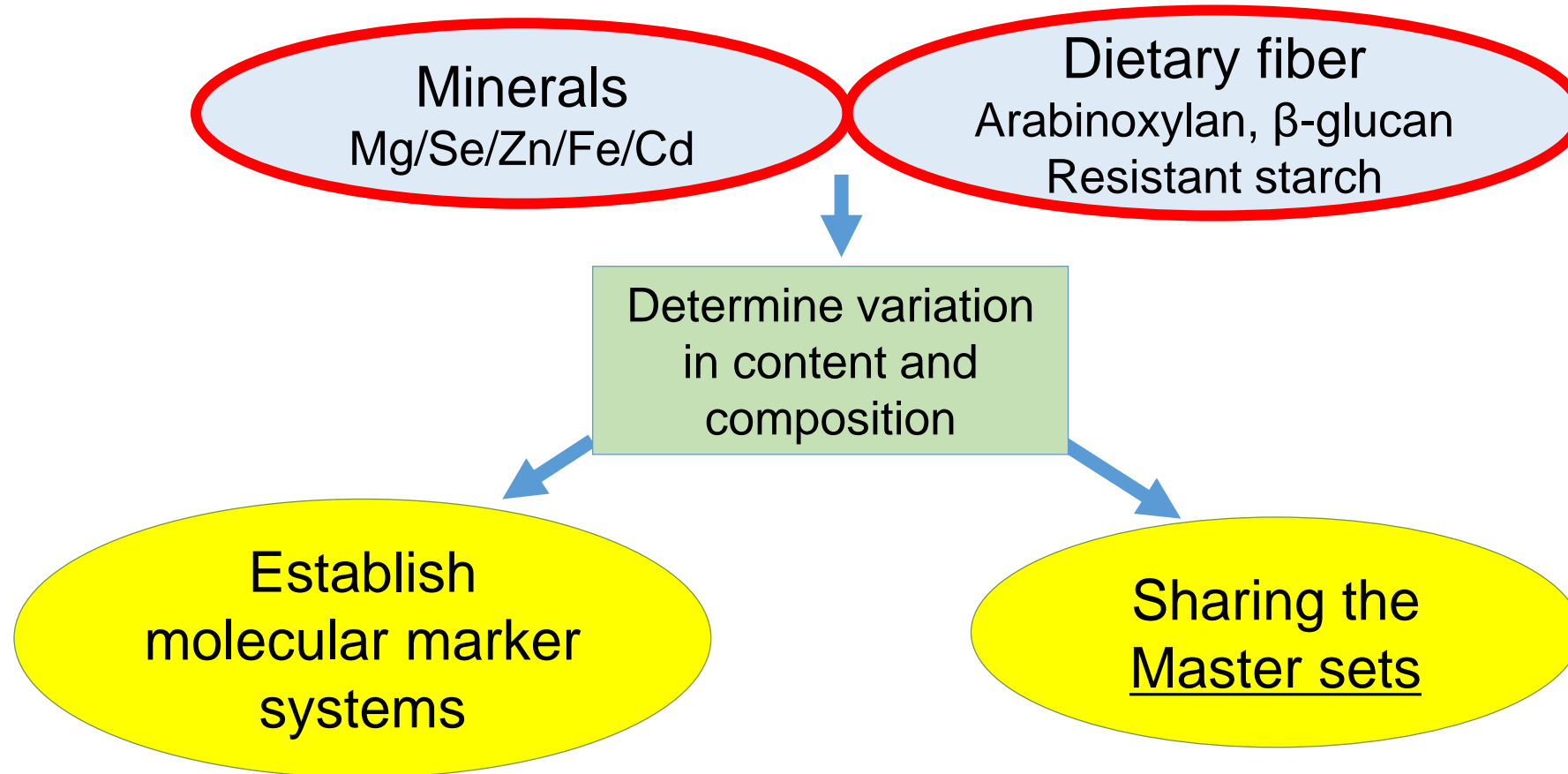
Genetic resources with decreased allergens, celiac disease associated proteins or FODMAP content

