



Department of  
Primary Industries



# Can manipulation of the glutenin composition of durum wheat improve bread loaf volume and still maintain pasta quality?

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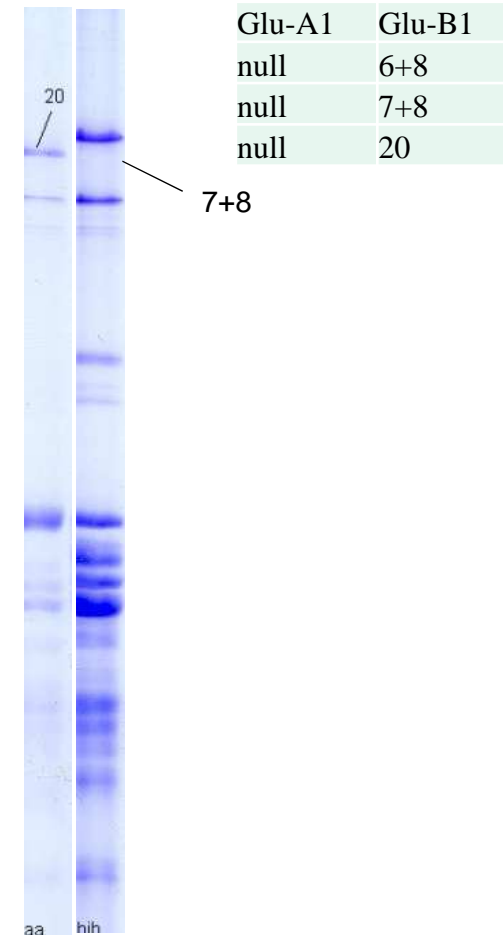
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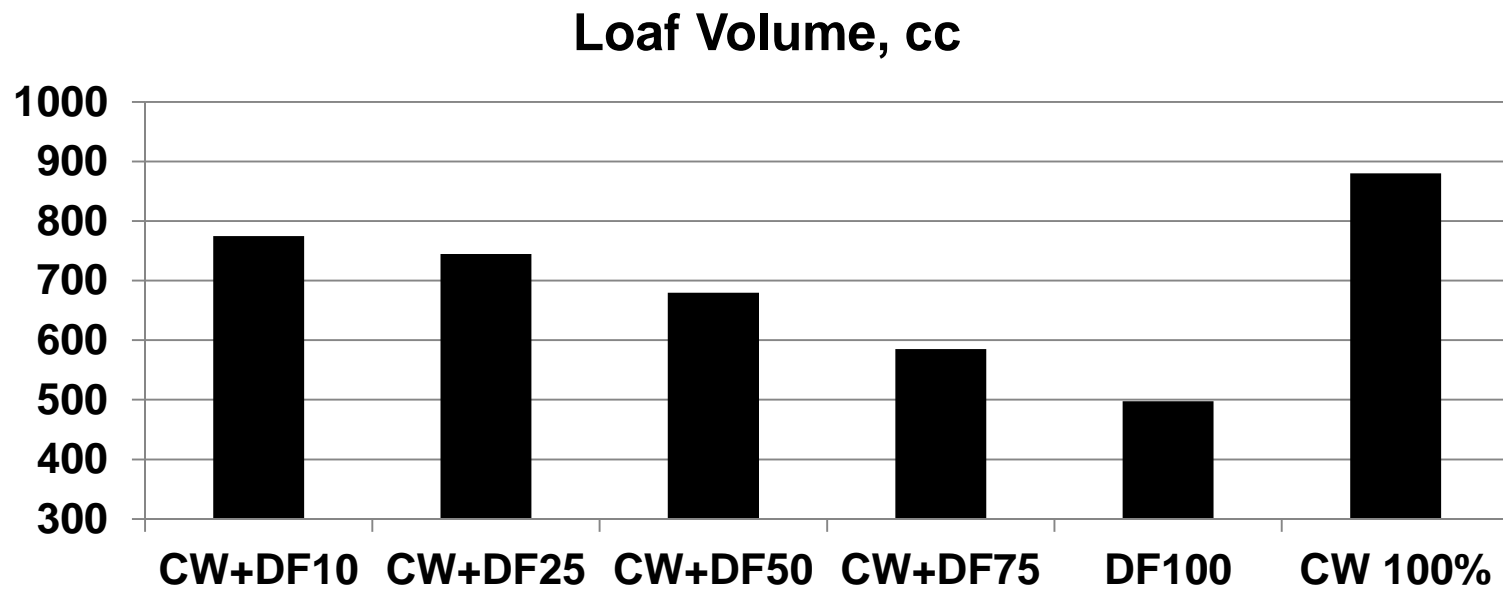
*Glu-1* encoded HMW-GS main contributors to bread-making quality; key subunits 1Dx5+1Dy10 encoded at *Glu-D1d*

For good pasta quality *Glu-B3* encoded LMW-GS are most important and less so from *Glu-B1*

**Dual-purpose durum wheat having both good pasta and breadmaking quality would be an advantage in the market**



Durum dough is inextensible reducing loaf volume



**Baker loaf**

**50% CW+DF**

Poor appearance  
Poor crumb & cell  
structure  
Yellow  
Unique taste

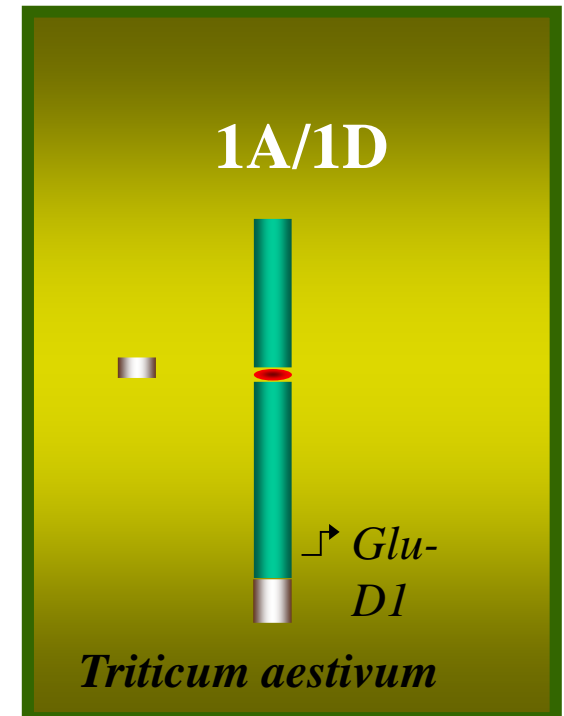
Transferring 1D storage protein genes into durum could widen the potential uses of durum wheat

- Transgenics [Barro et al 1997; Butow et al 2003; Blechl et al 2007; Gadaleta et al 2008; Yue et al 2008; León et al 2009, 2010; Graybosch et al 2011]
- Chromosome translocation lines produced via chromosome engineering [Vitellozzi et al 1997; Joppa et al 1998; Lukaszewski 2003; Gennaro et al 2012; Klindworth et al 2014]

Durum line WB 881 with translocated chromosome segment on 1AL of a short 1DL segment carrying genes for HMW-GS 5+10 (*GluD1d*) or 2+12 (*GluD1a*); were crossed and backcrossed (6x) with Svevo or Lira to introgress these subunits

