

Allelic diversity of HMW and LMW glutenin subunits and ω -gliadins in Canadian hard red spring bread wheat (*Triticum aestivum* L.) developed over 150 years

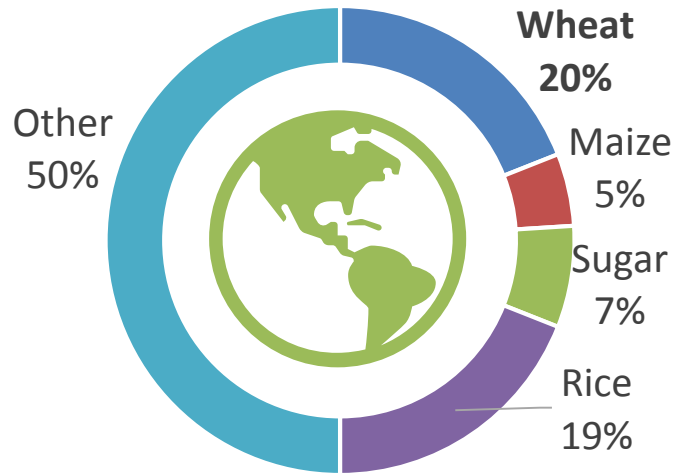
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Wheat worldwide

One of the most important staple crops

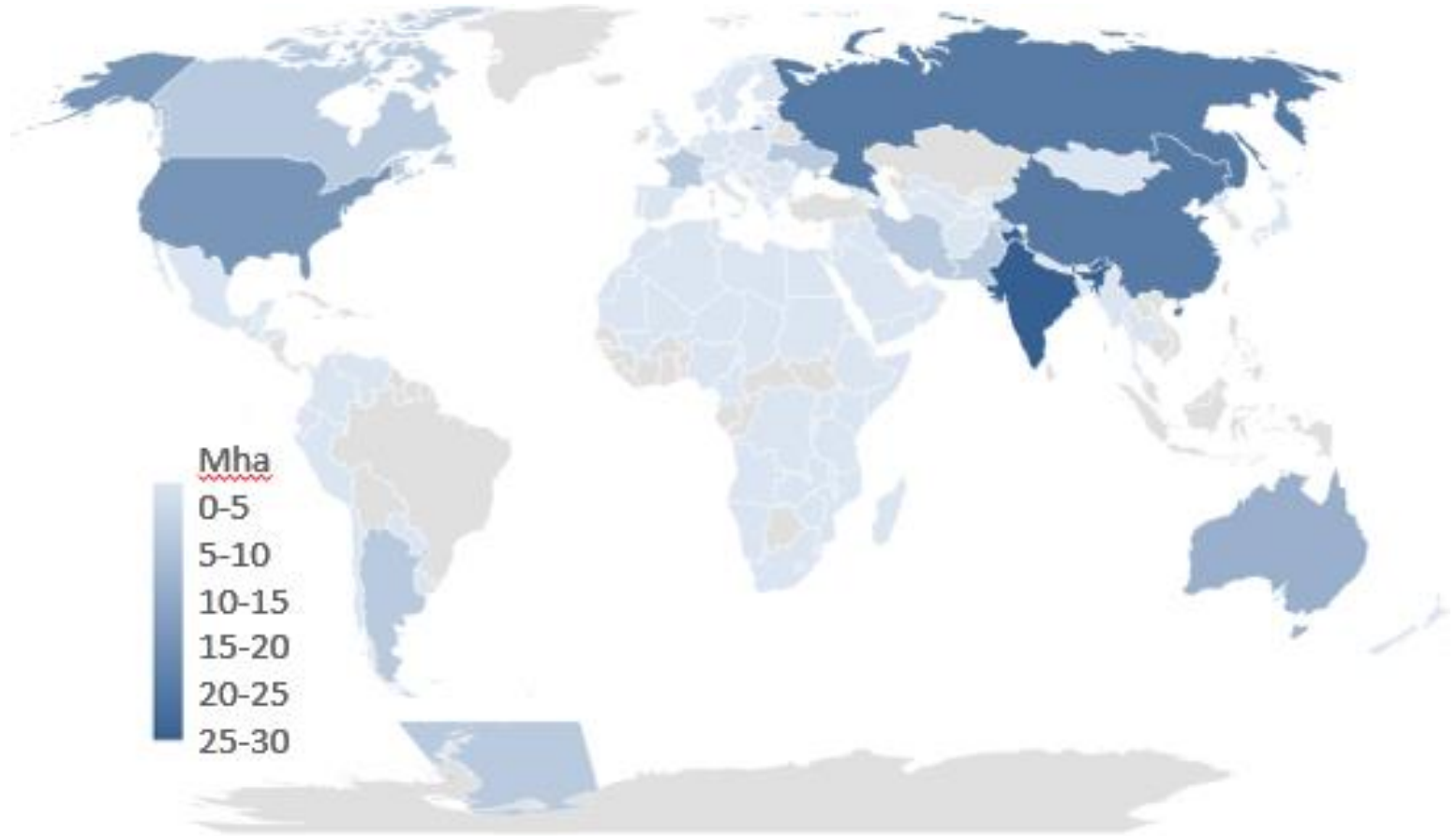
Major source of **energy** and **proteins** 



