Imaging Project

Grain Inspection Advisory Committee Meeting
May 17, 2016
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Qualysense

GIAC Resolution #1

July 2014 Resolution –

"The Advisory Committee recommends the GIPSA continue its work to utilize technology enhancements to advance efficiencies for grain inspections. For example, GIPSA should continue its work with the USDA Rice Studio (rice scanner project) by connecting with industry stakeholders for feasibility of using the technology for further evaluations: including rice brokens sizing, color, and potential uses with other grains."

GIAC Resolution #2

October 2015 Resolution –

"The Advisory Committee commends FGIS on the development of the USDA Rice Studio Rice Program; and recommends that imaging technology be studied for possible use in the determination of percent Dark Hard and Vitreous (DHV) for spring wheat sub classes. FGIS should also study the possible use of this technology to determine shrunken and broken kernel count in all wheat classes."

Current Rice Inspection needs

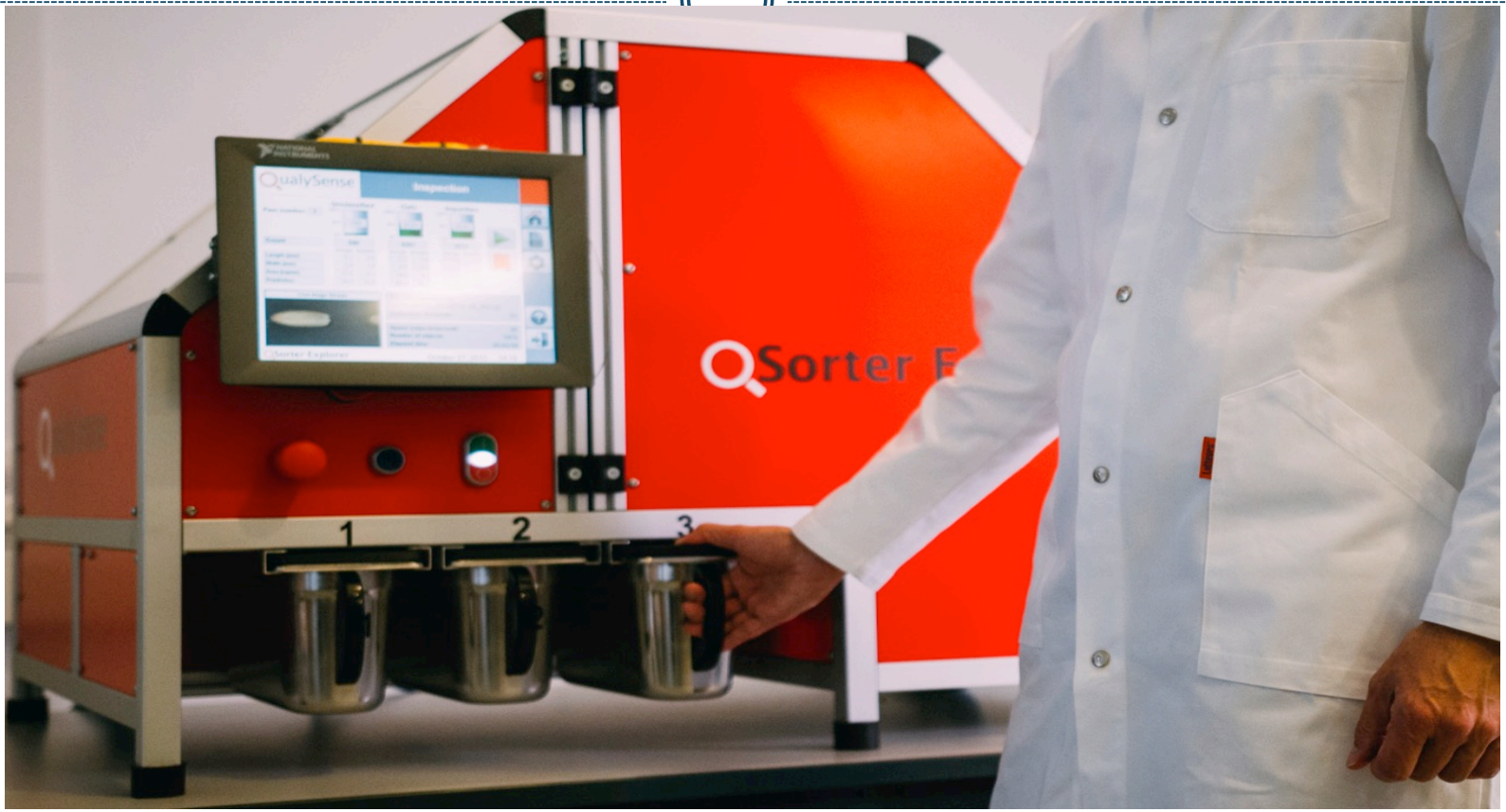
- Replacement for Foss GrainCheck
  - No longer manufactured or supported by Foss
  - Primarily used in California
  - Working with Cal-Agri to locate supplier for main consumable

