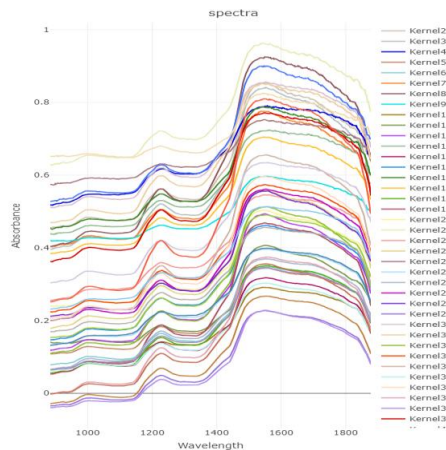


Singel Kernel (SK) Near Infrared (NIR) sorting : A Post-Harvest Tool for Developing More Viable Food Supply Chains



Cereal technology and sorting laboratory

Bruno Godin, Amaury Beaugendre, Pierre-Yves Werrie

Innovation for sustainable food systems - Namur - 13/05/25

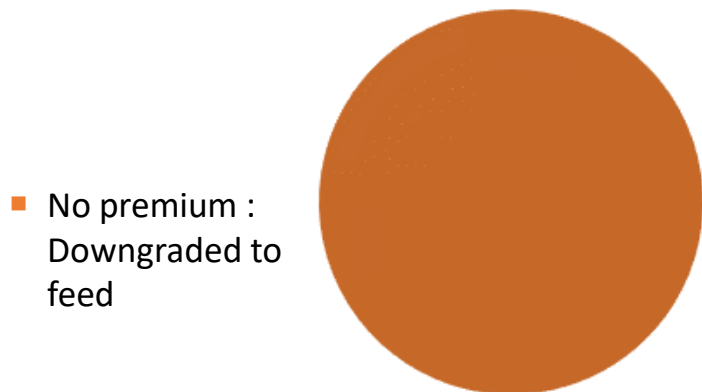
Sorting to manage the downgrading risk

- **Better use of grains in human food**
 - Reach technological and sanitary quality
- **Increase added value locally**
 - Better sector income
- **Increase possible food uses**
 - Better resilience

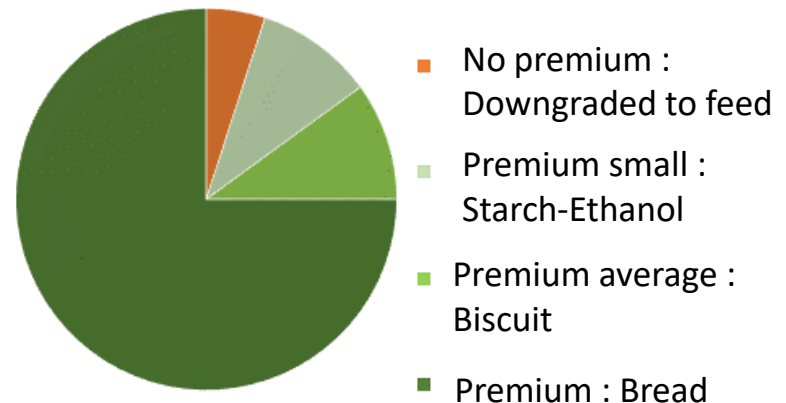
Generate more income with the same quantity of grains

Breadmaking quality variety in Belgium

Without sorting



With sorting



■ No premium :
Downgraded to
feed

■ No premium :
Downgraded to feed

■ Premium small :
Starch-Ethanol

■ Premium average :
Biscuit

■ Premium : Bread

Why is kernel sorting needed ?

Why is kernel sorting needed ?

- **Respect standards and contracts**
 - Operation intended to bring a batch of raw grains to the quality objectives
 - Sorters and its setting according to the problems and the targeted quality
 - Unavoidable cure tool especially with no or less use phytosanitary products



Why is kernel sorting needed ?

- **Sanitary quality**
 - Elimination of unwanted and toxic impurities
 - Reduction of contaminants



Why is kernel sorting needed ?

- **Seed commercial production**
 - Sanitary quality
 - +
 - Varietal purity
 - +
 - Specific purity + Germination rate



Why is kernel sorting needed ?

- **Crops grown in co-culture**
 - Sorting is unavoidable



Why is kernel sorting needed ?