Global wheat
Production (2017) **772**

Mt

(FAOSTAT, 2019)



Grain protein content in wheat

- Structural proteins
- Metabolic proteins
- Protective proteins
- Storage proteins

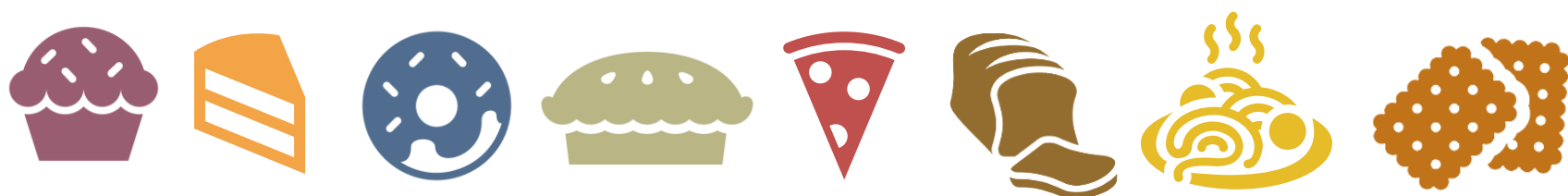


Total Protein in the grain

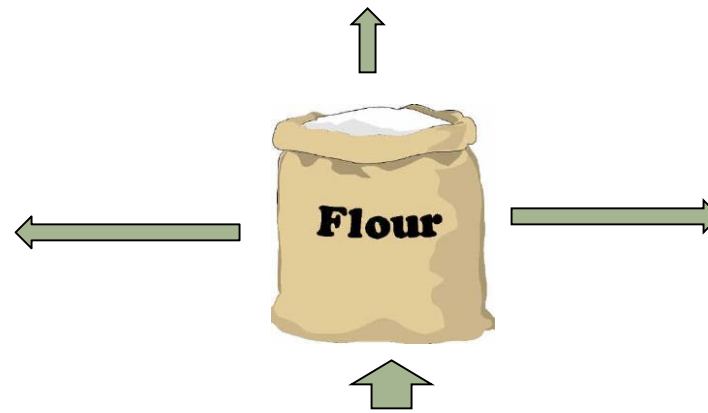
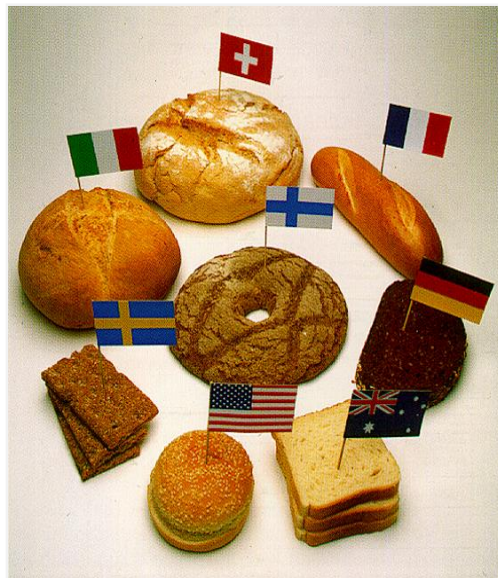


Gluten proteins

- Glutenins and gliadins form the gluten matrix after flour is mixed with water
- Confers viscoelastic properties to the dough
- Are major determinants for wheat grain end use
- Wide range of products



Wheat is consumed as diverse regional and ethnic products



Function and structure of gliadins and glutenins

Gliadins



Hsieh, F-H., "Use of Gliadin and Wheat Glutenin in Pasta and Noodles", Food Science & Engineering Unit, University of Missouri-Columbia.