- Next steps
  - Evaluate effects of sample size
  - Develop performance criteria
  - Solicit commercial instruments for evaluation

Cooperative Agreements

- Iowa State University
- Corvinus University
- University of California

QualySense* CRADA

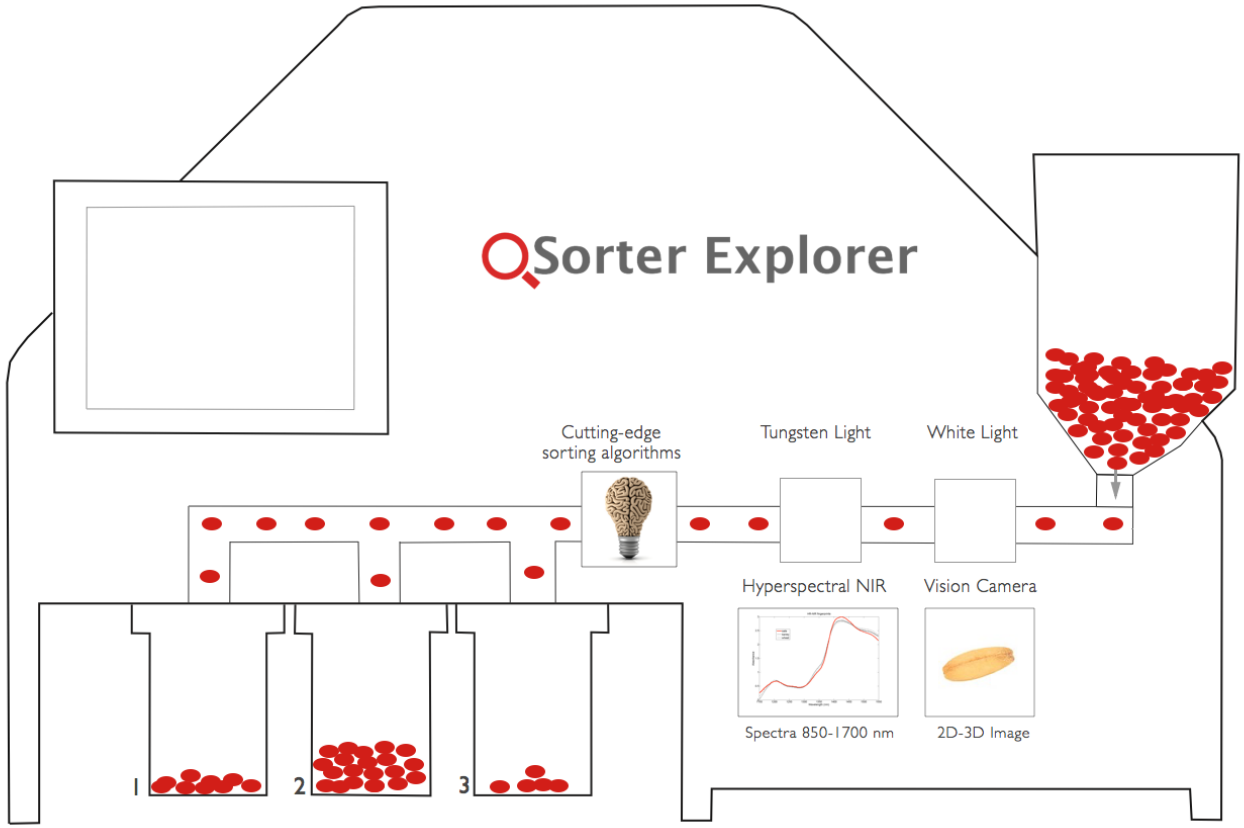


*The mention of firm names or trade products does not imply that they are endorsed or recommended by the USDA over other firms or similar products not mentioned.

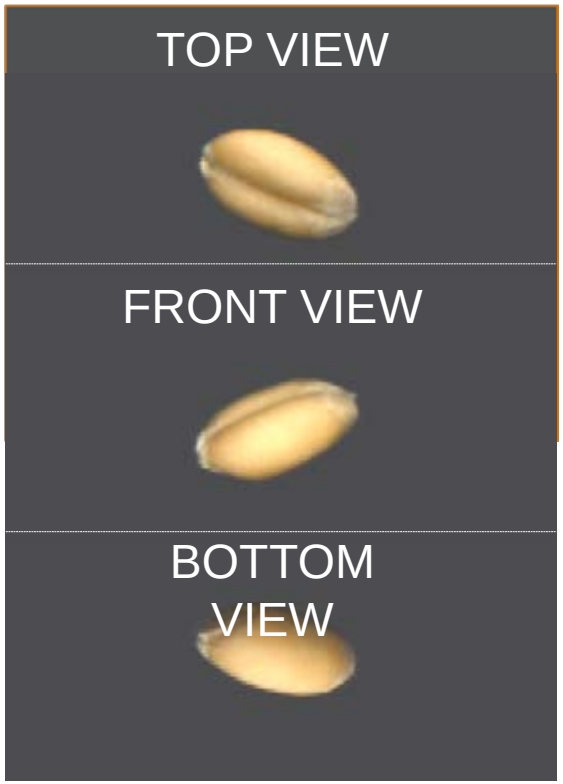
CRADA: Goals & Status