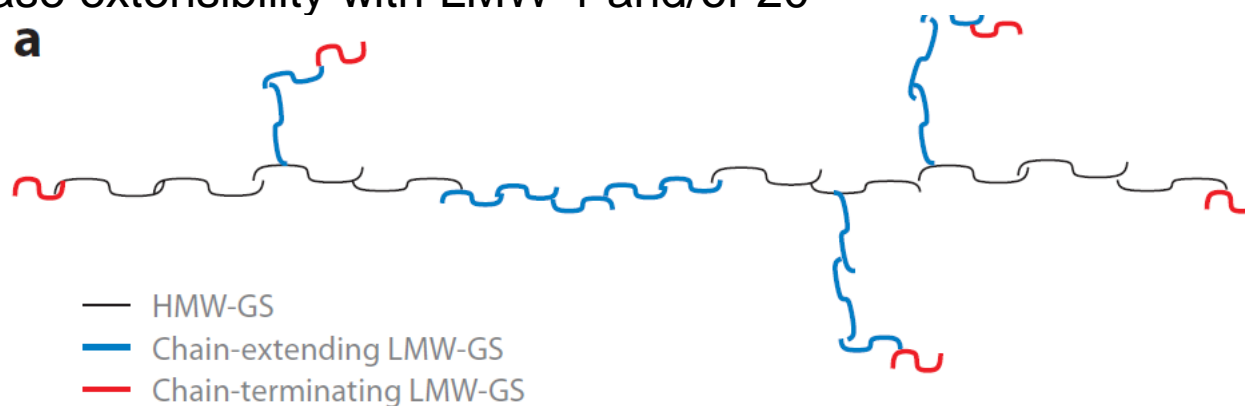
Introducing 2+12 or 5+10 in the Svevo background did not improve loaf volume and made pasta softer

Gennaro et al (2012) Mol Breeding 30:149–167  
Sissons et al (2014) Crop & Pasture Sc. 65:27-37



A better balance of extensibility with strength in the gluten macropolymer is needed to enhance BMQ while retaining PMQ

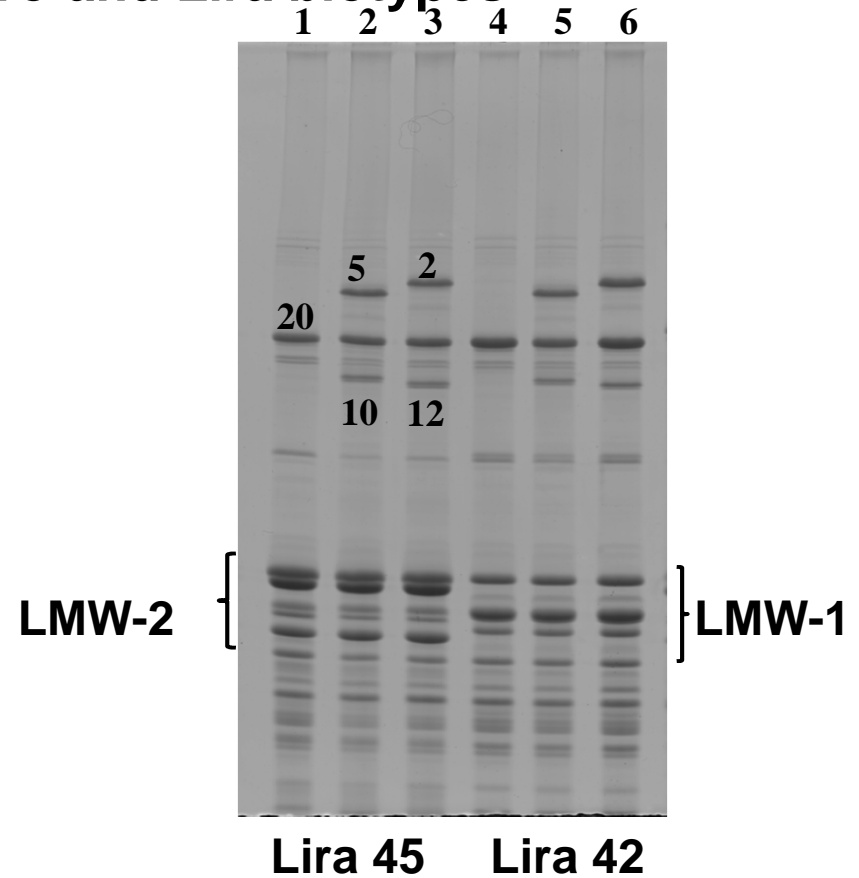
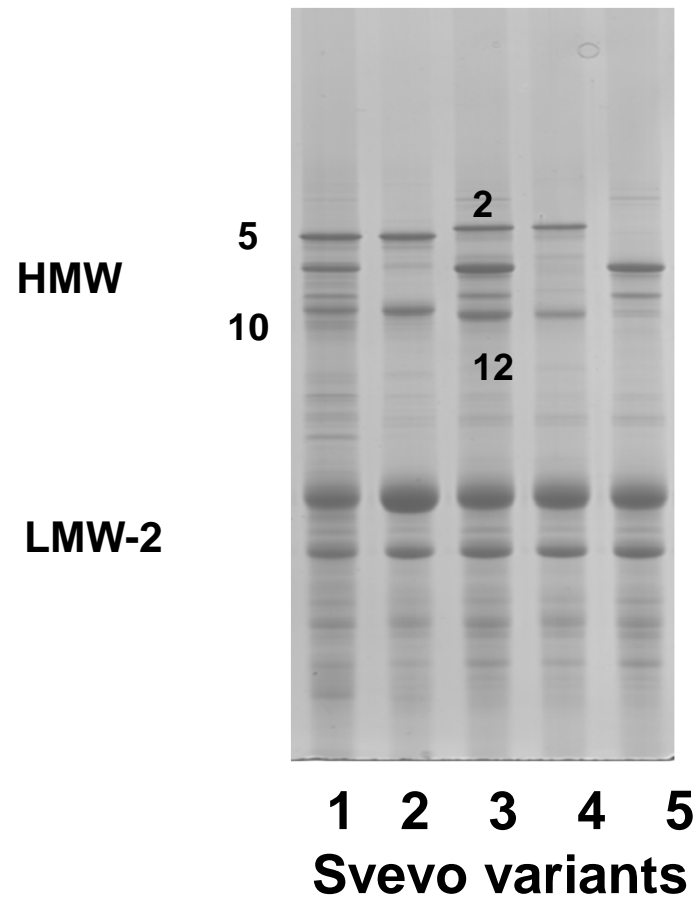
- Increase strength with 5+10/2+12 but needs modulating
- Increase extensibility with LMW-1 and/or 20



# Our aim

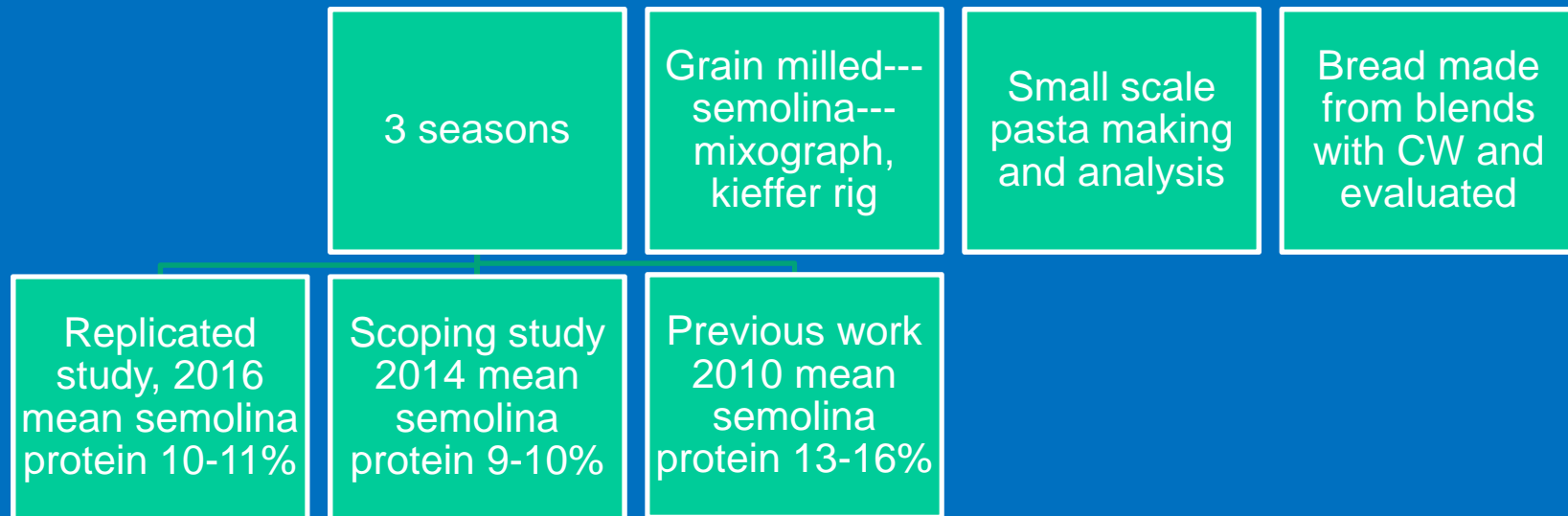
Determine the effect of different glutenin compositions on bread (durum blends) and pasta making quality