- Gliadins provide viscosity
- Allows the dough to respond to gas pressure

Gluten



Glutenins



- Glutenins provide strength
- High molecular and low molecular weight

Objective

To study the diversity in wheat glutenins and gliadins,
the two proteins that make up gluten, during 150 years
of wheat improvement in Canada



Material and Methods



Kernen Crop Research Farm
(U of S, Saskatoon, SK)
2013-2014

Con tecnología de Bing
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Weather data
NASA Prediction of Worldwide Energy
Resource (POWER)



Harvest in
September



Randomized complete block design



37

Hard Red Spring
varieties



1860-2007

≠ year of release



Sowing in May

250 pl/m²

Fallow
land

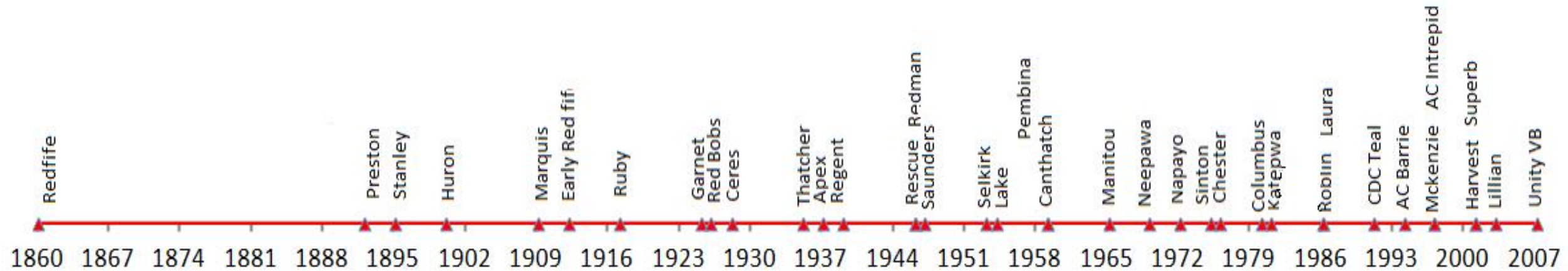


50
kg/ha

Varieties used in Historical Wheat Trials (1860 – 2007)

Year of registration	Number of Varieties
1860 – 1935 (Historical varieties)	11
1936 – 2007 (Current varieties)	26
Total	37

Experimental Study Plan



A	B	A	B
C	D	C	D

2013

2014

Material and Methods

→ SDS-PAGE

(Sodium dodecyl sulfate - polyacrylamide gel electrophoresis)

Protean[®] II xi Cell (Bio-Rad)

→ Extracted 20 mg whole wheat sample (Singh et al., 1991)

→ Standards from Canadian Seed Bank and CIMMyT (Bread Wheat Master Set)

Material and Methods

→ Nomenclature for high molecular weight glutenins

Payne and Lawrence (1983)

→ Nomenclature for ω -gliadins and low molecular weight glutenins

Appelbee et al. (2009)

Branlard et al. (2003)

Jackson et al. (1996)

