



Quadram
Institute

Science Health
Food Innovation



John Innes Centre

Unlocking Nature's Diversity

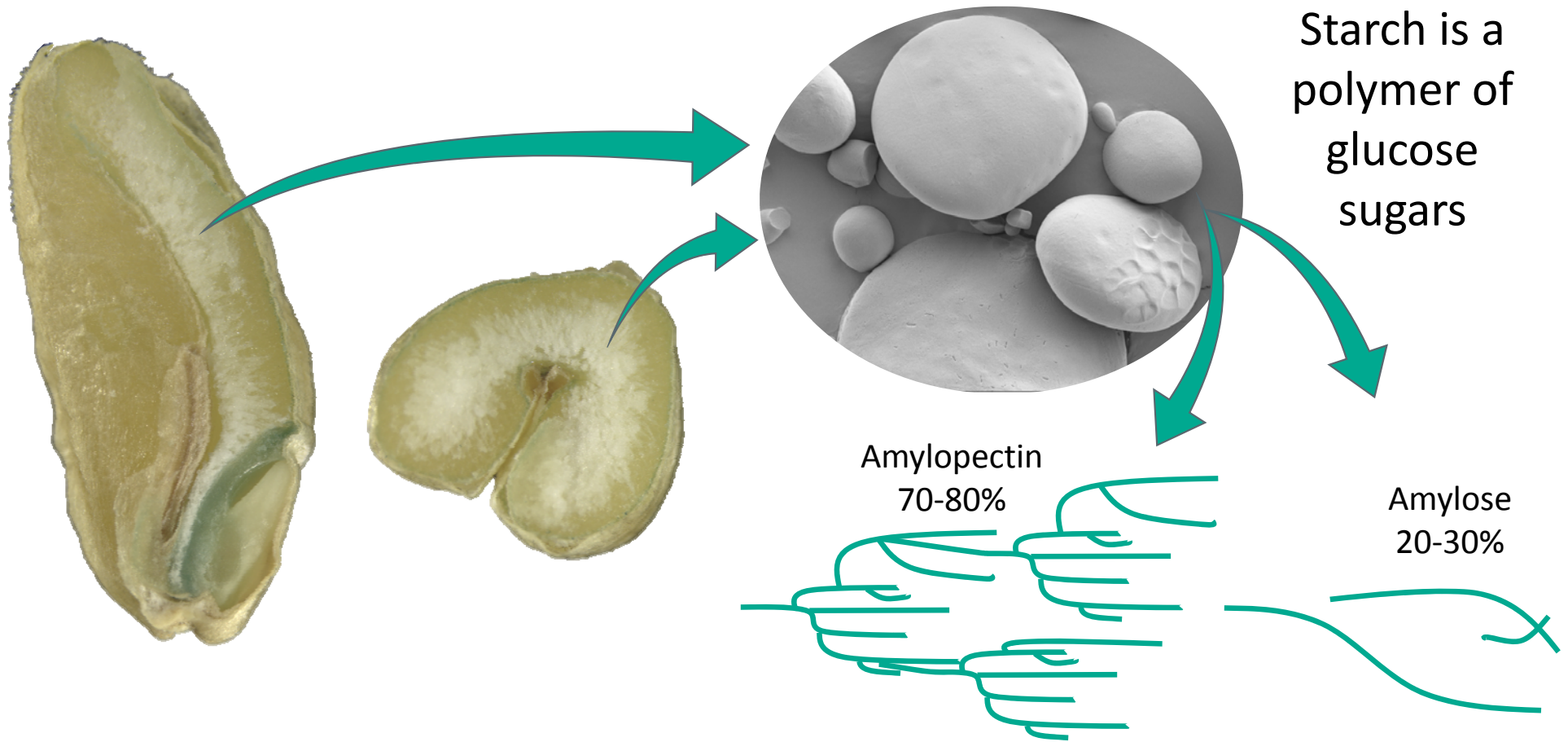
Designing new wheat starches

Brittany Hazard

15th WGIN Stakeholders' Meeting
Rothamsted Research
30 November 2017



Wheat grains are mostly starch



Aim: Increase resistant starch in wheat

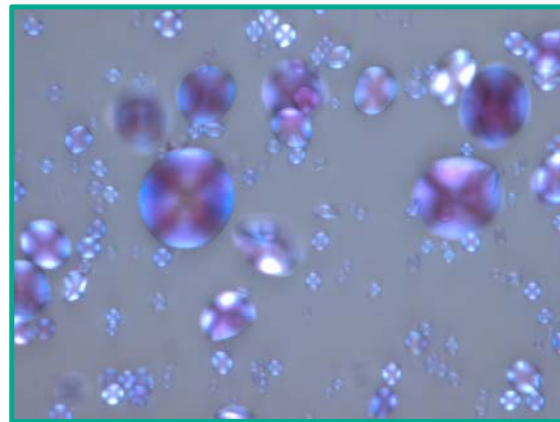
- Type of dietary fibre
- Resists digestion in the small intestine
- Fermented in the large intestine by gut bacteria
- Consumption associated with
 - Improved gut health
 - Reduced glycaemia
 - Increased satiety