Angela Juhasz (Australia)

	Prolamin target	Genotype	Reference
Natural sources	Gliadin null lines	<i>Gli-A1</i> , <i>Gli-D2</i> – Saratovskaja 29 <i>Gli-B1</i> – Spada <i>Gli-D1</i> – Darius <i>Gli-A2</i> – Reader <i>Gli-D2</i> – Saratovskaja 29 Pegaso- <i>Gli-A2/Gli-D2</i>	Redaelli et al 1994 Lafiandra et al 1990 Branlard et al. 2003 Lafiandra et al., 1987 Camerlengo et al., 2017
	Low gliadin	T. monococcum	Gell et al – in progress
	Low FODMAP	T. spelta	Pauk et al., - Bekes et al – in progress
RNAi silencing	Alpha-, gamma-, omega gliadins	D783 D793	Gil-Humanes et al., 2010
	Gamma gliadins	D577, C655	Piston et al., 2013
	Omega gliadin	35b, 45a	Altenbach et al., 2014
Genome editing	Alpha gliadin	BW208 T545	Sanchez-Leon et al., 2017

Improving wheat nutrients

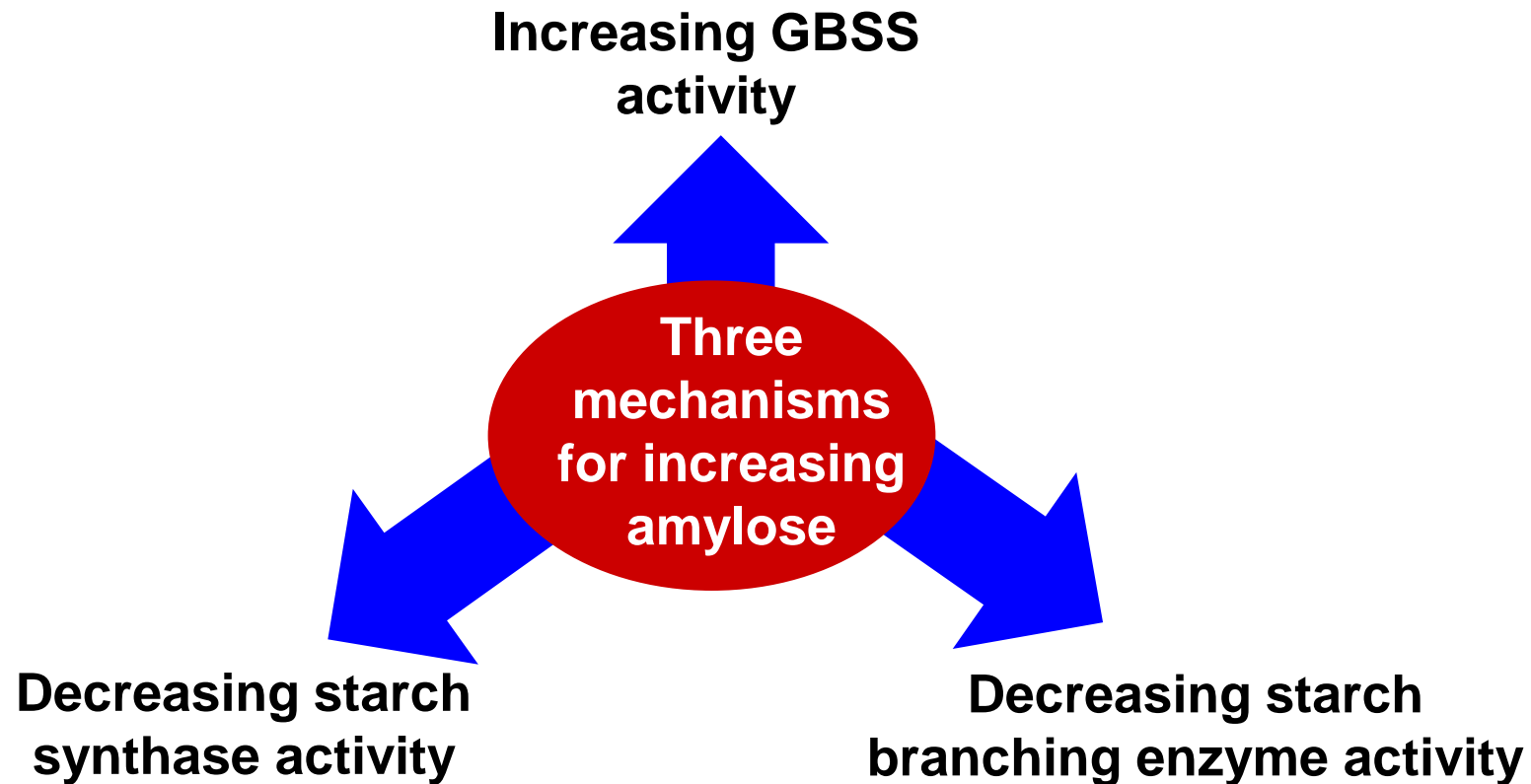
Peter Shewry (UK)