→ Based on raw data - pie charts

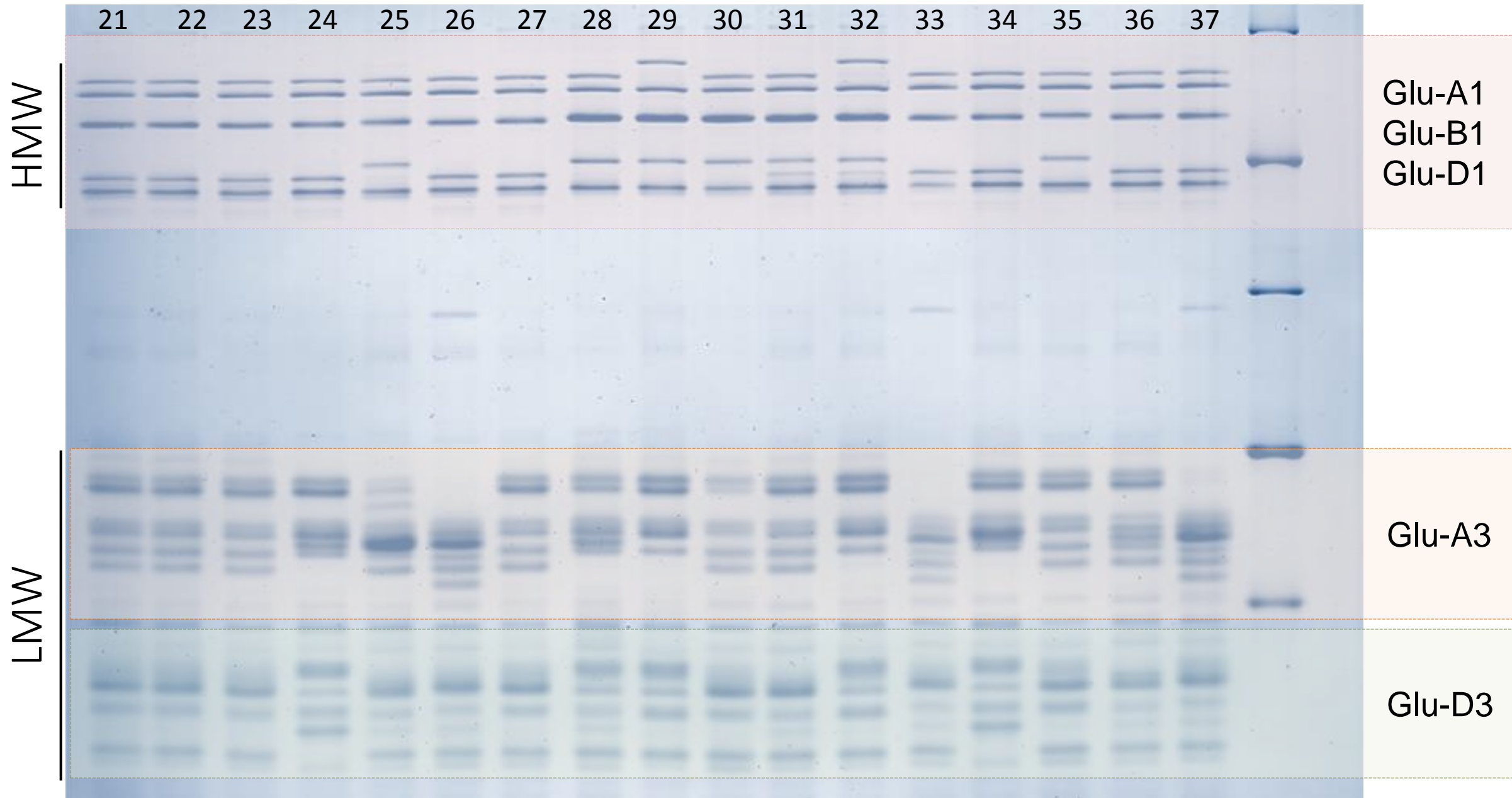
Payne and Lawrence (1983) Cereal Res. Commun., 11: 29-35

Jackson et al. (1983) Theo. App. Gen., 66: 29-37

Branlard et al. (2003) Gen. Res. Crop Evol., 50: 669-679

Appelbee et al. (2009) J. of Cereal Sci., 49: 254-261

SDS-PAGE of HMW and LMW Glutenins



Allelic composition of HMW and LMW glutenin subunits and ω -gliadins in historical wheats

Genotype	Year of release	HMW			LMW			ω -Gliadins
		Glu-A1	Glu-B1	Glu-D1	Glu-A3	Glu-B3	Glu-D3	Gli-B1
Red Fife	1860	2*	7+8	2+12	e	b'	a	b
Preston	1892	2*	7oe+8	5+10	c	b'	a	b
Stanley	1895	2*	7+8	5+10	e	i	b	m
Huron	1900	1	7+8	5+10	e	i	b	m
Marquis	1909	1	7+9	5+10	e	b'	a	b
Early Red fife	1912	2*	7+8	5+10	e	b'	c	b
Ruby	1917	1	7+9	5+10	e	g	b	f
Garnet	1925	1	7+9	5+10	e	g	b	f
Red Bobs 222	1926	1	7+9	5+10	e	b'	a	b
Ceres	1928	2*	6+8	5+10	e	b'	c	b
Thatcher	1935	2*	7+9	5+10	e	h	c	d