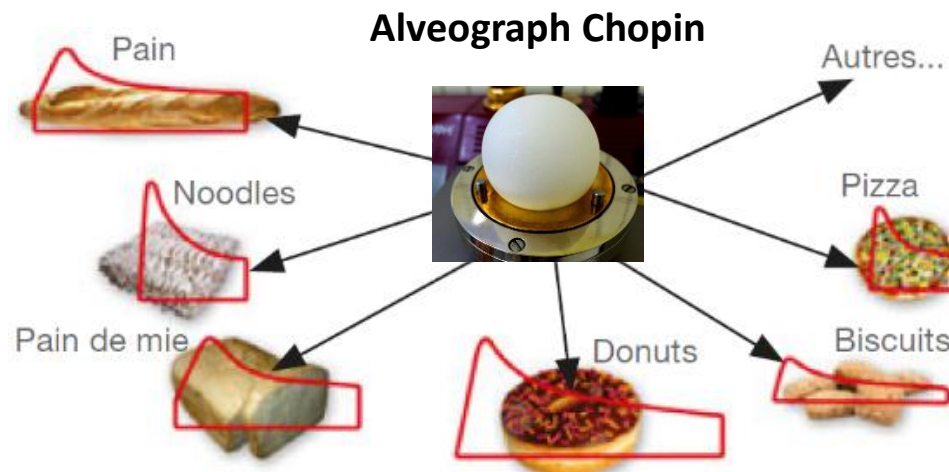
- **Technological quality**

- Respect standards and contracts
→ e.g. Euronext basic miller wheat : 76 kg/hl / 220s Hagberg / 11% proteins
- Depends on the final buyer, the targeted product and the transformation

- **Relevant criteria and order of importance**

1. Quality of chemical constituents → **Variety** e.g. : Gluten strength and quality
2. Quantity of chemical constituents → **Variety** e.g. : Protein content
3. Physical parameters of the grain → **Variety** e.g. : Specific weight

Gluten strength and quality

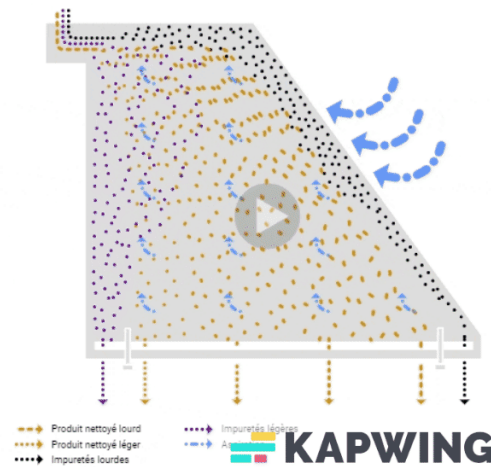
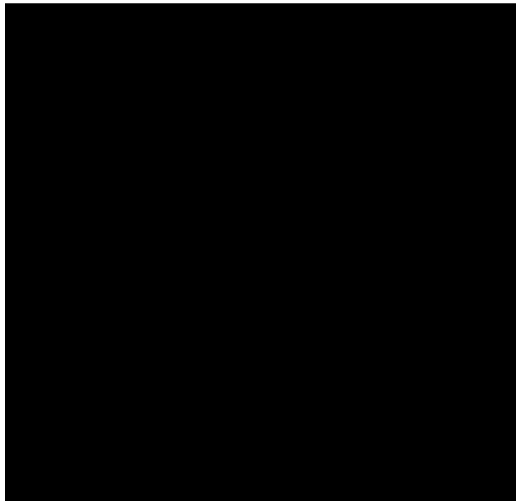


Kernel sorting

Kernel sorting

- **Sorting is based on mechanical and/or chemical characteristics**
 - Each type of sorting device has as specific purpose
→ **The perfect sorter does not exist**