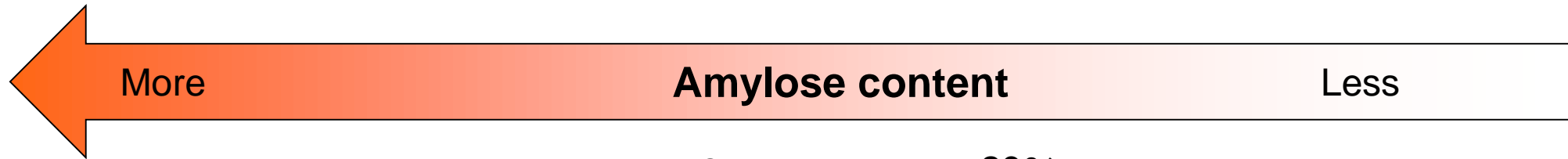
Increasing amylose and resistant starch content for healthier foods

Regina Ahmed (Australia)

Control of % amylose in cereals



Starch quality (amylose content)



More

Amylose content

Less

≈ 30%
Normal

≈ 27%
Partial waxy

≈ 23%
Partial waxy

≈ 0%
Waxy

Sgp-1
null

Wild

*Wx-A1*null

*Wx-B1*null

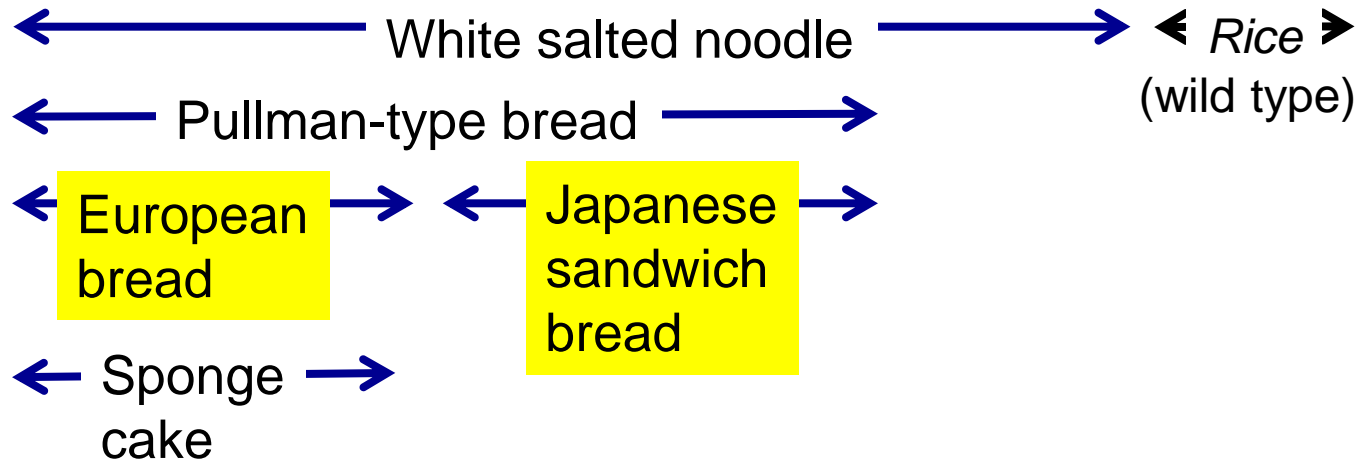
Wx-A1/Wx-B1
double null

Wx-A1/Wx-B1/
Wx-D1 all null

Less

Springiness

More

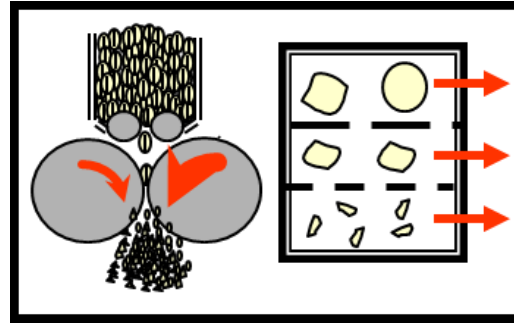


High
amylose

Processing subgroup

Valérie Lullien-Pellerin (FR)

Milling