Allelic composition of HMW and LMW glutenin subunits and ω -gliadins in current wheats

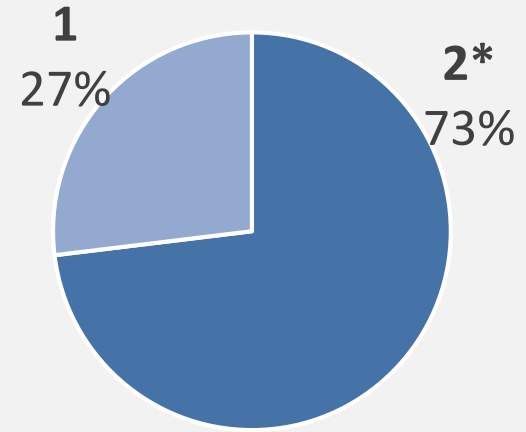
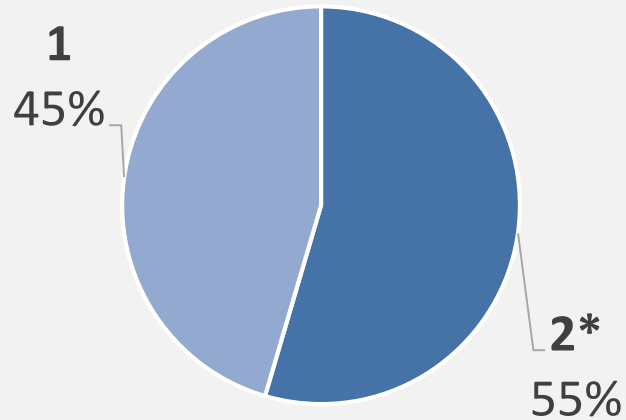
Genotype	Year of release	HMW			LMW			ω -Gliadins
		Glu-A1	Glu-B1	Glu-D1	Glu-A3	Glu-B3	Glu-D3	Gli-B1
Apex	1937	1	7+9	5+10	c	b'	a	b
Regent	1939	1	6+8	5+10	d	g	a	f
Rescue	1946	1	6+8	5+10	d	g	a	f
Redman	1946	1	7+9	5+10	e	h	a	d
Saunders	1947	2*	7+9	5+10	e	b'	c	b
Selkirk	1953	1	6+8	5+10	e	g	a	f
Lake	1954	2*	6+8	5+10	c	g	a	f
Canthatch	1959	2*	7+9	5+10	e	h	c	d
Pembina	1959	2*	7+9	5+10	d	g	c	f
Manitou	1965	2*	7+9	5+10	e	h	c	d
Neepawa	1969	2*	7+9	5+10	e	h	c	d
Napayo	1972	2*	7+9	5+10	e	h	c	d
Sinton	1975	2*	7+9	5+10	f	h	a	d

Allelic composition of HMW and LMW glutenin subunits and ω -gliadins in current wheats

Genotype	Year of release	HMW			LMW			ω -Gliadins
		Glu-A1	Glu-B1	Glu-D1	Glu-A3	Glu-B3	Glu-D3	Gli-B1
Chester	1976	2*	7oe+8	5+10	d	b'	c	b
Columbus	1980	2*	7+9	5+10	e	g	c	f
Katepwa	1981	2*	7+9	5+10	e	h	c	d
Roblin	1986	2*	7oe+8	5+10	f	h	b	d
Laura	1986	1	7oe+8	5+10	e	h	b	d
CDC Teal	1991	2*	7oe+8	5+10	e	h	c	d
AC Barrie	1994	2*	7oe+8	5+10	e	h	c	d
AC Intrepid	1997	1	7oe+8	5+10	e	h	b	d
McKenzie	1997	2*	7+9	5+10	e	g	c	f
Superb	2001	2*	7+9	5+10	f	h	a	d
Lillian	2001	2*	7oe+8	5+10	e	h	c	d
AC Harvest	2001	2*	7+9	5+10	f	h	c	d
AC Unity VB	2007	2*	7+9	5+10	d	g	c	f