Food	g per serving
White bread rolls	0.44
Porridge	0.27
White rice	2.16
Bananas (ripe)	0.98
Bananas (green)	6.8
Lentils	2.72

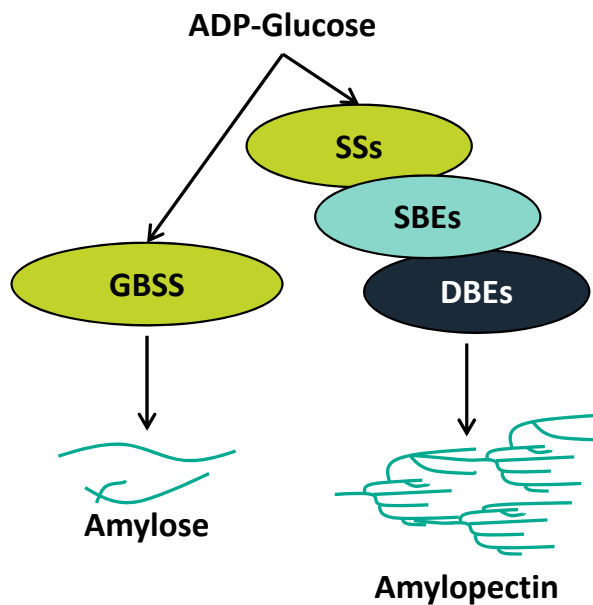
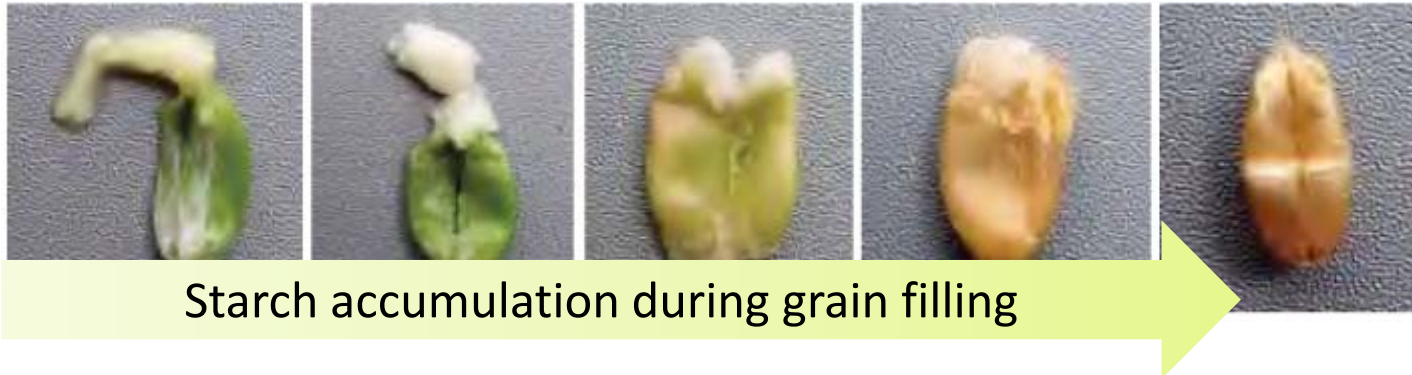
Starch properties influence its digestibility

- Length of chains
- Amylose : Amylopectin
- Size of polymers
- Amount of branching
- Arrangement of polymers in the granule



Starch granules illuminated with polarized light

Genes that control starch structure



Starch Synthases (SSs)

Starch Branching Enzymes (SBEs)

Starch Debranching Enzymes (DBEs)

New wheat genomics tools



- Library wheat genotypes with unique sets mutations across the genome



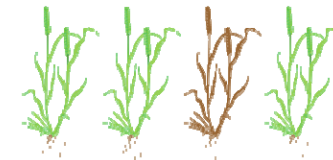
- Genes sequenced and information available in an open database