Establishing a dataset for relationships between genotypes, climates, cultures, and tissue distribution & milling fraction properties

Safety, Nutrient, Allergen subgroups

Determining sustainable processing which help to reduce contaminants and allergens, improve nutritional density and maintain product sensory and technological quality



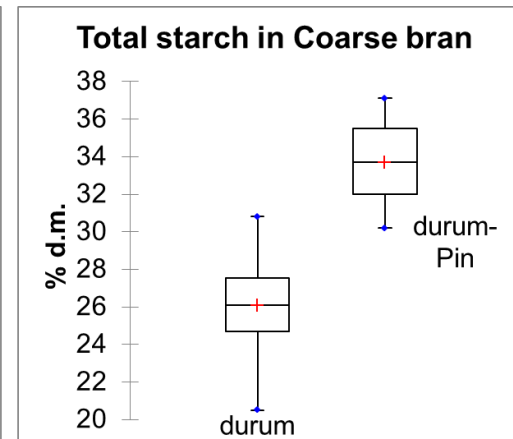
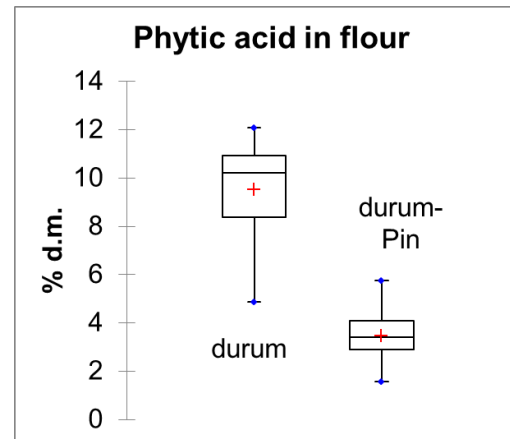
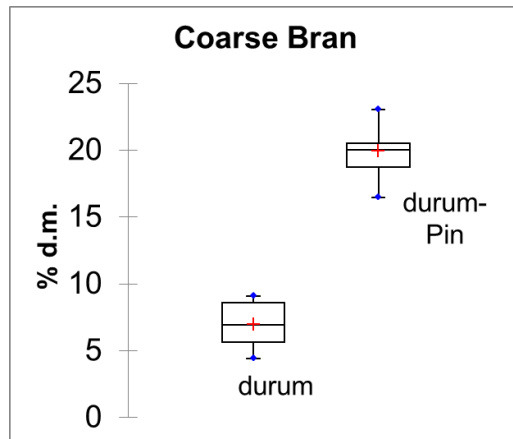
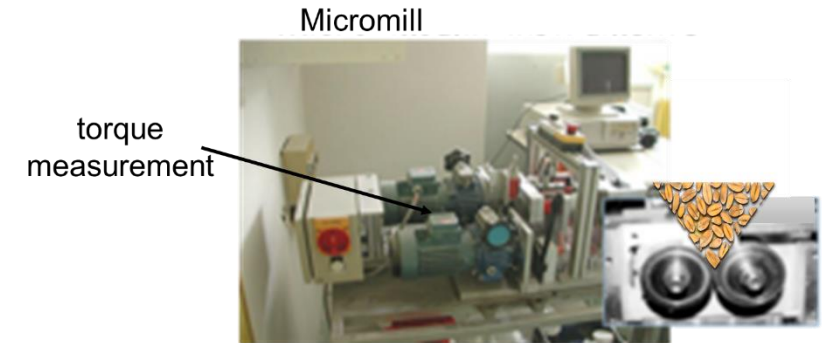
Puroindoline genes introduction into durum wheat : leads to a soft wheat like behavior