**SDS-PAGE showing the HMW-GS introgression of the *Glu-D1* alleles into durum wheat Svevo and Lira biotypes**



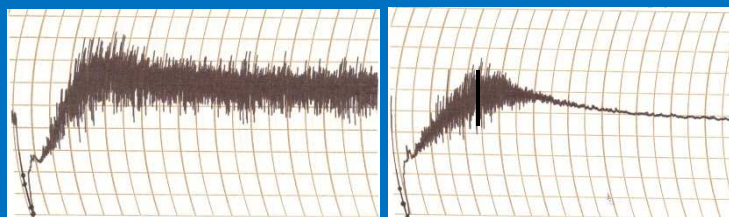


# Methods



# Dough evaluation of genetic lines

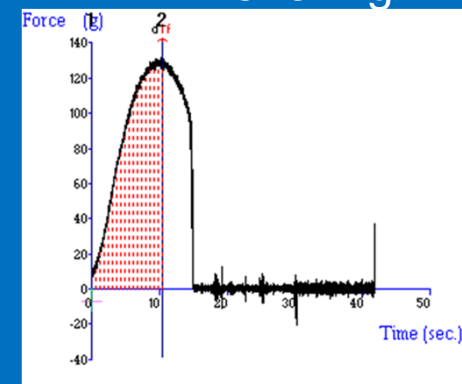
## Mixograph



Mixograph Peak Time

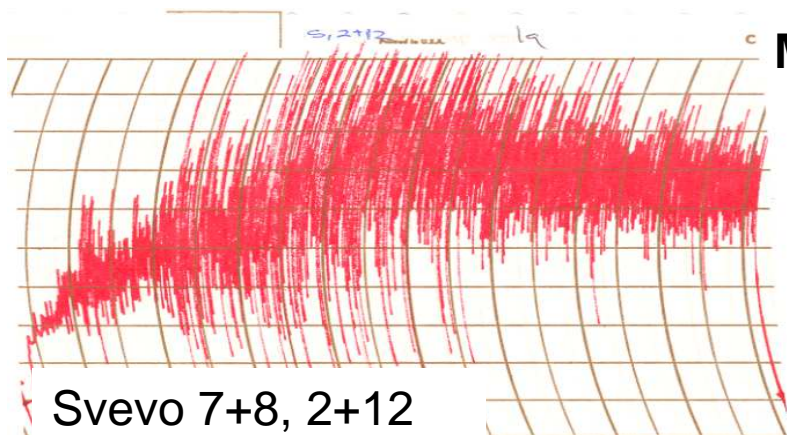
Resistance  
Breakdown

## Kieffer rig



Peak force  
Area under peak

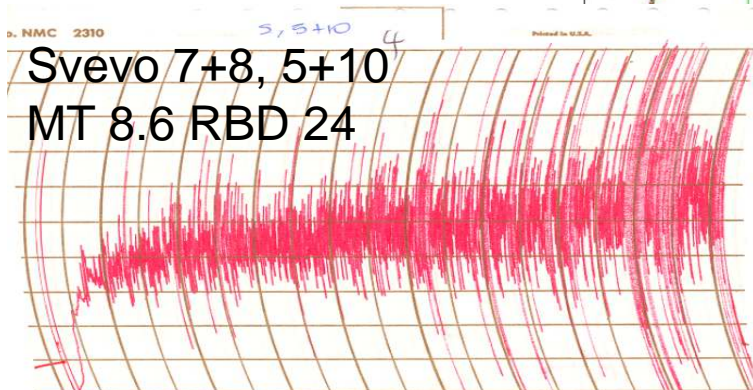
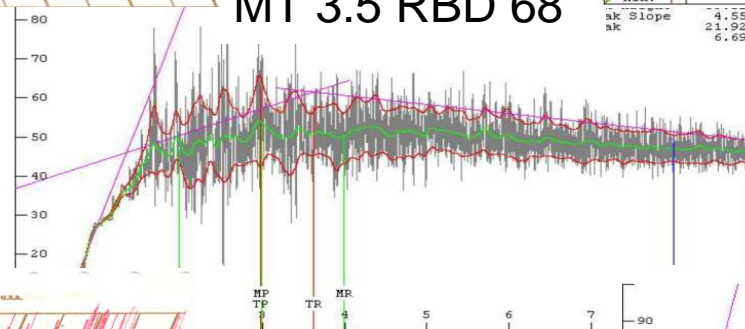