- Search database for mutations in target genes

- Study function of target genes

- Non – ‘GMO’ approach

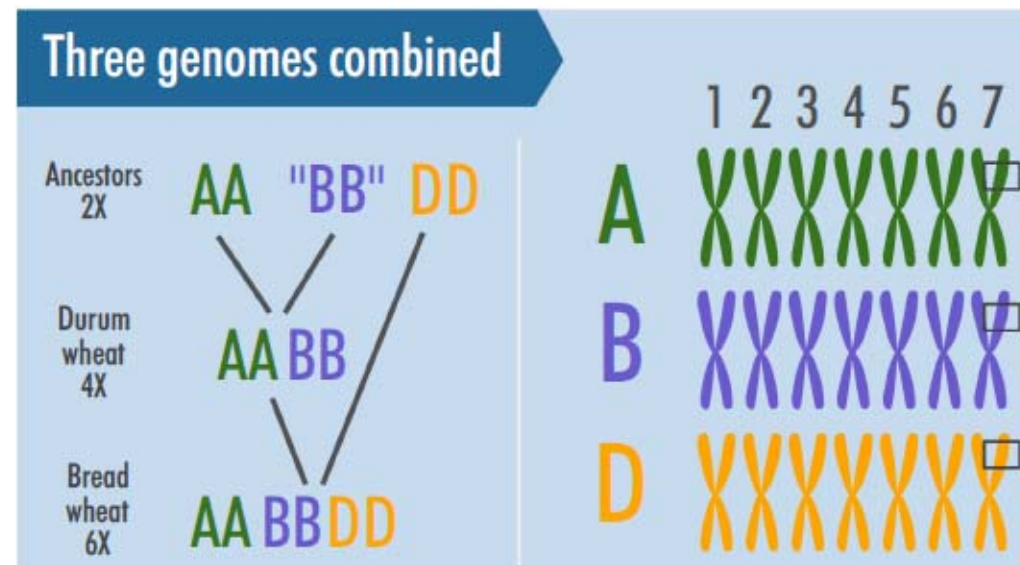


Wheat TILLING

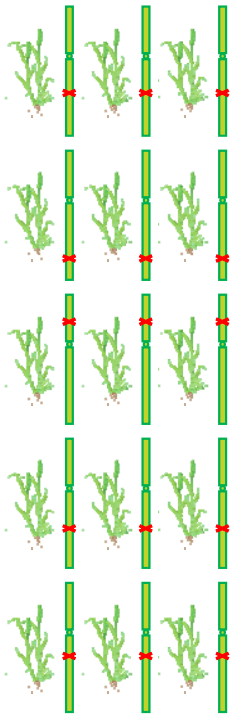


Wheat has a large and complex genome

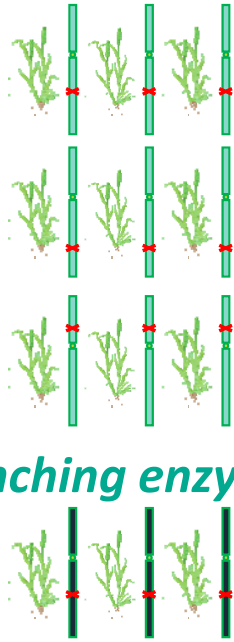
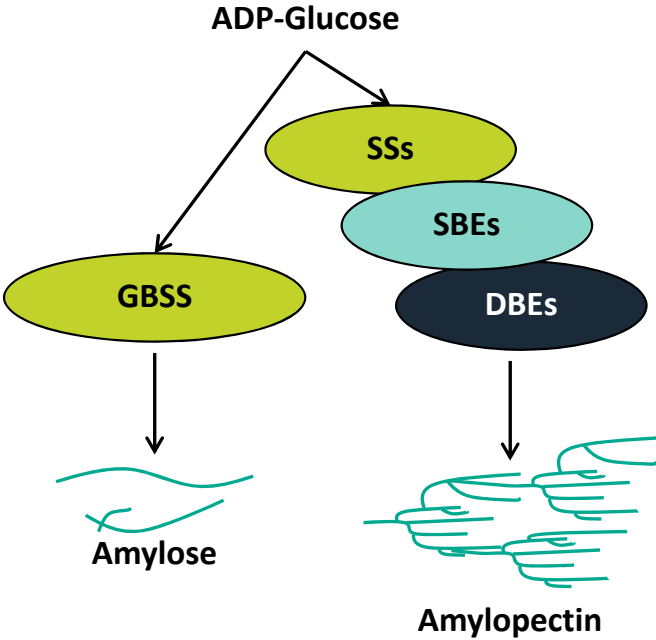
- Hexaploid
 - 3 genomes combined
- Usually three copies of each gene
- Many genes are functionally redundant