Collaboration between INRA (V. Lullien-Pellerin) and USDA (C. Morris)

Heinze et al., JCS 2016

changes

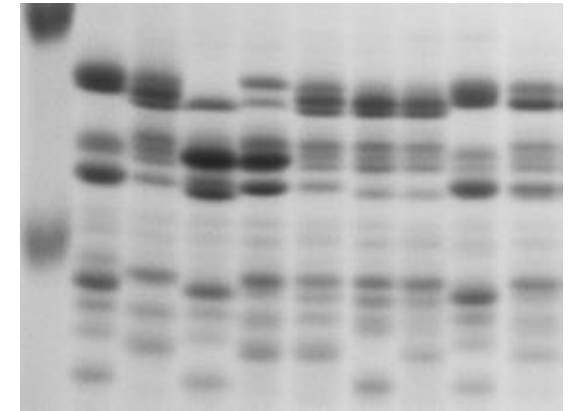
- milling energy → reduced
- flour yield → increased
- tissue dissociation → changed
- starch damage → reduced



Unifying and standardizing methods

“Protocol repository & Interlaboratory comparison”

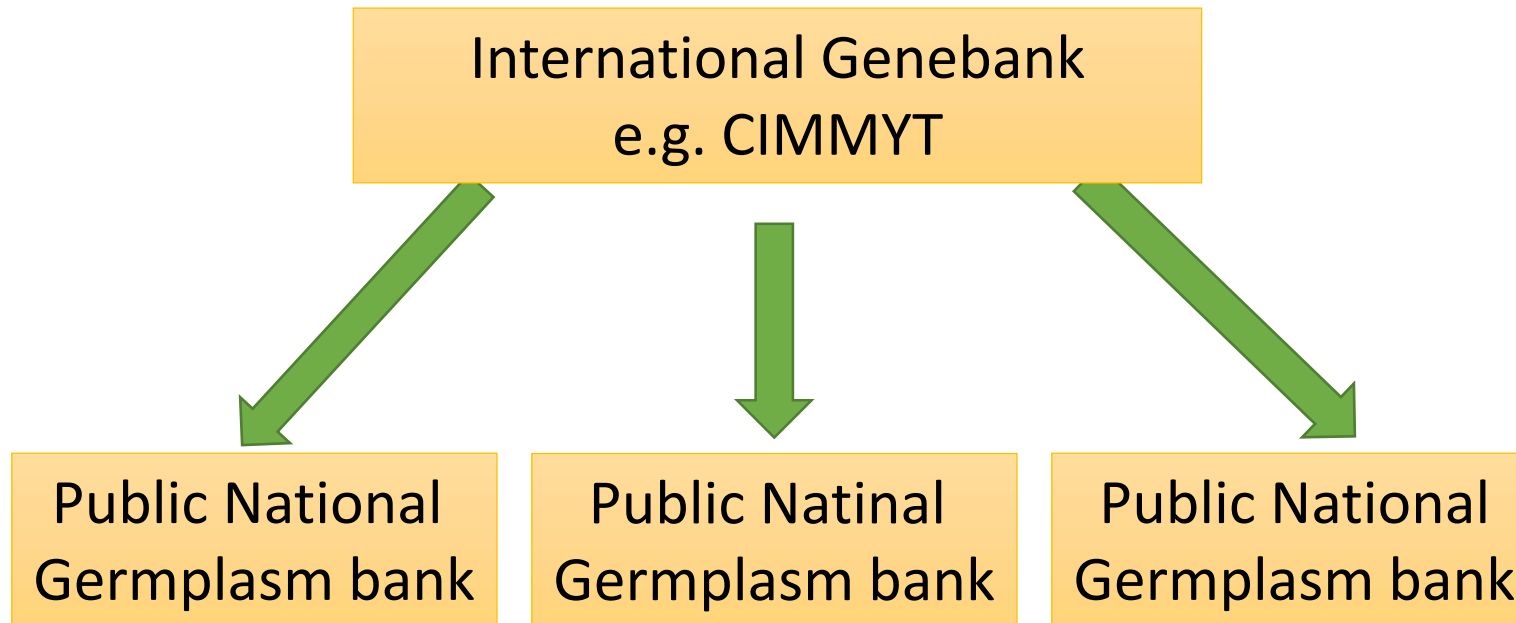
- Select methods have been approved neither by AACCI nor ICC
- SDS-PAGE for glutenin and gliadin analyses
- Acid-PAGE for gliadin analysis
- SE-HPLC analysis for glutenin/gliadin ratio
- Pentosan content (capillary viscosimeter)
- Amylose content (iodine, HPLC)
- We will discuss with ICC to form a joint project.