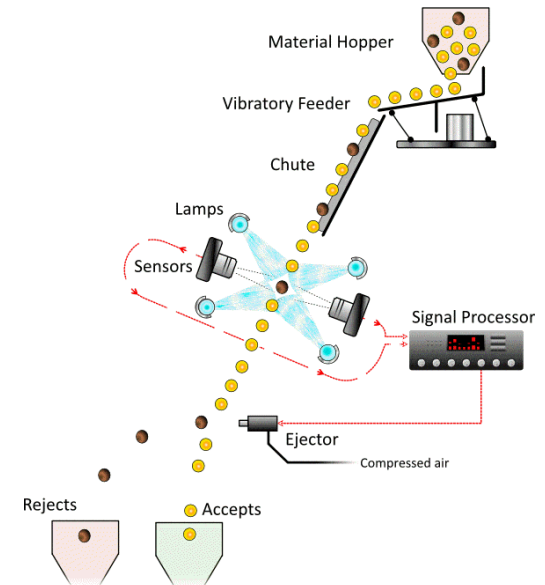
Mechanical sorting



Physical characteristics

- Dimension, density, terminal velocity
- Needs big differences

Optical sorting

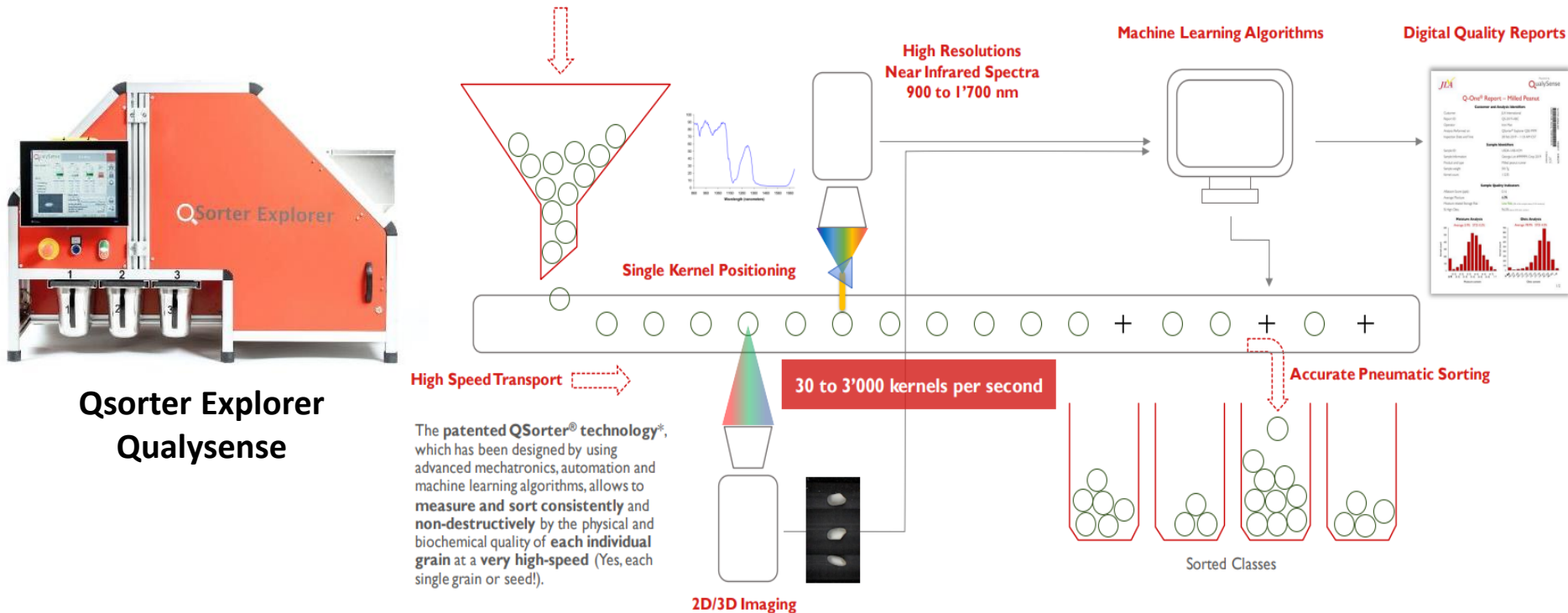


Optical characteristics

- Shape, **color, biochemical characteristics**
- **Very specific**

Singel Kernel (SK) Near Infrared (NIR) sorting

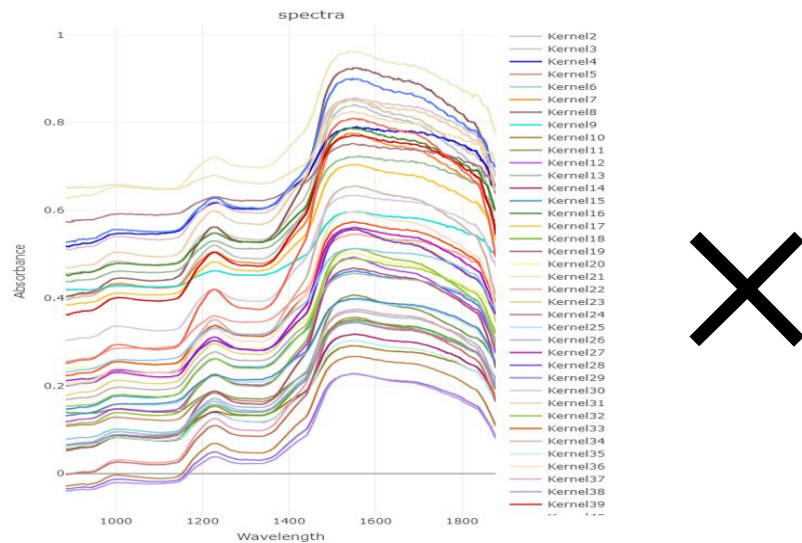
- Based on the prediction of a specific chemical characteristics



1. Acquisition NIR spectrum by reflection 900-1700 nm and RGB image
2. Predictions - Machine Learning