Found at least 2 mutations for each gene copy



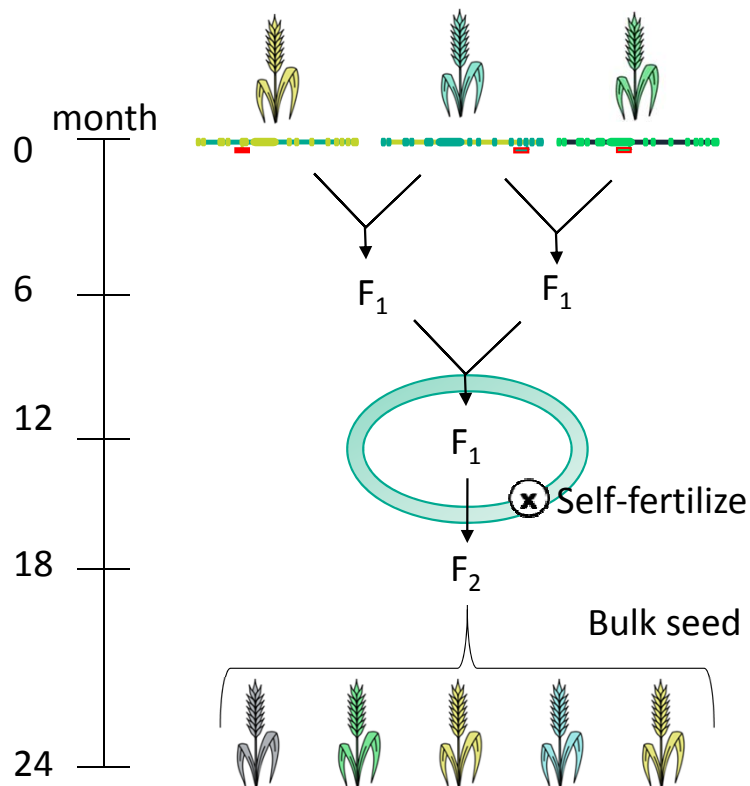
30 starch synthase mutations



18 starch branching enzyme mutations

6 starch debranching enzyme mutations

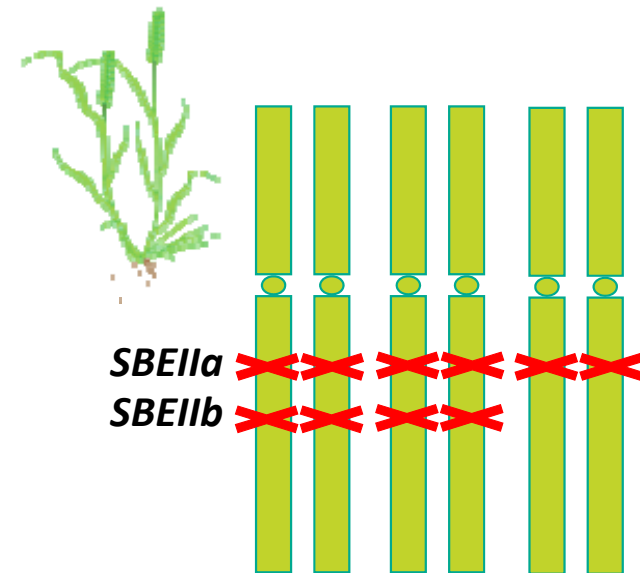
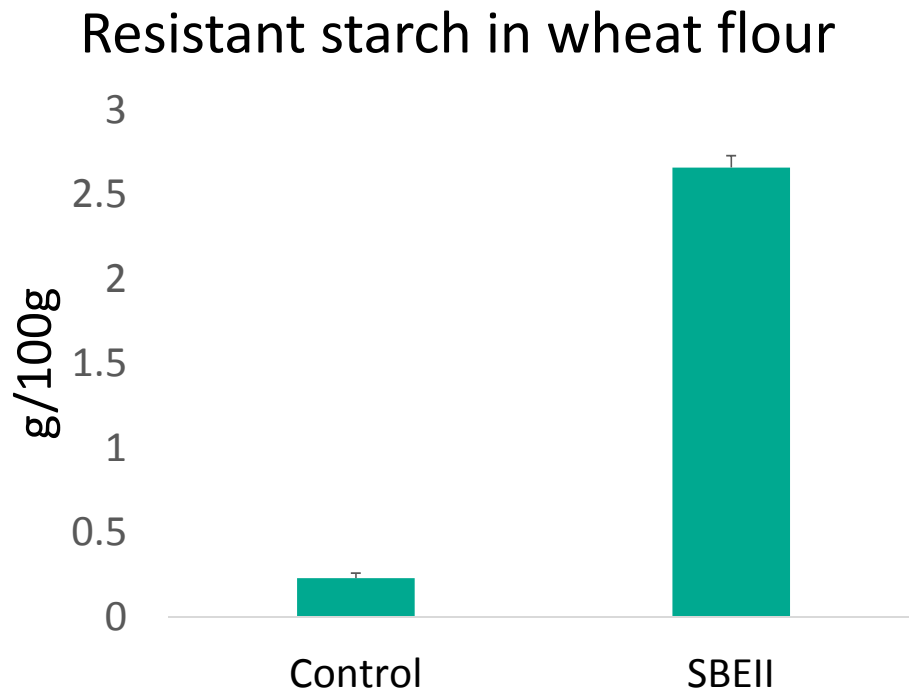
Combining mutations in different gene copies