Selecting master sets based on breeding purposes

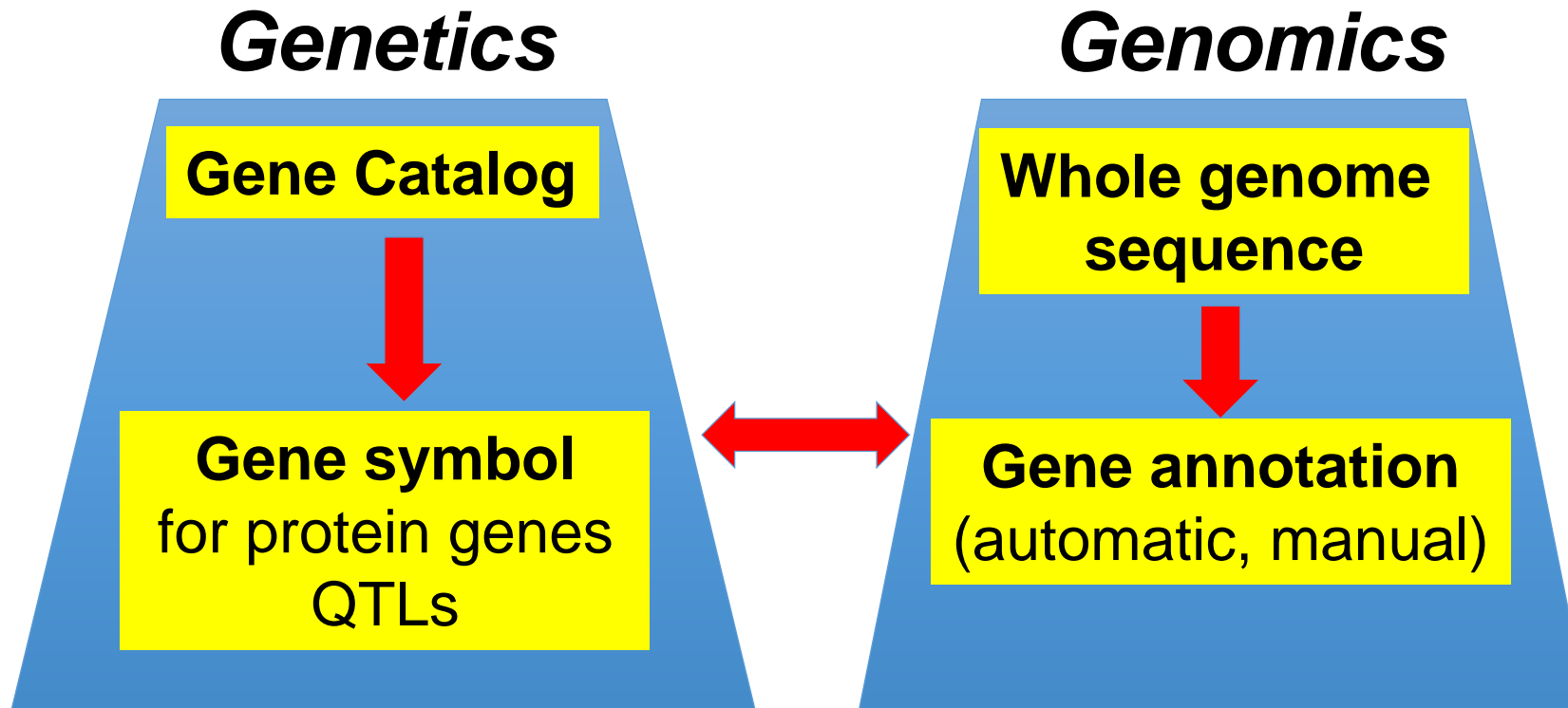
- Glutenin, gliadins
- Puroindolines
- Waxy
- Allergens
- Traits
 - Bread-making
 - Noodle-making
 - Micro-nutrients
 - Fiber
 - Safety