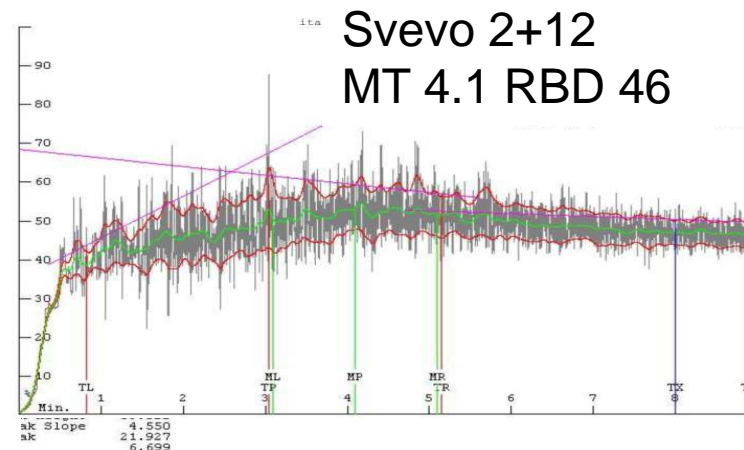
Svevo 7+8, 2+12  
MT 5.7 RBD 24

## Mixograph

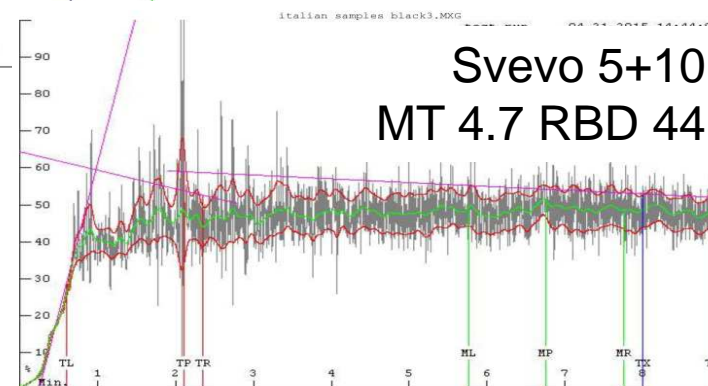
Svevo  
MT 3.5 RBD 68



Svevo 7+8, 5+10  
MT 8.6 RBD 24



Svevo 2+12  
MT 4.1 RBD 46

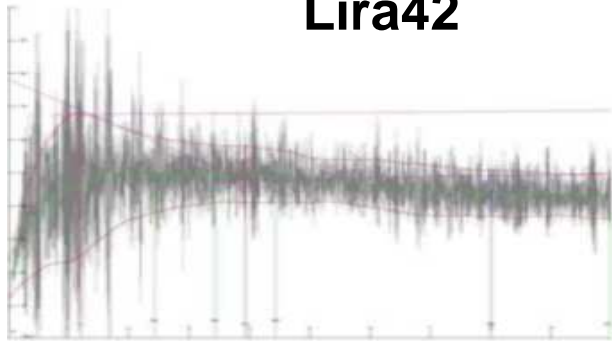


Svevo 5+10  
MT 4.7 RBD 44

## Mixograph

MT 1.7 RBD 88

**Lira42**



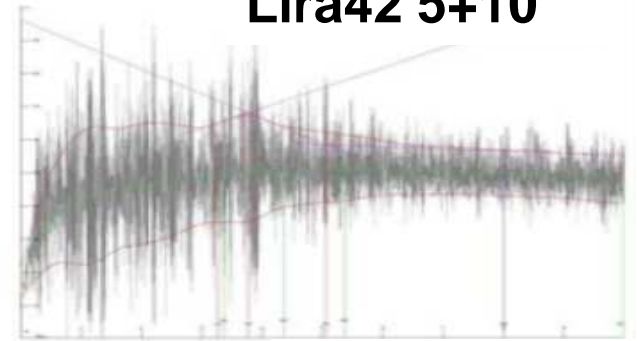
MT 4.1 RBD 68

**Lira42 2+12**



MT 7.4 RBD12

**Lira42 5+10**



**Lira45**



**Lira45 2+12**



**Lira45 5+10**



MT 2.5 RBD 57

MT 6.1 RBD 34

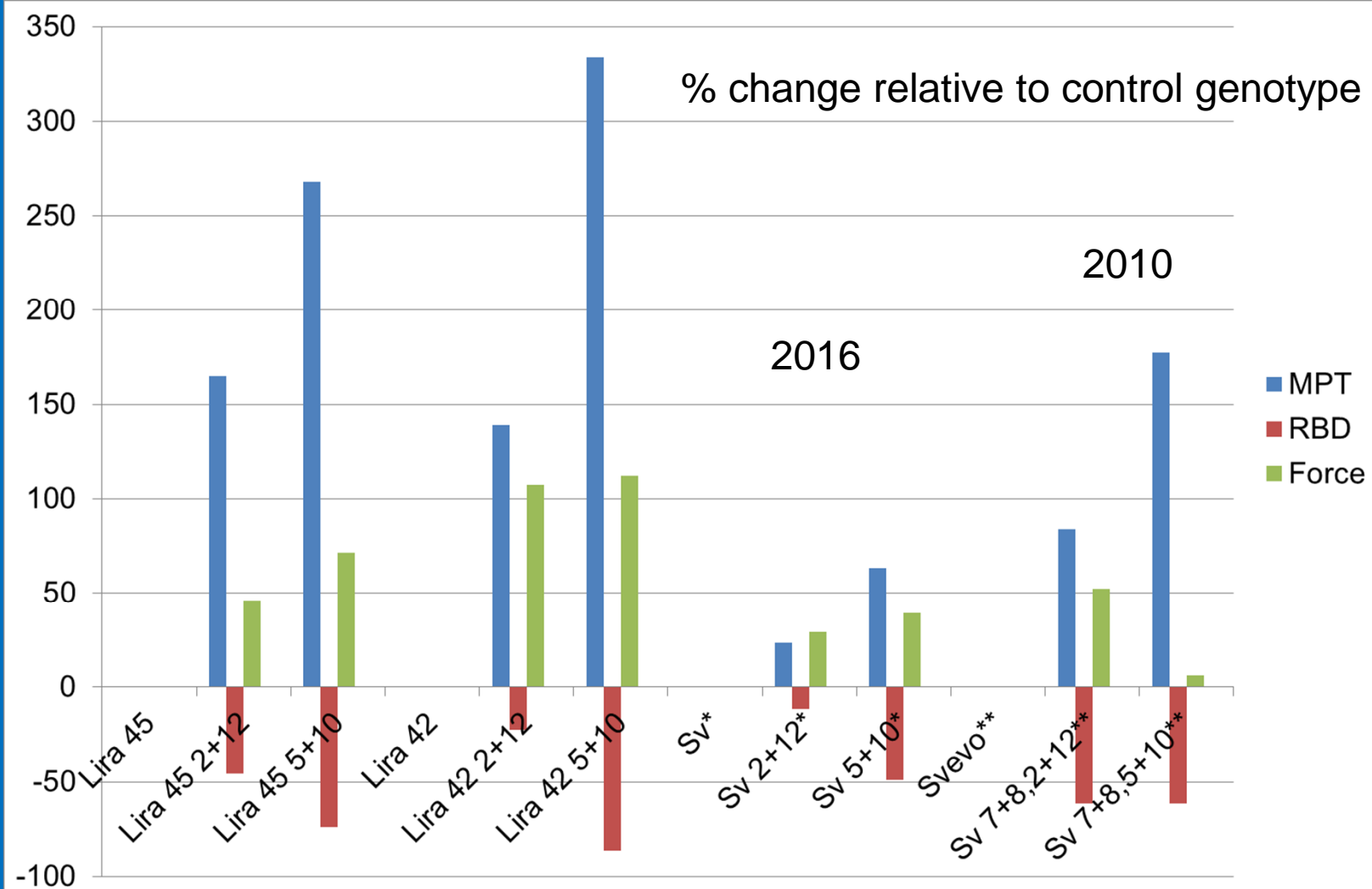
MT 7.6 RBD 23

Addition of *Glu-D1* subunits into Lira cultivar backgrounds increased mixograph peak time and width, indicating increased gluten strength.