3. Sorting by fixed or variable cut-off threshold

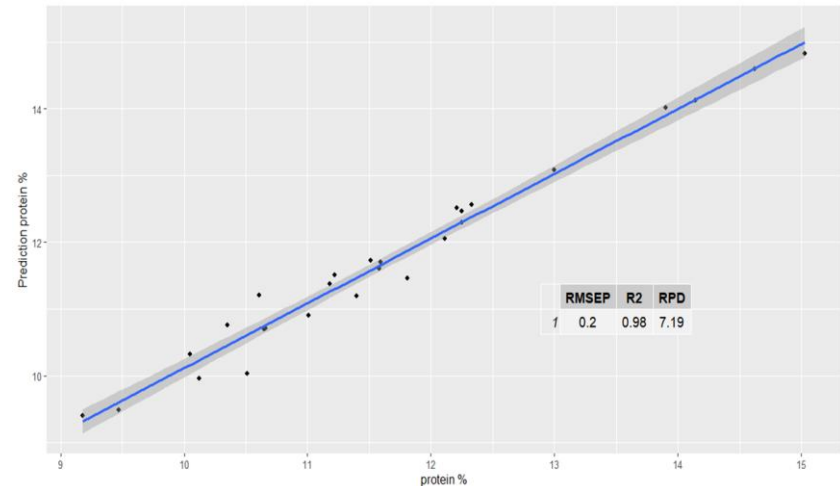
Singel Kernel (SK) Near Infrared (NIR) sorting

- **Based on the prediction of a specific chemical characteristics**
 - Machine Learning
 - Development and implementation of PLS-R and PLS-DA models



Singel kernel NIR spectra wheat
+ Spectral pretreatment
e.g. SNV and Savitzky-Golay
+ Mean spectra of ± 1500 kernels

Predicted value based on NIR spectra
e.g. Proteins content wheat



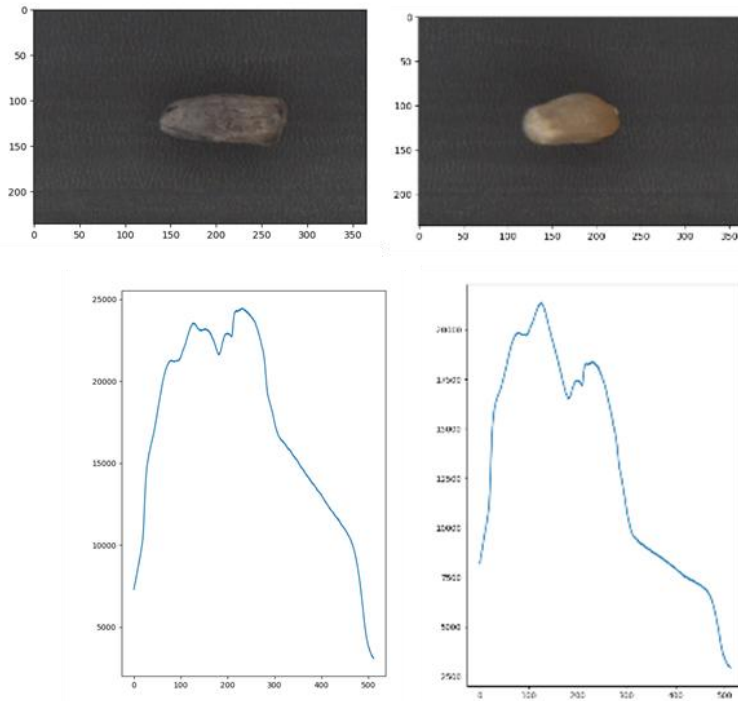
Reference analysis values
e.g. Proteins content wheat