Sharing various quality related master sets among germplasm banks



- Sharing identical materials among researchers.

Collaboration with WheatIS EWG for connecting the gene catalog and genome data



Wheat Gene Catalogue

B. McIntosh et al.





121 Gene classes

Phenotype and protein related genes.
Many alleles and QTLs

Symbol	Wild Type	Wx-B1
	Allele	Wx-B1a , Wx-B1b , Wx-B1c , Wx-B1d , Wx-B1e , Wx-B1f , Wx-B ^S 1g , Wx-B ^{SL} 1h
Synonyms		Wx-A1b{1054}
Chromosomes		Null allele
Germplasms		v:Kanto 79{1617}, v:Kanto 82{1617}, v:Kanto 107{1617}, v:Norin 98{1617}, v:Gabo{1617}, v:Reward{10032}, v:Satanta{1617}, v:Yukon{10032}, v2 :Mochi-Otome <i>Wx-A1b Wx-D1b</i> {10032}, v2 :Nebarigoshi <i>Wx-A1b</i> {10032}, v:For list of Australian wheats, see{1650}, tv :Blaquetta (BG-13701){0111}
Comment		An ELISA-based method was developed for distinguishing wheat lines carrying this null allele {10325}.


Genome Database


 [HMMER](#) | [BLAST](#) | [BioMart](#) | [Tools](#)


 **Triticum aestivum** (TGACv1) ▼


New Search

Search Ensembl Plants
└ [New Search](#)

 [Configure this page](#)

 [Custom tracks](#)

 [Export data](#)

 [Share this page](#)

