Wheat quality means different things, depending who you are in the wheat processing chain.
The breeder must also understand the impact of the production environment has on quality

- The types of quality possible in an environment
- The impact of G x E on quality
- Annual or regional variability
- Influence on breeding and selection
Wheat quality

Know your environment

Climatic effects
  - Rainfall - how much and distribution
  - Temperature variation over the growing season - winter/spring?

Soil effects
  - Fertility, pH, toxicities and deficiencies

Biological effects
  - Biotic stresses
    - Foliar and root pathogens, nematodes, viruses
Hitting the quality target

Early generations
1000’s of lines

Mid stage
100’s of lines

Late stage
10’s of lines

The target, one line, the variety
Hitting the target

Must have the ability to test for quality in:

Early generations, rapid, small scale

Mid generations, still predictive tests

Final stages, full end product testing
Hitting the target

Must have the ability to test for quality in:

- Early generations, rapid, small scale
- Mid generations, still predictive tests
- Final stages, full end product testing

Molecular Markers
Prioritizing the components of quality

The fundamentals

Grain hardness (texture)

Protein content

Protein quality

Defect elimination
Grain hardness (texture)

Influences milling performance via effect of

- Puroindoline genes
- Grain softness proteins

I. Hard grained wheat produces

- Higher yield of flour
- Flour with more damaged starch granules
- Flour with higher water absorption
- Flour with higher lipid content

Targeted at production of leavened products, a range of noodle styles
Grain and flour protein are used as indicators of dough properties and processing performance.

Higher protein content is used to indicate flours with higher water absorption, stronger and more extensible dough properties, better baking performance, superior firm noodle texture.
Lower protein content indicates lower water absorption, less strong, but extensible dough properties, reduced ability to retain gas during fermentation of leavened products such as bread, so reduced loaf volume.

Noodles with reduced firmness
II. Soft grained wheat produces confectionary products such as cakes and biscuits which require low water absorption & weak & extensible dough properties.

Soft wheats are also used for steamed bread manufacture & white salted noodles.
It is the breeders role to develop during the process of selection, wheats with the relationship between protein content and end product performance that meet industry expectations.
Relationship between grain protein and hardness, and end product suitability
Grain protein and hardness requirements for major end-uses of wheat (WQOG, 1995)
Breeding for quality

Importance of choice of parents:

What hardness type are we after?

A hard, high milling quality wheat must have
- high yield of white flour
- high flour water absorption
- strong and extensible dough

What will the genetics allow?

Flour colour (reflectance $L^*$, $a^*$ and $b^*$) all have good $h^2$

Puroindoline and grain softness proteins control hardness
- simple genetics

High and low molecular weight glutenins
- simply inherited (Gliadins also in blocks)
- Glutenin simulator can help parental choice
High and low molecular weight subunits in wheat

Table 1. Primary standards for allocating allele designations for HMW subunits of glutenin

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<tr>
<th>Locus</th>
<th>Allele</th>
<th>Primary Standard</th>
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Table 2. Primary standards for allocating allele designations for LMW subunits of glutenin

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Source: Wrigley et al
Glutenins are main determinants of breadmaking quality

Source: R.J. Peña

<table>
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Breeding for quality

Early generation quality tests: (000’s)

- Simple
- Rapid, with high daily throughput
- Correlated with and predictive of end-use performance (medium to high $h^2$)
- Cost-effective

Measure the three major components of functionality, ie, hardness, protein content and protein quality
Breeding for quality

Early generation quality tests:

**Hardness** - grinding tests, Near Infra Red (NIR) spectrometry (whole grain or reflectance), Milling quality - milling yield and colour L*,a*, b*

**Protein content** - Dumas combustion, Kjeldahl protein, NIR, etc.

**Protein quality**
Physico-chemical - SDS sedimentation volume, Zeleny volume

Dough based tests - Pelshenke fermentation time (flour or wholemeal)
Change in the percentage of lines ranking in the top 10% for W, P/L, LV, Yield and a combined index with decreasing selection intensity for P%

Source: Trethowan et al, 2001
Breeding for quality

**Mid stage selection tests:** (00’s)

- Protein content (NIR)
- Milling yield and flour colour (Quadrumat or Buhler)
- Dough properties - mixograph, farinograph, extensograph
- End-products - test baking, noodle sheets, etc (small scale level)
Breeding for quality

Late stage testing - (0’s)

Protein content

Milling yield (Buhler) and flour quality (L*, a*, b*, ash content, starch damage)

Dough properties - farinograph and extensograph

End products - bread loaf volume and score; noodle sheet colour and colour stability; noodle texture, steamed bread volume, score and texture
Molecular Markers for Quality traits

QTLs and markers identified for:

Pre-harvest sprouting resistance (dormancy)
Late maturity alpha-amylase production
Black point

Robust markers available for:

Flour color / *P. neglectus* (linkage with *Rinn-1*)
Starch pasting viscosity (*GBSS-null*)
Hardness (*PinA & B*)
Dough Strength (*Glu1BX*)
Protein content (from *T. dicoccum*)
Ensuring quality meets needs of processors and consumers

Production side

Grade standards - who sets and manages them
Pricing structures - need to reflect value of quality

Who decides a line has good enough quality to release?

How is variety release managed so that quality standards are maintained?

Australia and Canada (single desk marketers) have centralised Classification systems