Singel Kernel (SK) Near Infrared (NIR) sorting

- **Application 1 : Automation of Quality Control**
 - Sanitary quality of wheat
 - Ergot (*Claviceps purpurea*)

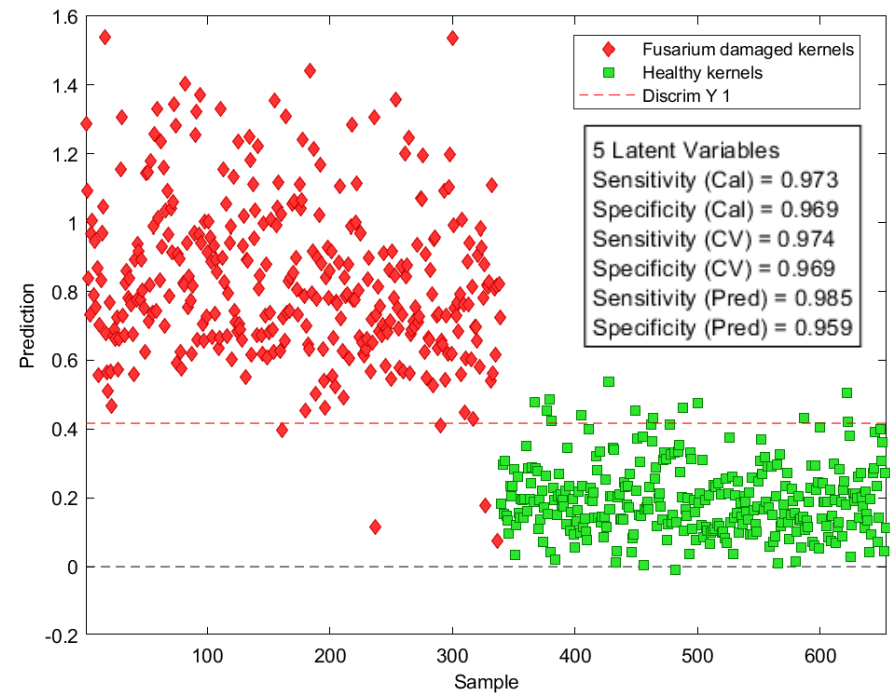
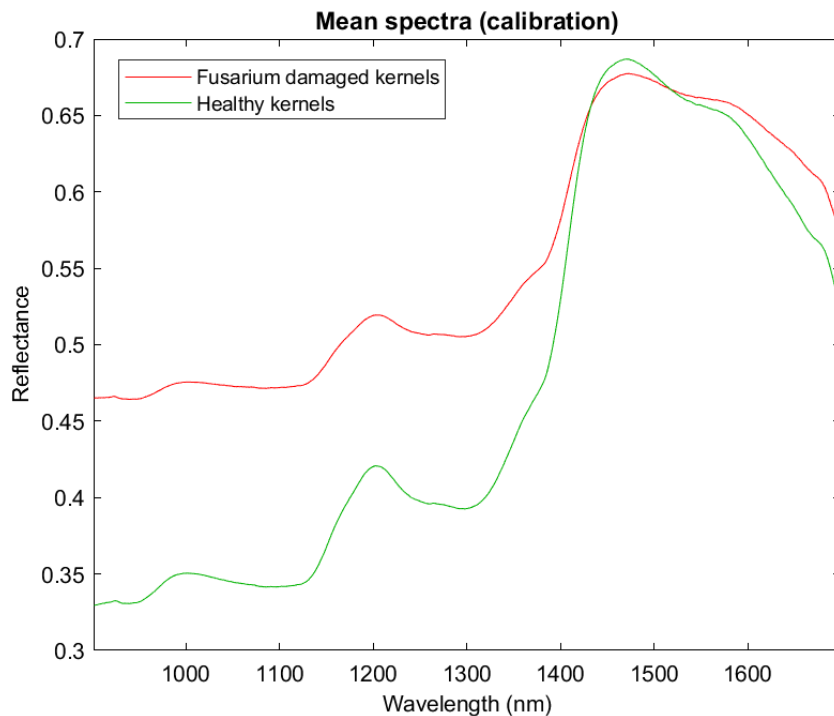
European Directive 1399/2021