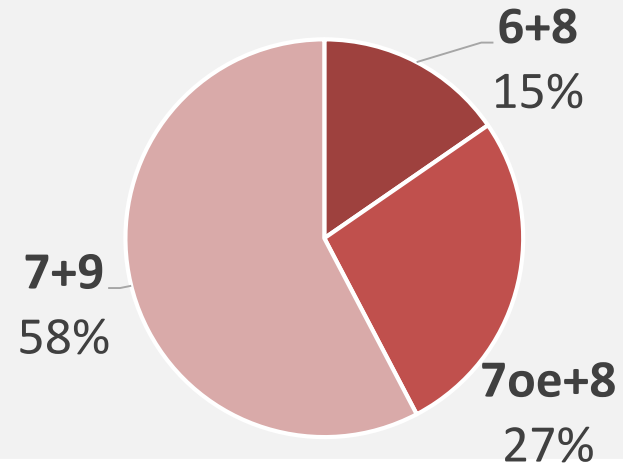
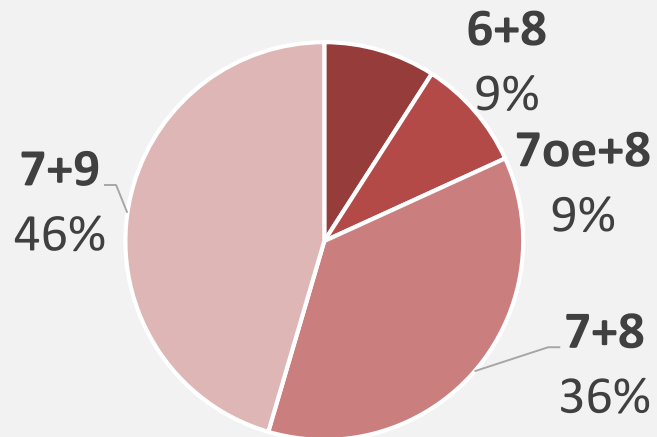
Predominant alleles encoding for HMW glutenins are similar in both groups

Glu-A1



2*

Glu-B1



7+9

Historical

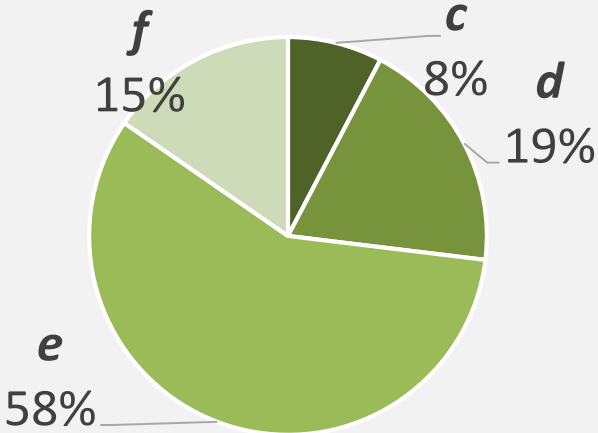
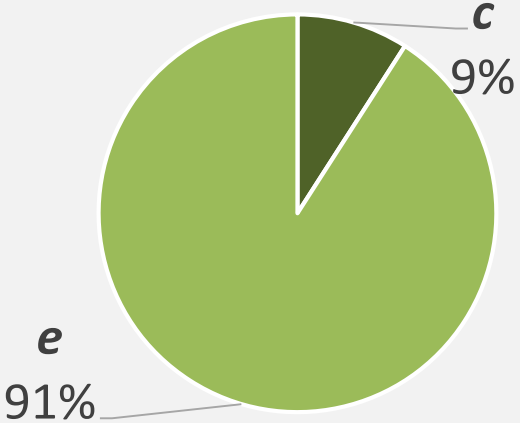
Current