- Use of imaging and NIR for grain inspection applications
- Development of novel inspection standards for measuring quality traits
- Identify and resolve limitations and issues to improve performance and suitability
- Identify and address issues for specific crop and/or applications, sampling processes, inspection procedures, and other factors that may impact accuracy, consistency, or efficiency of quality assessments

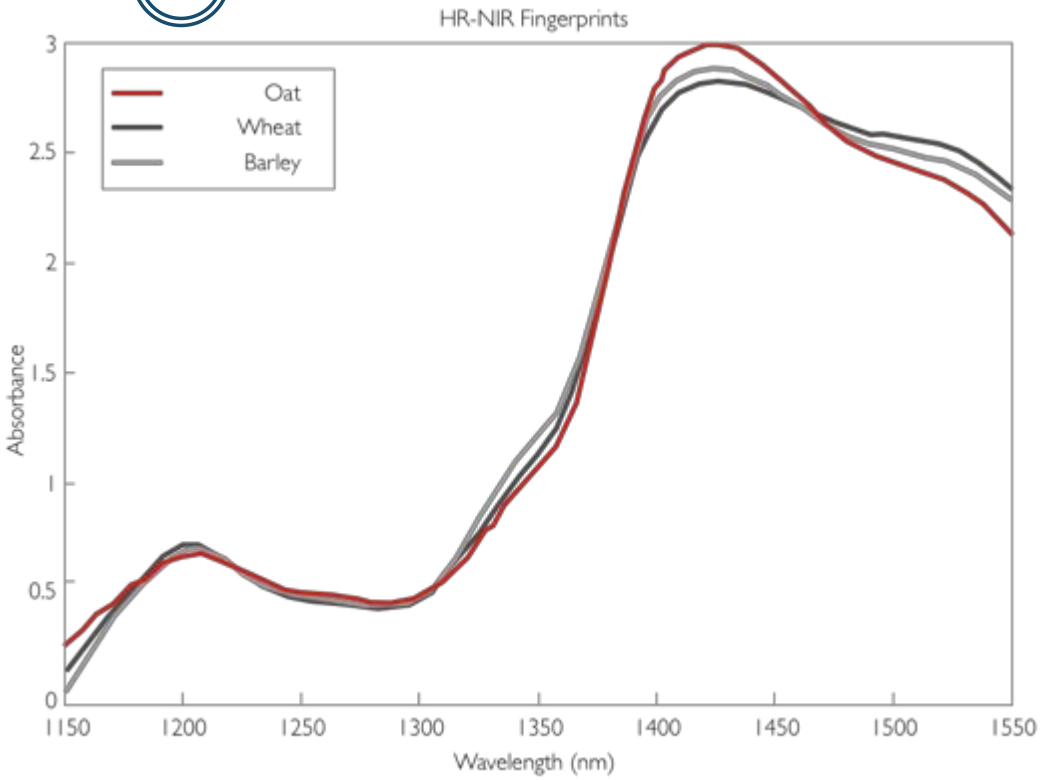
High-Speed one by one analysis and sorting of grains