Presence of sclerotia in batches of cereals intended for foodstuffs must not exceed 0.2 g/kg (3 to 5 sclerotia)



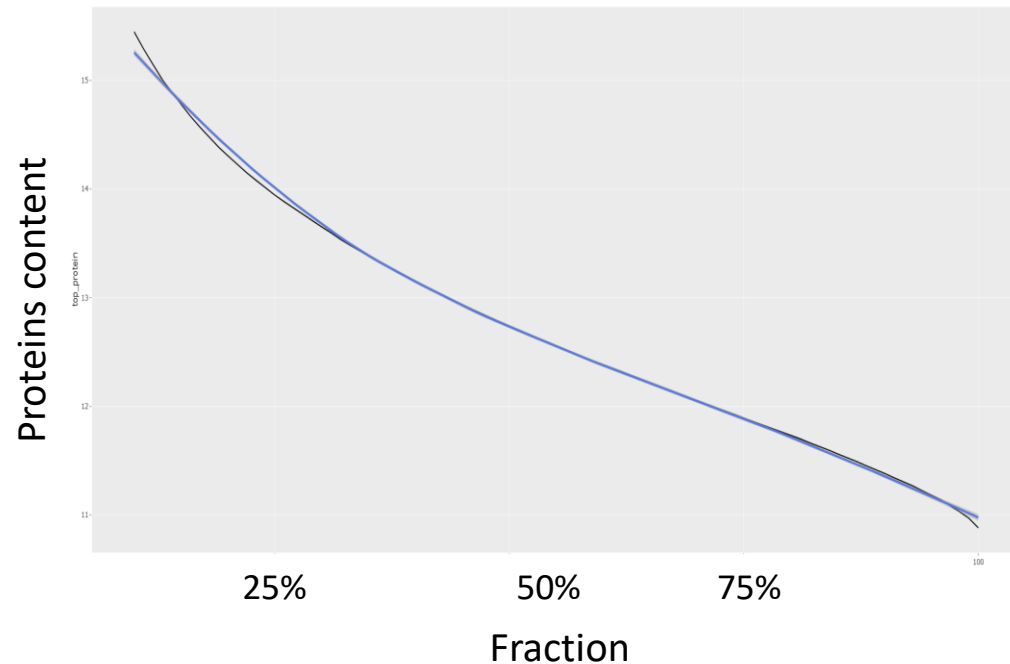
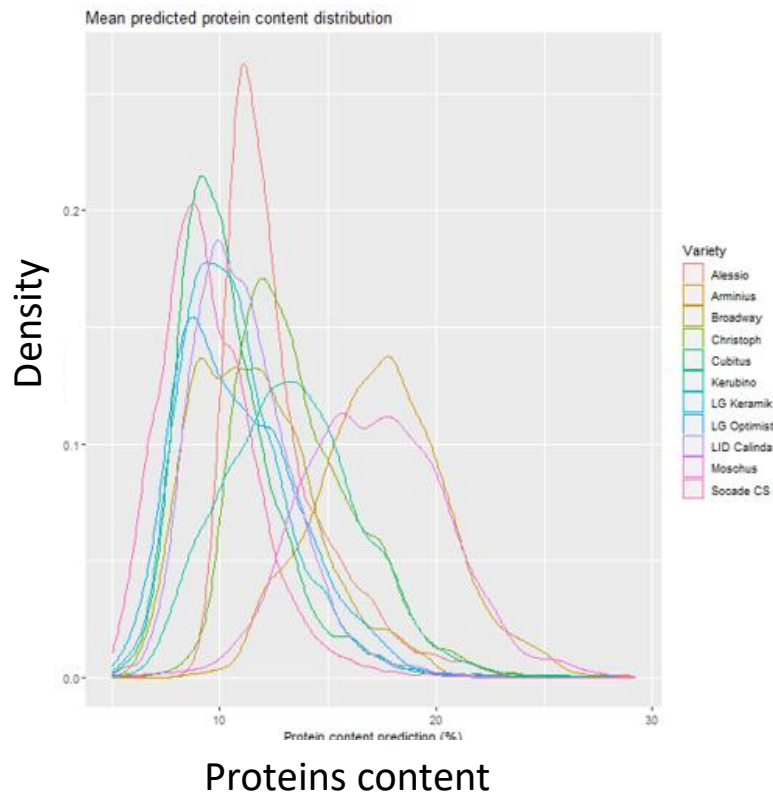
Singel Kernel (SK) Near Infrared (NIR) sorting