Predominant allele encoding for HMW glutenins is similar in both groups

Genotype	Year of release	HMW			LMW			ω -Gliadins
		Glu-A1	Glu-B1	Glu-D1	Glu-A3	Glu-B3	Glu-D3	Gli-B1
Red Fife	1860	2*	7+8	2+12	e	b'	a	b
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Early Red fife	1912	2*	7+8	5+10	e	b'	c	b
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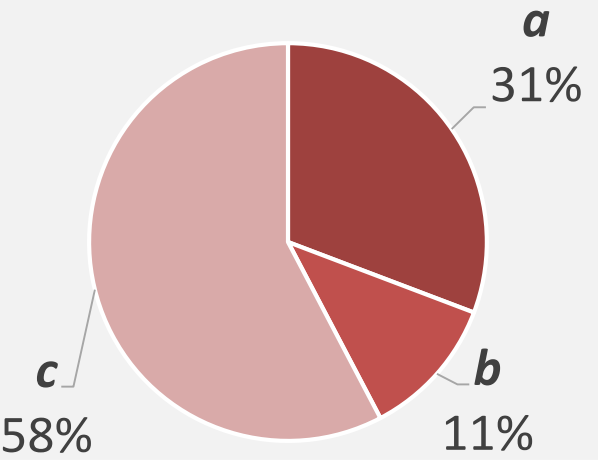
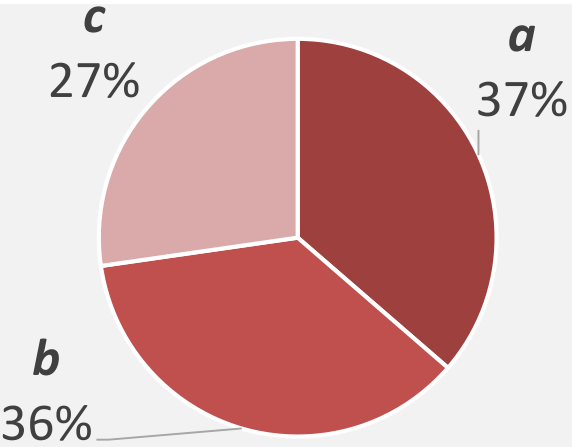
Predominant alleles encoding for LMW glutenins in both groups

Glu-A3



e

Glu-D3



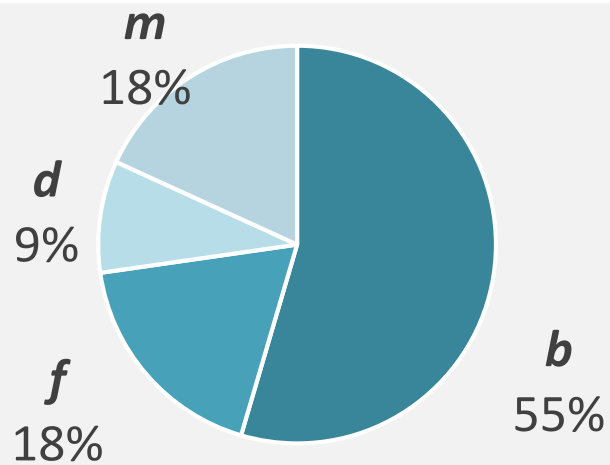
a (historical)
c (current)