## Glutenin polymeric distribution

- LMW-1 more gliadin
- Glu-D1* increased UPP 5+10>2=12

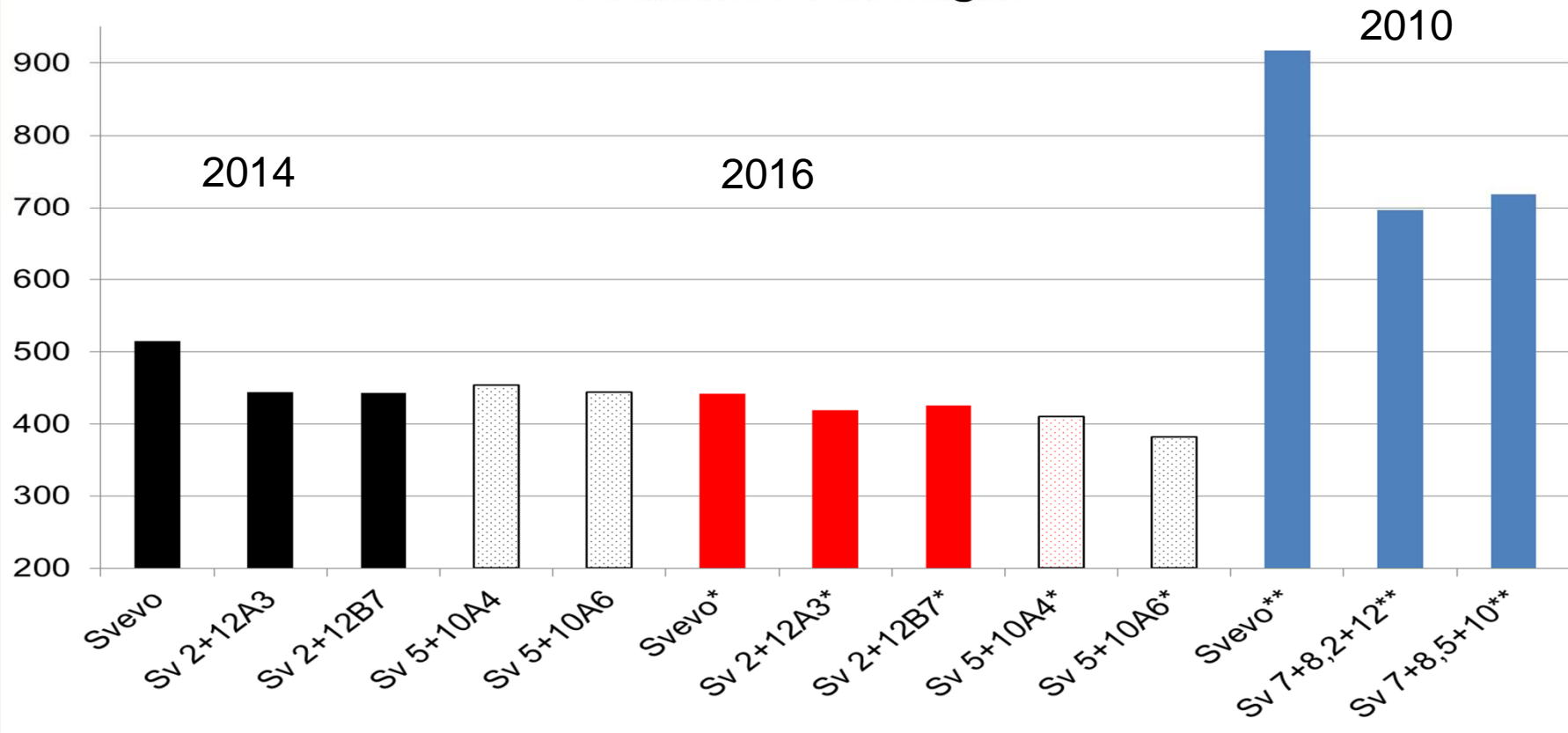
Genotype	Glu/Gli	UPP%
Svevo	1.22	31
Sv 2+12(3)	1.30	35
Sv 2+12(7)	1.30	39
Sv 5+10 A4	1.38	44
Sv 5+10 A6	1.36	43
Lira 42	1.40	21
Lira 42 2+12	1.63	37
Lira 42 5+10	1.61	39
Lira 45	1.60	22
Lira 45 2+12	1.94	36
Lira 45 5+10	1.98	40



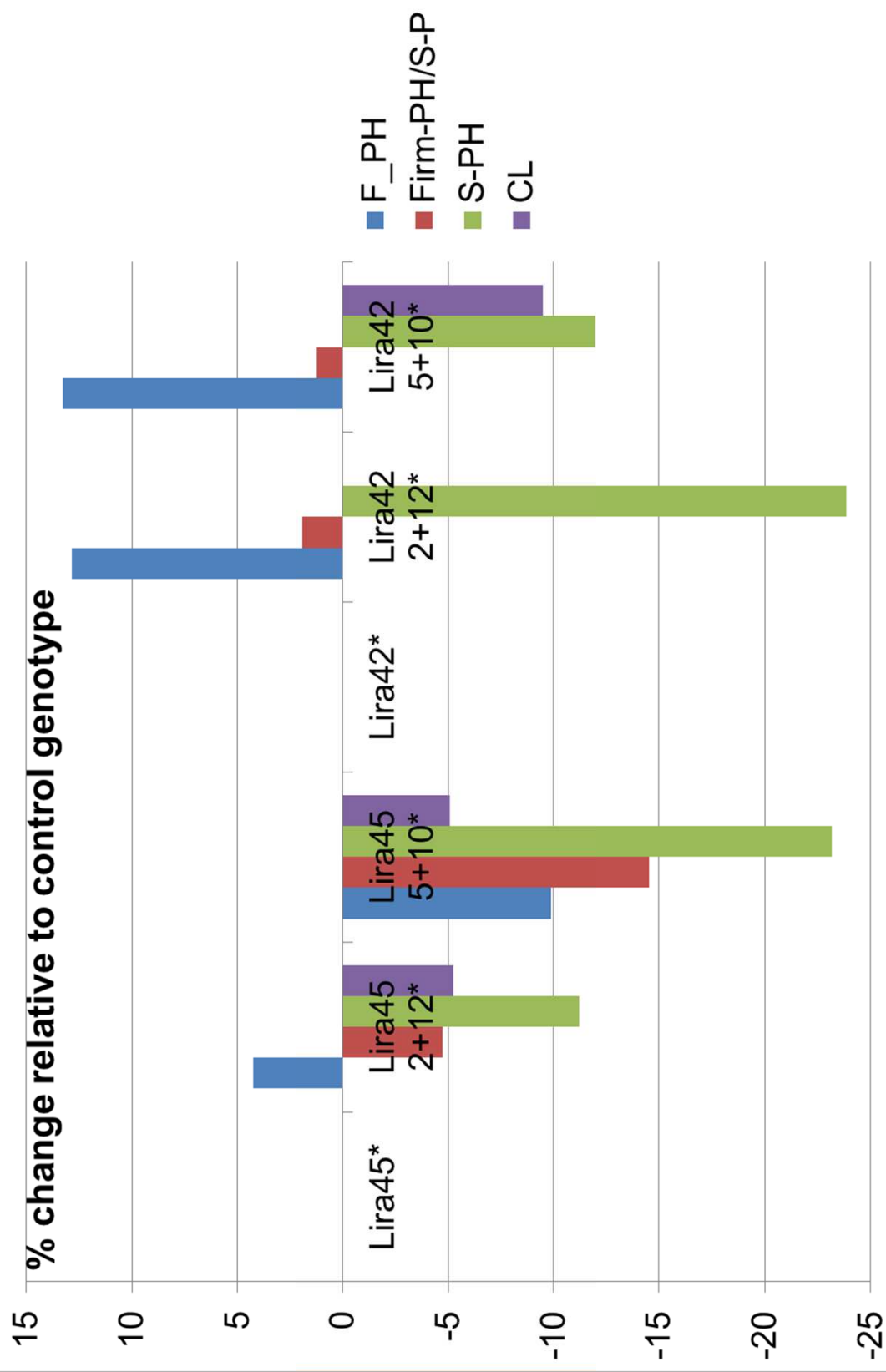
# Summary effects on dough

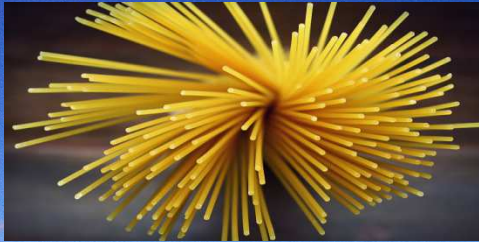
- Addition of 2+12 or 5+10 to Svevo (null, 7+8) increases dough strength, 5+10 making it inextensible.
- Removal of 7+8 reduces the over strong dough
- For Lira biotypes Lira 42 (LMW-1) responded more to 5+10 than in Lira 45 (LMW-2) and impacts of *Glu-D1* were much greater than in Sv
- 2+12 in Lira is a better balance of dough properties

### Firmness-Peak Height









## Summary effects on Pasta

- Sv 7+8 plus 2+12/5+10 makes softer pasta but this effect almost eliminated with removal of 7+8
  - minimal impact on water absorption and stickiness with a slight decrease in cooking loss with added subunits
- Lira45 (LMW-2) + 5+10/2+12 reduced firmness but also stickiness/CL
- Lira42 (LMW-1) + 5+10/2+12 increased firmness and reduced stickiness