- **Application 1 : Automation of Quality Control**
 - Sanitary quality of wheat
 - Fusarium Damaged Kernels



Singel Kernel (SK) Near Infrared (NIR) sorting

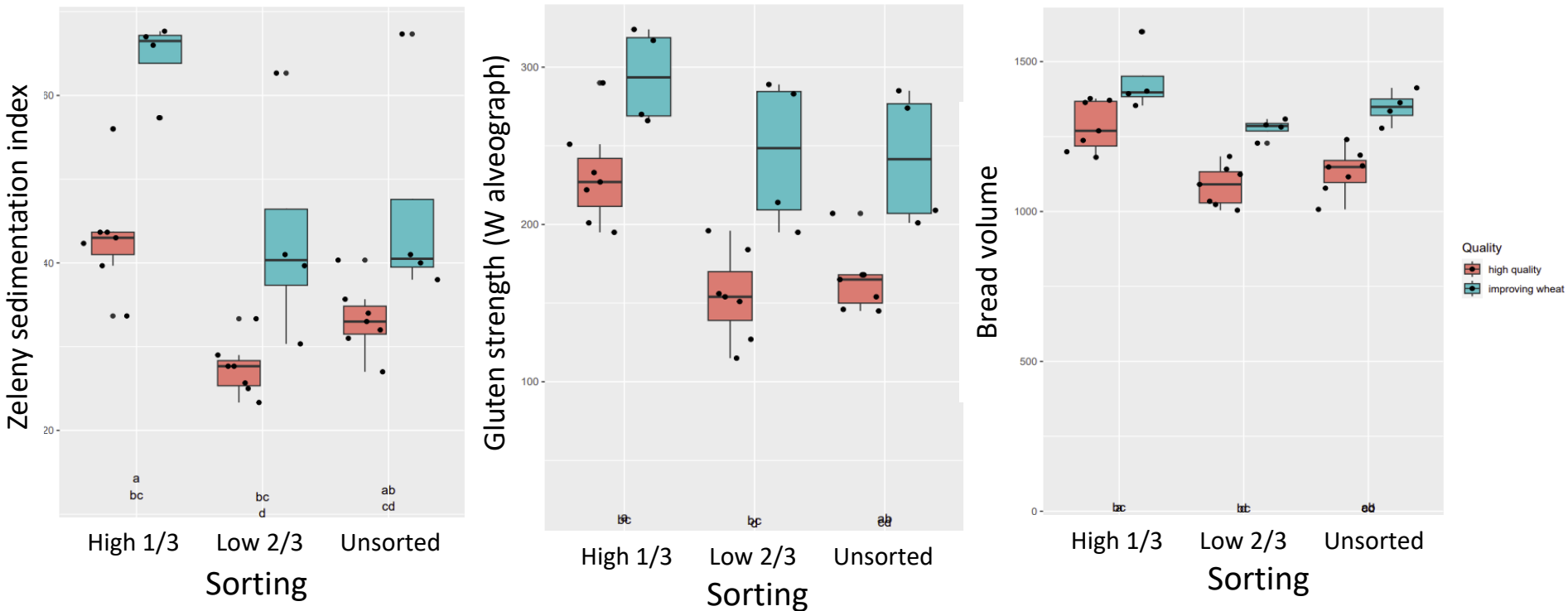
- **Application 1 : Automation of Quality Control**
 - Technological quality of wheat
 - Distribution curve → Batch homogeneity
 - Sorting potential