Historical

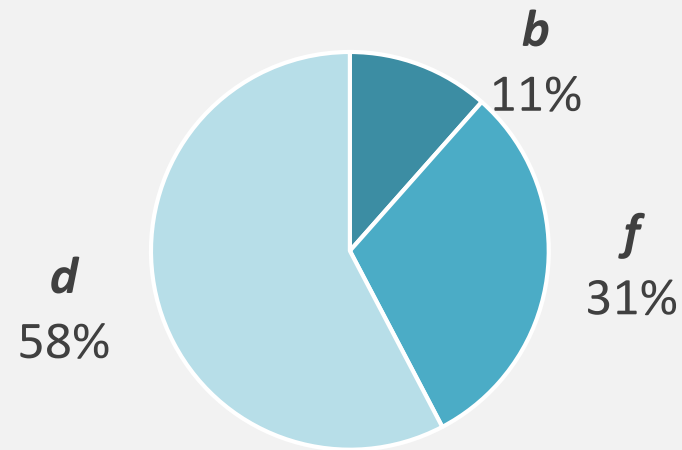
Current

Predominant alleles of ω -gliadins

Gli-B1



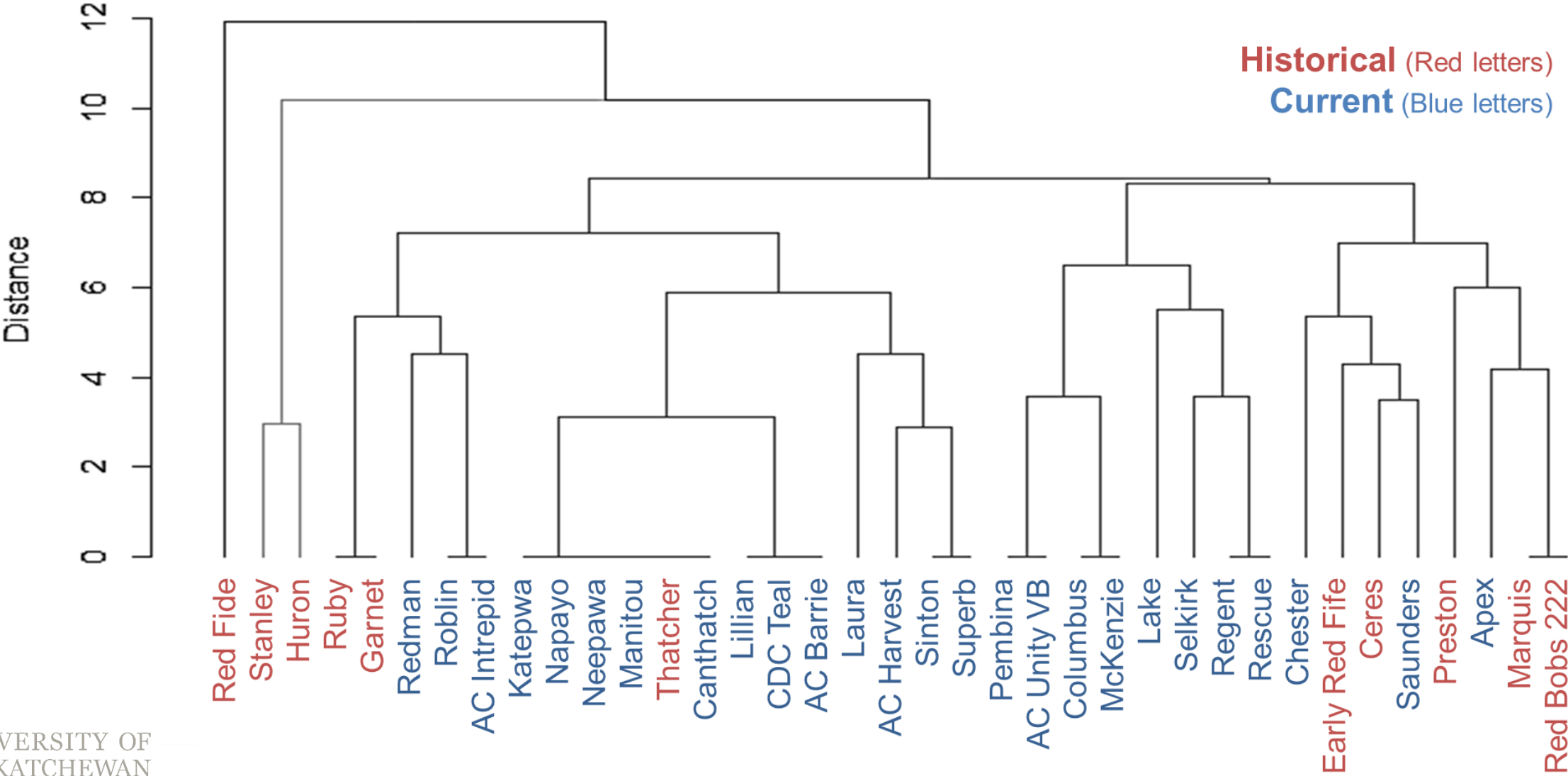
Historical



Current

b (historical)
d (current)

Dendrogram of the 37 wheat varieties showing genetic similarity based on glutenins and gliadins polymorphism



Summary and Conclusions

- Glu A1 “2*”, Glu B1 “7+9”, Glu D1 “5+10” and Glu A3 “e” - *Similar*
- Some alleles vary in their presence - *not novel*
- Frequencies are in general distinctive of every country
- The impact of gluten allele variations on the incidence of Celiac disease is currently being studied

Acknowledgements

University of Saskatchewan

Ravi Chibbar

Pierre Hucl

Monica Båga

Guillermo Gerard

Anna Jacobson



University of Alberta

Leo Dieleman



Funding Agencies



Chaires
de recherche
du Canada

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Thank you



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