# Baking method

\*Bread wheat flour: durum flour  
90:10; 75:25; 50:50

Semolina



Re-grind to flour



Bake mix 100g

Flour*	100%
Yeast	3%
Fat	2%
Salt	1%
Sugar	1%
Improver	0.5%

baked twice in a semi -  
randomized design

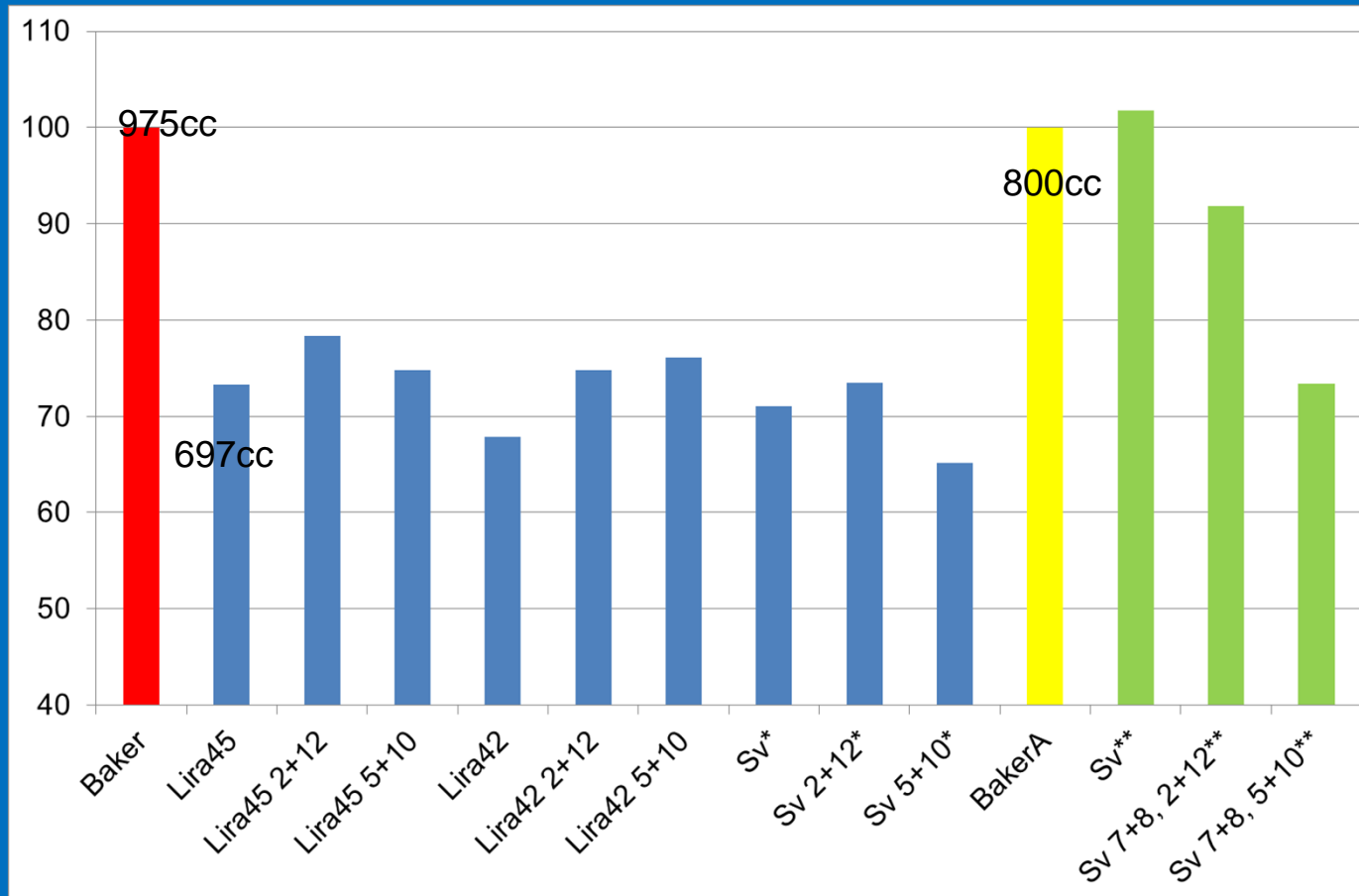


120min fermentation, 30°C,  
knock at 96min. Loaves tinned  
at 120min, proofed for 60min  
baked 215°C for 24min



Hobart mixer-  
standard Australian  
straight dough (bulk  
fermentation) method

## Loaf volume as % of baker's control, 50% blends





### Bread

- Sv 2+12/5+10 with 7+8 depressed LV
- LV depression reduced in Sv 5+10 no 7+8
- **Adding 2+12 to Svevo (no 7+8) and Lira increased LV slightly**
- **Both 2+12/5+10 increased LV in Lira42**

### Pasta

- Adding 2+12/5+10 to Sv without 7+8 has similar PMQ to Svevo, little softer for 5+10
- Adding 2+12 to Lira 42 (LMW-1) improved PMQ (firmer, lower stickiness) vs Lira42/45



**Message-Adding 2+12 to Lira or Svevo (without 7+8) provides benefits to bread and pasta**

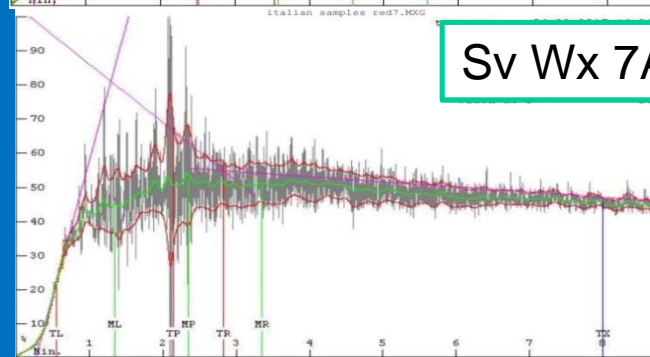
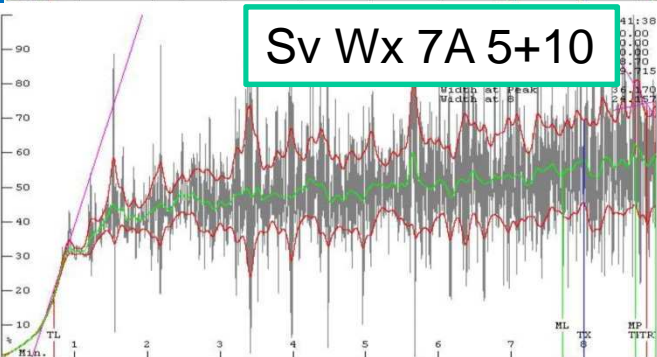
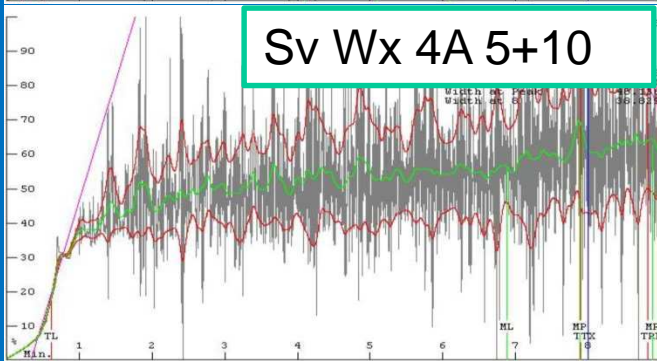
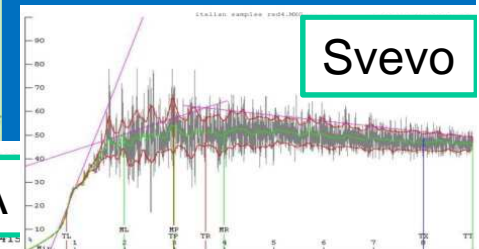
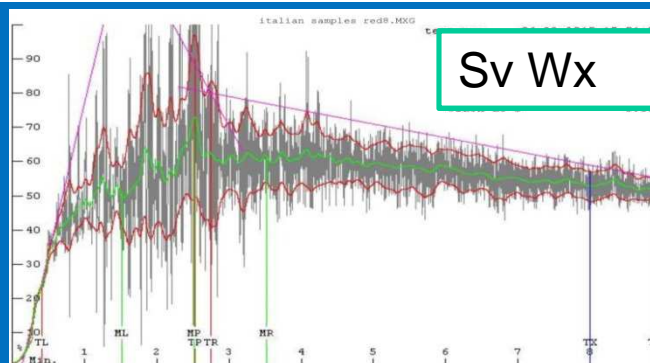
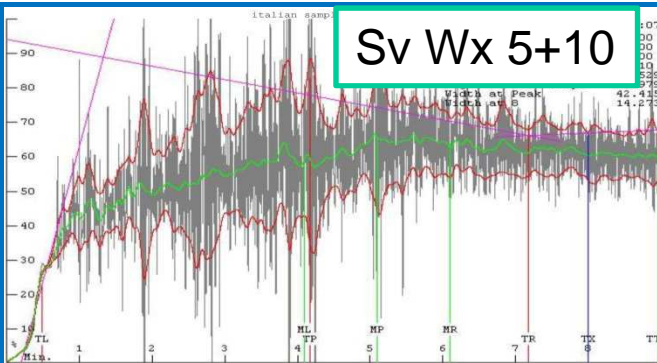
## **Waxy genotypes**