- 63 different combinations of mutations
- **Will produce a range of starch properties!**

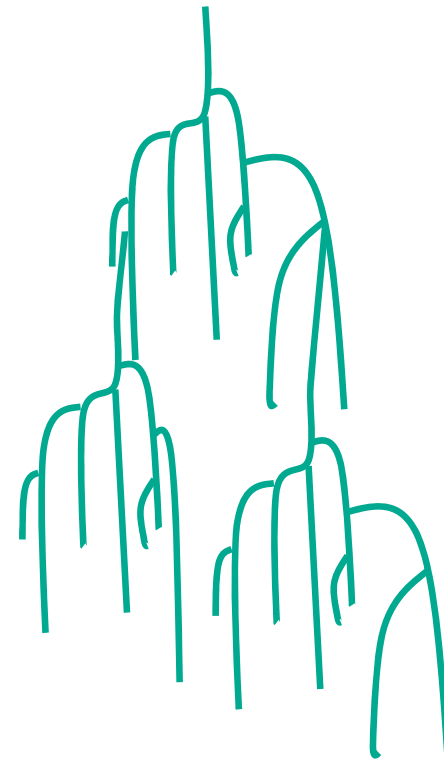
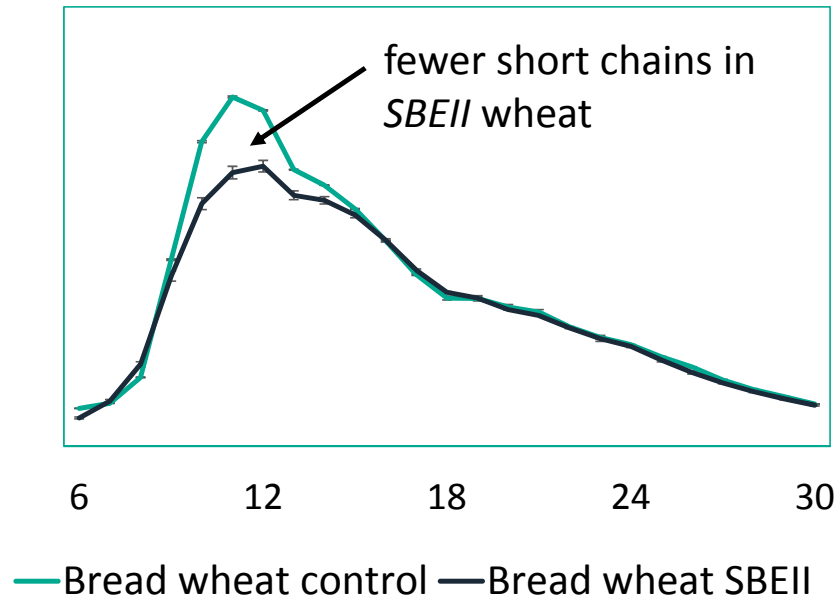