Using 3D imaging and NIR



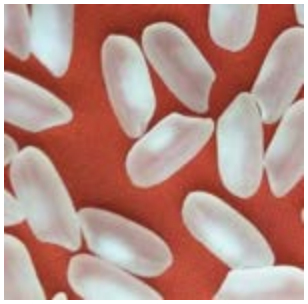
3D image – wheat kernel



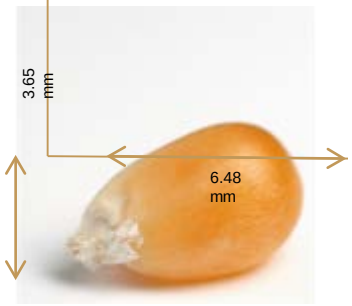
NIR spectra for oat, wheat and barley

Physical and biochemical properties at once

INSECT DAMAGE



BROKEN KERNELS



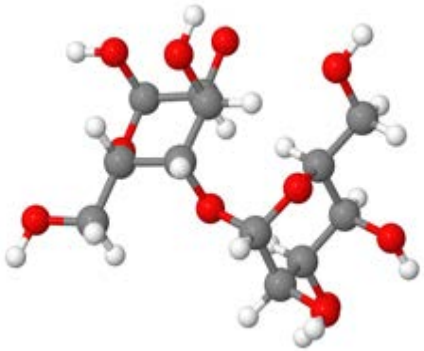
GEOMETRY

DISEASES