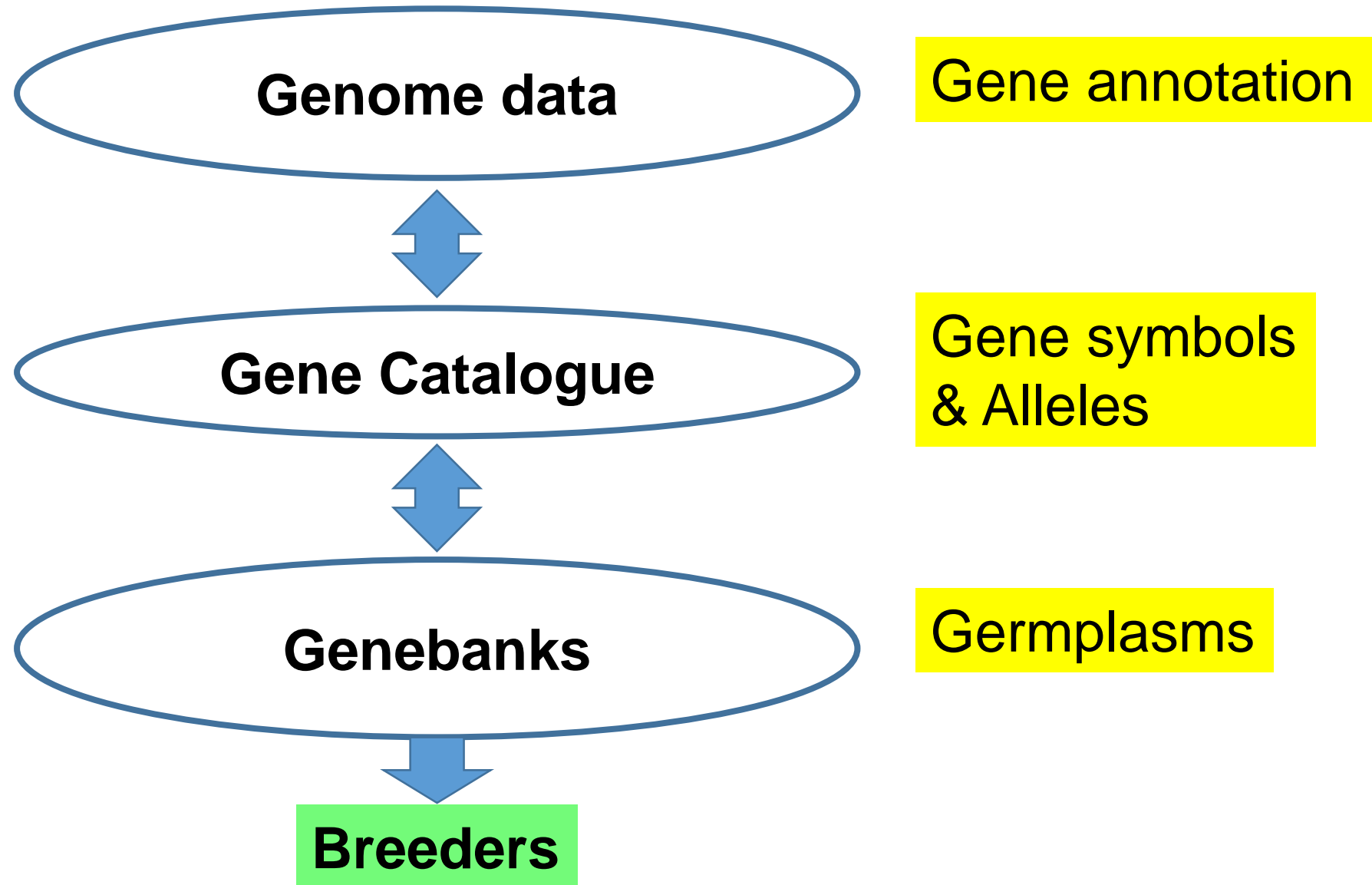
Search results for 'Wx-B1'

Your search for 'Wx-B1' returned no results

Suggestions:

- Make sure all terms are spelled correctly
- Try using wildcards, e.g. ['Wx-B1*'](#)
- Broaden your search:

Genome data for breeders



Collaboration with Durum Wheat Genomics and Breeding EWG

Quality characterization of their core collection (~500 accessions) including the glutenin master set

- Protein content, amino acid composition
- Glutenins/gliadins, gluten strength
- Grain softness protein-1, Lipxygenase (*Lpx*)
- Yellow pigments (*Psy*), semolina milling yield, pasta quality
- Phenolic acids, antioxidant activity
- Fe-Zn and phytic acid

Sharing research a platform among us



Expert Working Group
Sharing a same platform



Improving Wheat Quality and Safety

Inviting you as active members!