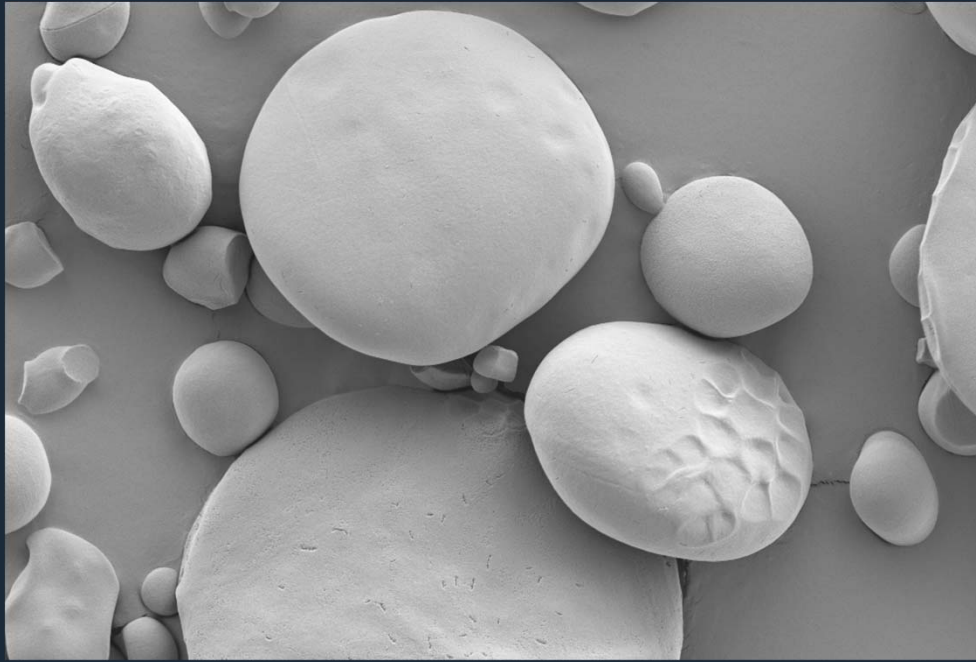
Wheat with mutations in *SBEII* genes has more resistant starch



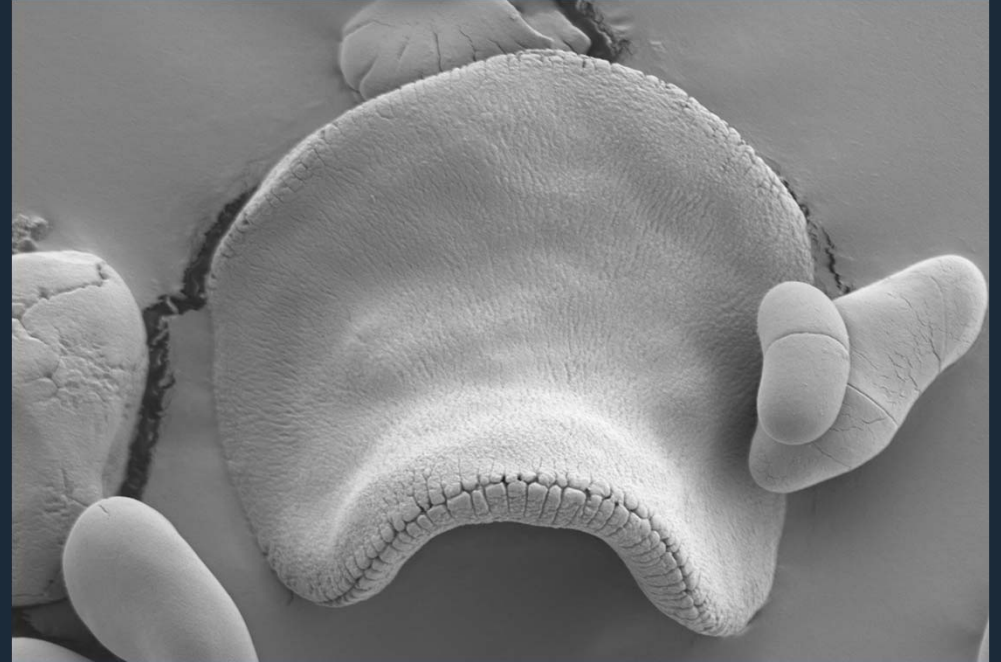
Mutations in *SBEII* affect starch structure