- The waxy character in durum makes the pasta much softer and stickier (Sissons et al 2005; Grant et al 2004) while blends waxy/non-waxy are acceptable up to ~20%
- Bread containing 25% durum flour is softer without adversely affecting BMQ (Boyacioglu and D'Appolonia, 1994)
- Staling is retarded in loaves baked with blends (10-30%) of waxy durum flour but loaf volume is not affected (Bhattacharya et al., 2002; Mouliney et al 2011)

# Waxy variations

Sample	Amylose (pasta)	<i>Glu-B1</i>	<i>Glu-D1</i>	LMW type
Sv Waxy	14.8	7+8		2
Sv Waxy 5+10	20.1	7+8	5+10	2
Sv Wx4A	25.3	7+8		2
Sv Wx4A 5+10	24.1	7+8	5+10	2
Sv Wx7A	27.6	7+8		2
Sv Wx7A 5+10	26.5	7+8	5+10	2
Svevo	29.3	7+8		2

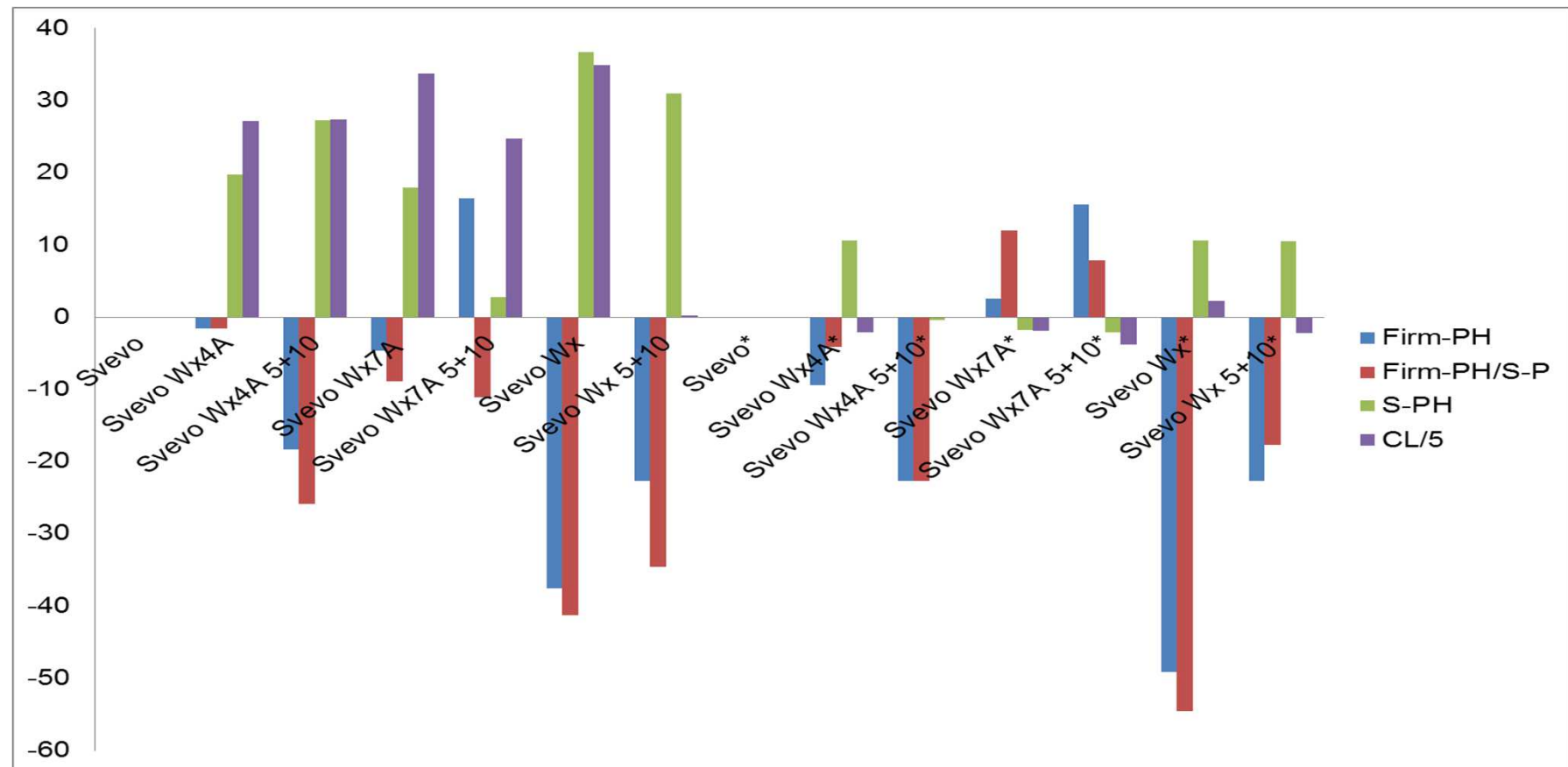




G	UPP
Sv	30.8
SvWx4A	29.4
SvWx4A5+10	39.8
SvWx7A	17.8
SvWx7A5+10	42.8
SvWx	24.0
SvWx5+10	30.3



Pasta properties of Waxy Svevo genotypes 2014 and 2016(\*) season 's data expressed as percentage change relative to control genotype