Singel Kernel (SK) Near Infrared (NIR) sorting

- **Application 2 : Improving Batch Quality**

- Technological quality of breadmaking wheat
 - Sorting on proteins content – e.g. 2/3 low proteins : 1/3 high proteins



→ Production of very high quality of improving fraction which is very hard to find on the market and can replace gluten addition

Singel Kernel (SK) Near Infrared (NIR) sorting

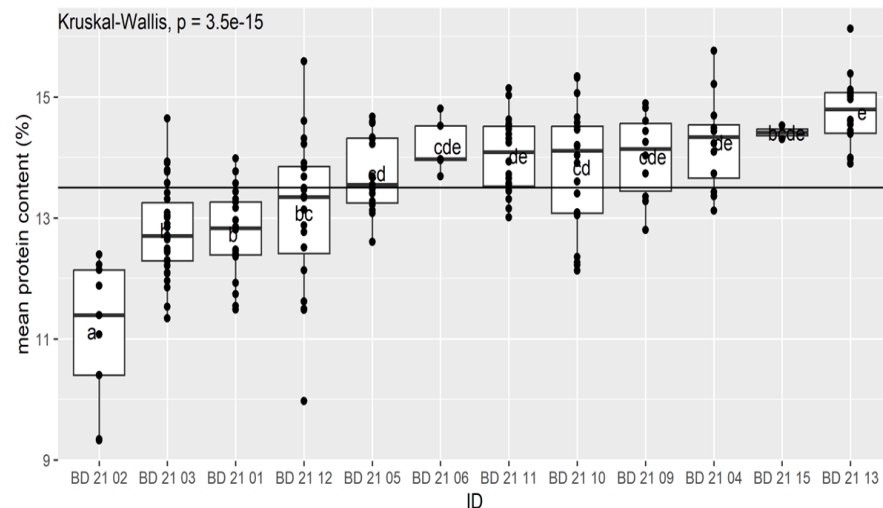
- **Application 3 : Support for Varietal Creation**

- Kernel phenotypic selection
 - Durum protein content of the same initial crossing

F3 crossing unsorted

mean protein of durum cross

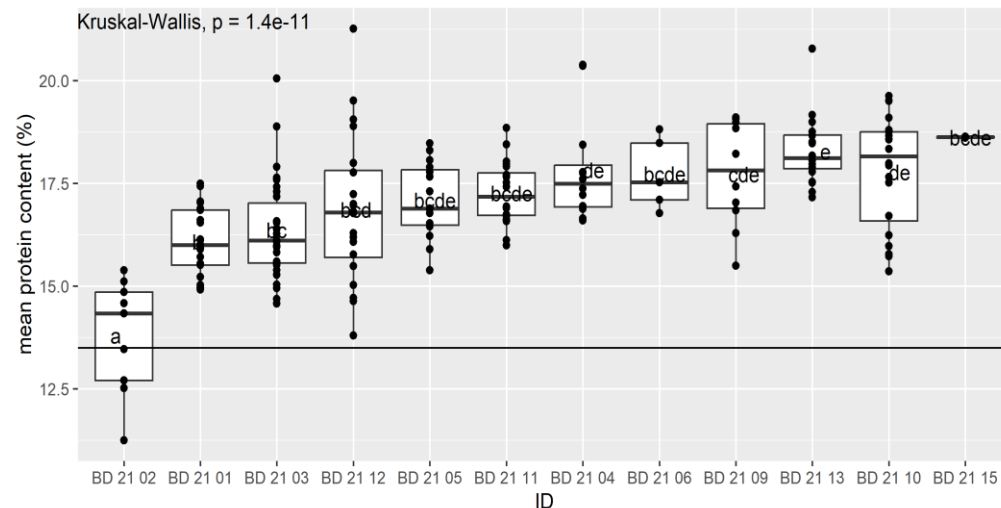
Kruskal-Wallis, $p = 3.5e-15$



F3 crossing sorted above 20% fraction proteins

mean protein of durum cross after SK-NIR sorting (20%)

Kruskal-Wallis, $p = 1.4e-11$



Fast and cheap classification of offspring tool

Singel Kernel (SK) Near Infrared (NIR) sorting

- **Improving quality and decreasing downgrading to feed**
 - Proteins quality and Hagberg falling number
→ To be developed
 - Invisible unhealthy kernel (fusarium mycotoxin content)
→ To be developed

Thank you for your attention



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