Length of debranched starch chains

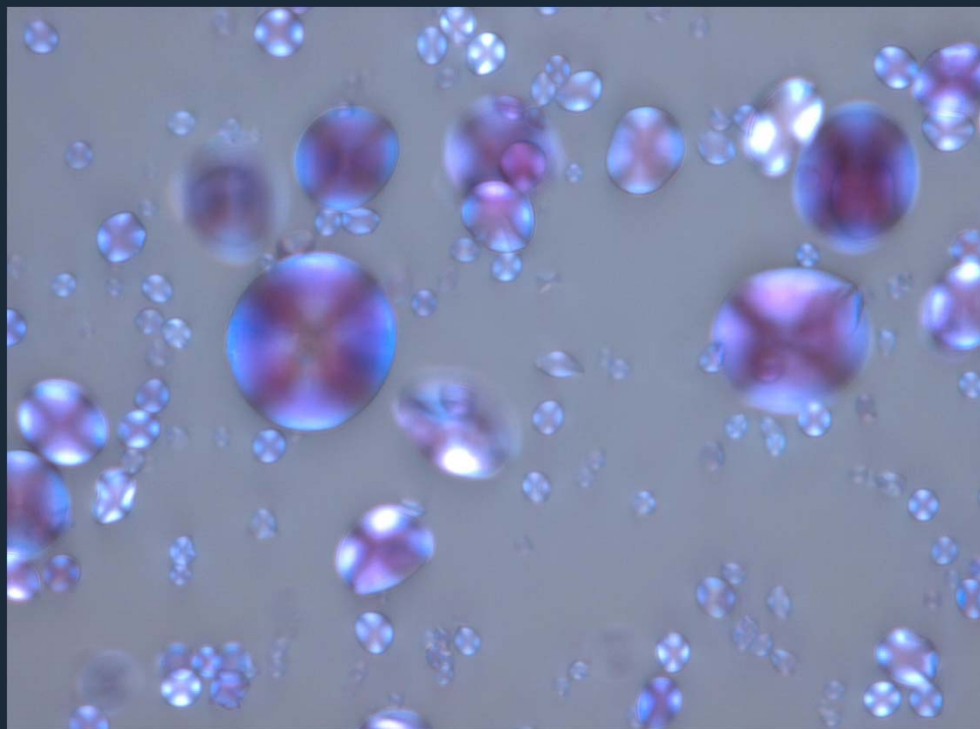




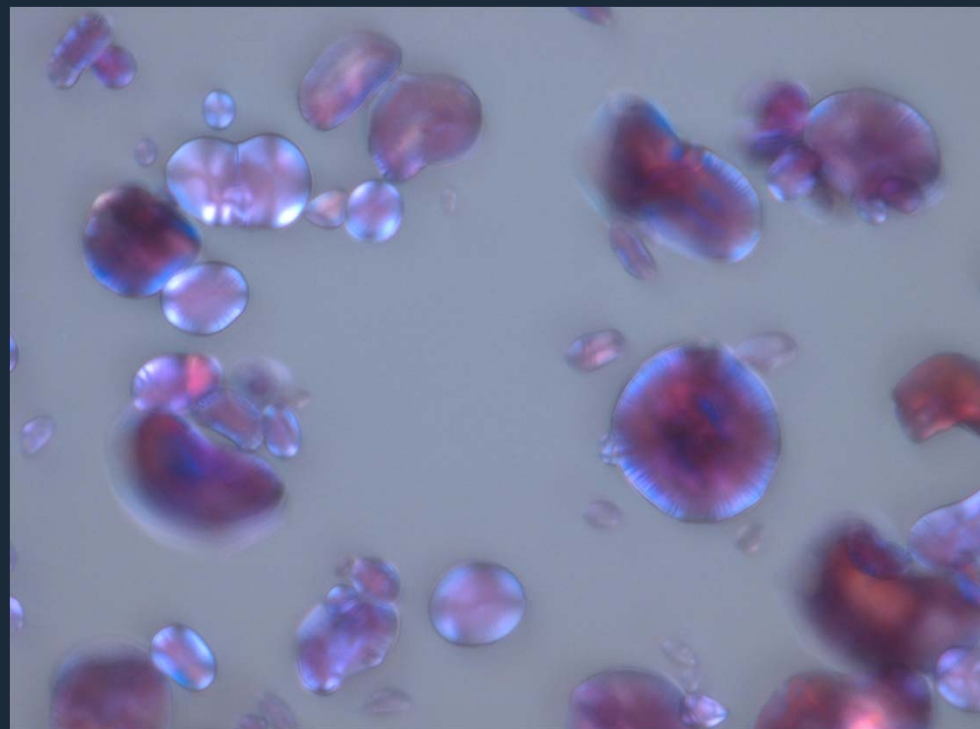
Normal wheat starch



SBEII wheat starch

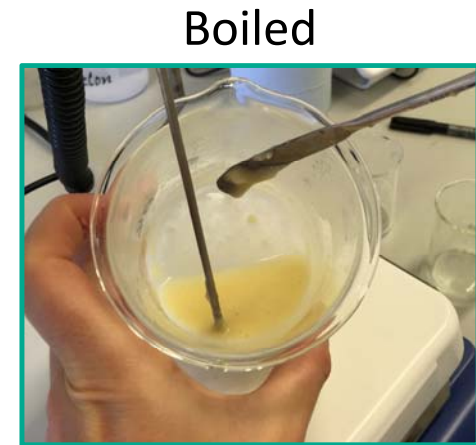
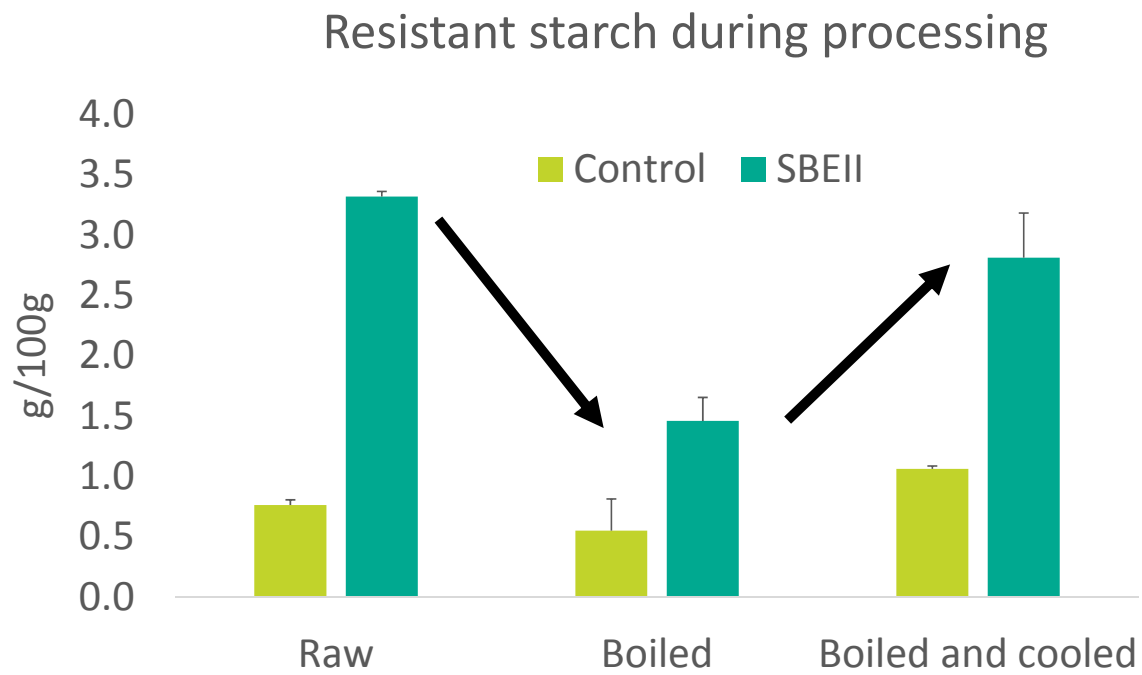


Normal wheat starch



SBEII wheat starch

Does resistant starch change during processing?



Boiled and cooled

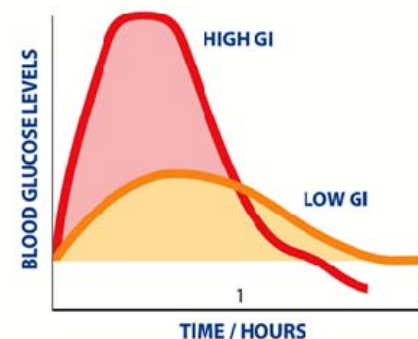


Glycaemic response of wheat pudding with increased resistant starch

- Collaboration with Imperial College London
- Randomized cross-over controlled trial
- 10 - 12 volunteers
- Boiled and cooled 'semolina pudding'

Control pudding

sbei pudding



Marina Corrado

Other factors to consider...

- Agronomic performance
 - Are there yield penalties?
- End-use functionality
 - Flour and bread quality?
- How does the growing environment affect starch structure?
 - Climate change? Drought? Heat?
 - Working with the **International Maize and Wheat Improvement Center** in Mexico to investigate this



Thank you!

Lab members

Oscar Gonzalez
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Brendan Fahy
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Gary Frost
Ed Chambers
Anna Cherta