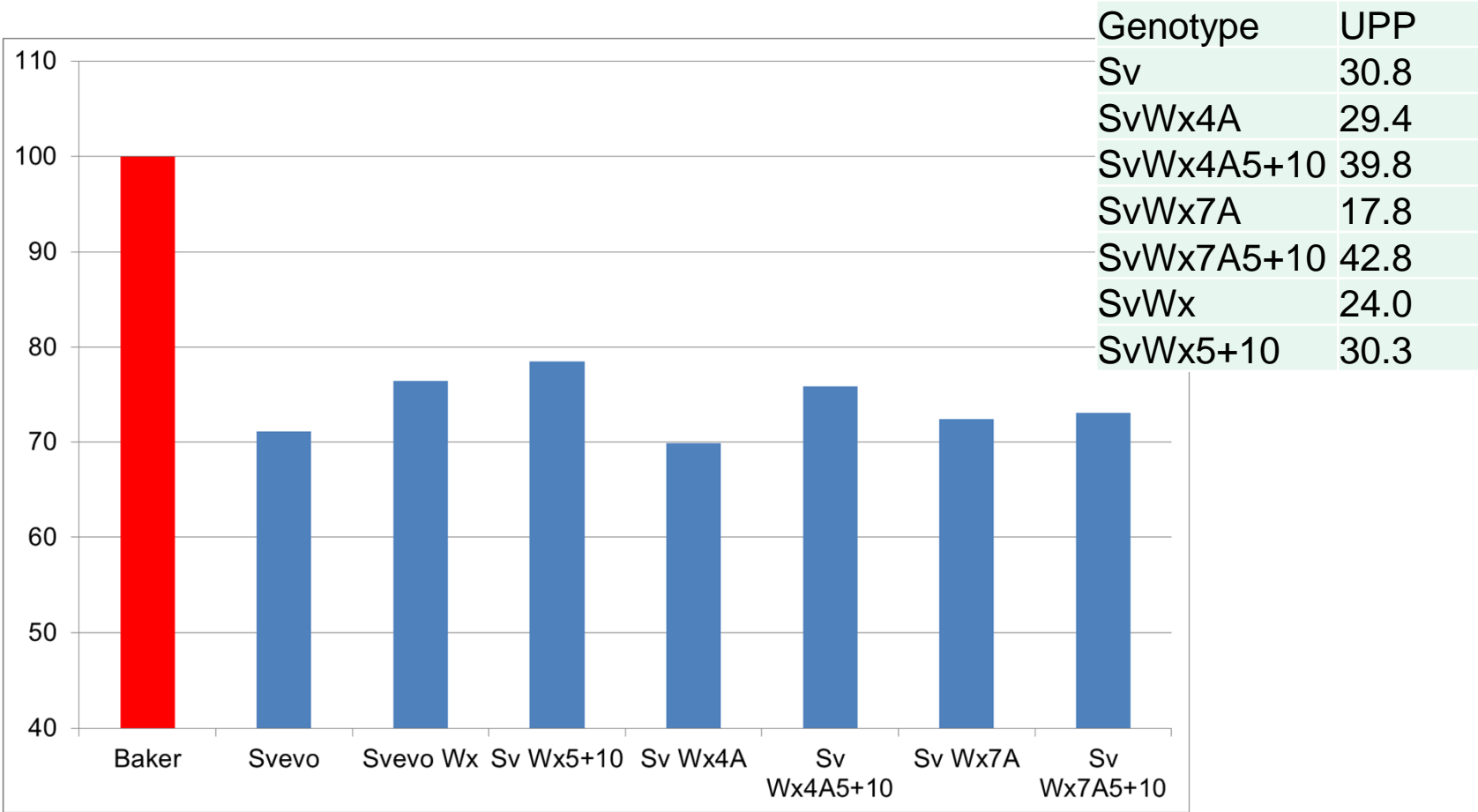


# Pasta



- Partial waxy stickier, esp. full Wx
- Wx4A,5+10 gets softer no improvement in stickiness
- Wx7A,5+10 firmer than Sv reduced stick vs Wx7A
- Wx,5+10 reduces the softness of Wx, no change in stickiness but CL reduced

# Loaf volume as % baker's, 50% blends with durum flour

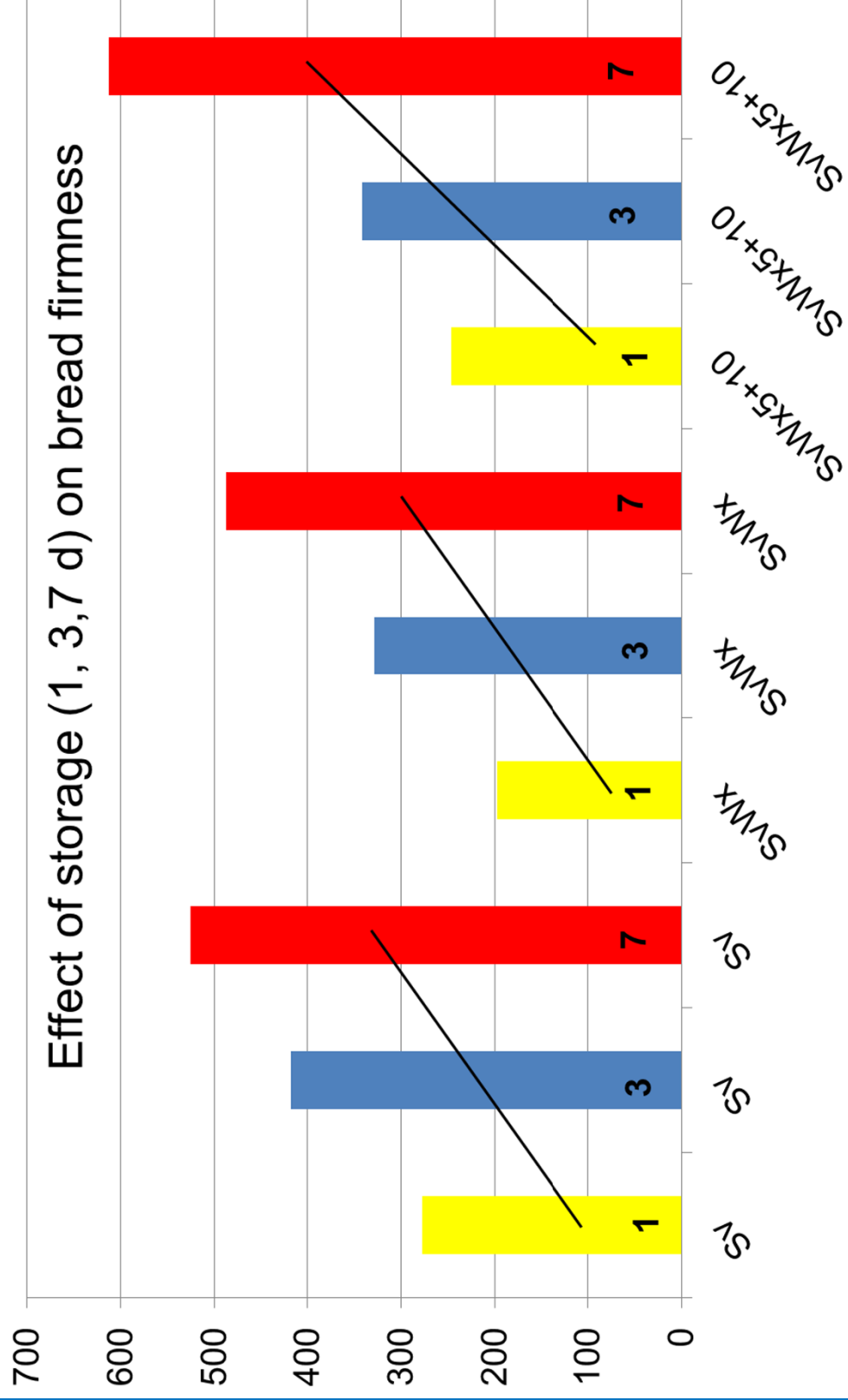


## Bread staling study

- Baker flour 75:25 durum flour (Wx, Wx5+10, Svevo); 2 reps
- Loaves stored 1, 3, 7d in airtight containers and slices sampled and tested for moisture, texture, DSC



Effect of storage (1, 3,7 d) on bread firmness



**Messages**

## **PMQ**

- Adding 2+12 to Svevo in absence of 7+8 makes pasta of similar quality to Svevo but not 5+10
- Adding 2+12 to Lira 42 (LMW-1) improved PMQ (firmer, lower stickiness), less so for 5+10

## **BMQ**

- 2+12 in Lira and Svevo slightly increased LV while 5+10 had little effect
- SvWx & SvWx,5+10 had slightly higher LV than Svevo

## **Bread firming**

- The waxy durum flour reduces staling
- Adding 5+10 to SvWx increased the staling rate and made bread firmer after 7 days



- Some potential for 2+12 introgressions for pasta and bread quality
- More research is needed to develop strategies to increase LV of durum-common wheat blends



### **Tamworth team**

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Shaylene Sissons  
Blake Brangwin  
David Gulliford

### **Viterbo team**

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