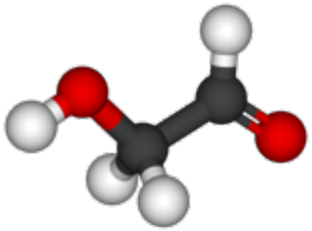
IDENTIFY IMPURITIES

VARIOUS COMPOSITIONAL PROPERTIES

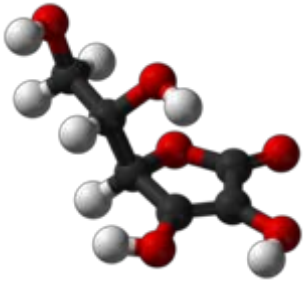
FATTY ACIDS



PROTEIN FRAGMENT

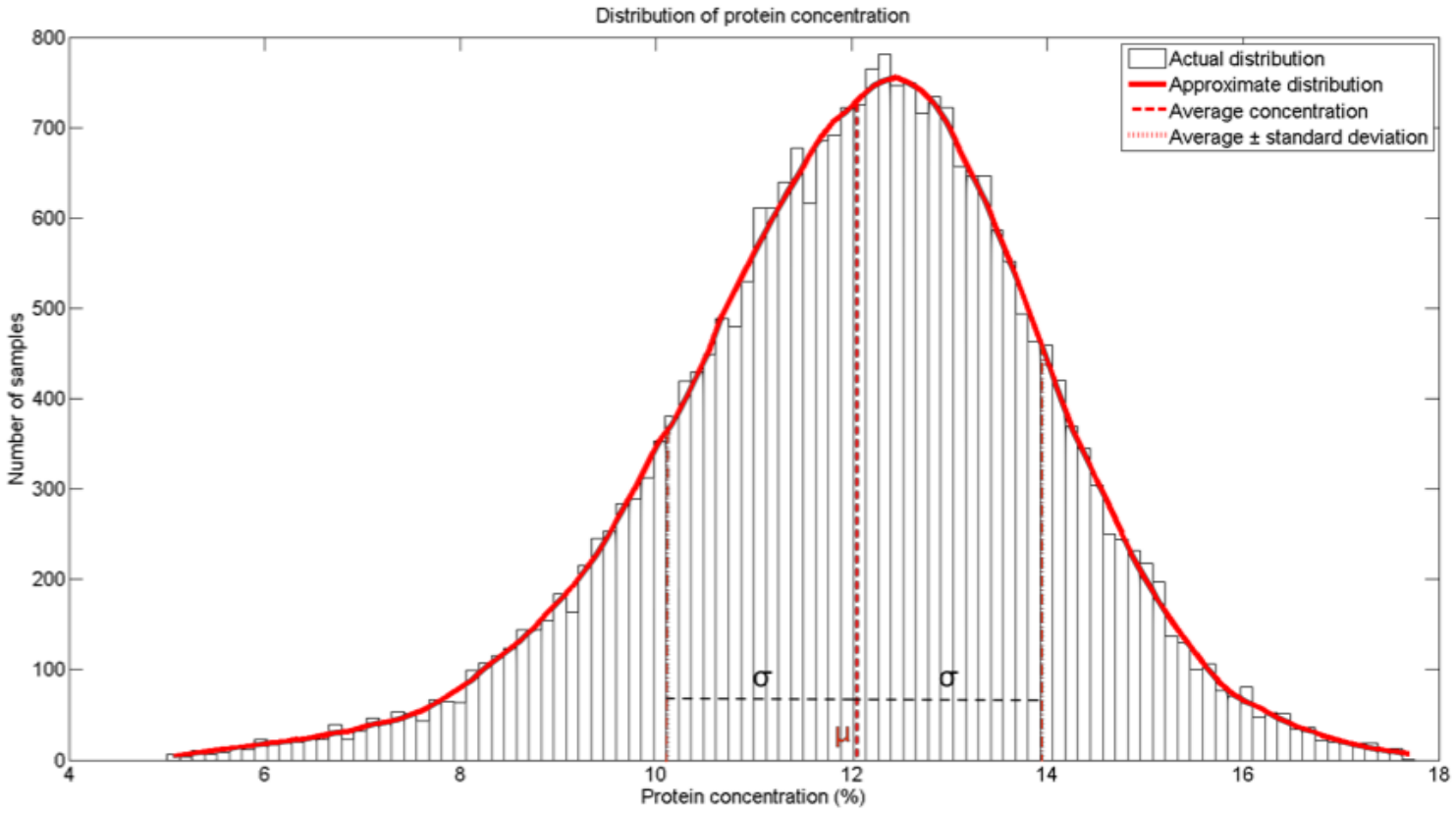


SUGAR

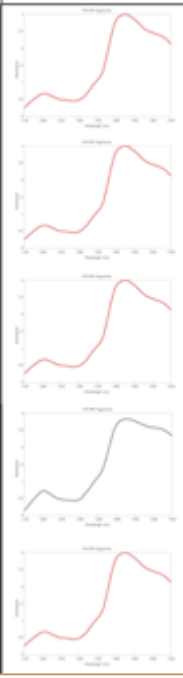


ANTIOXIDANTS

We acquire information for the entire batch…



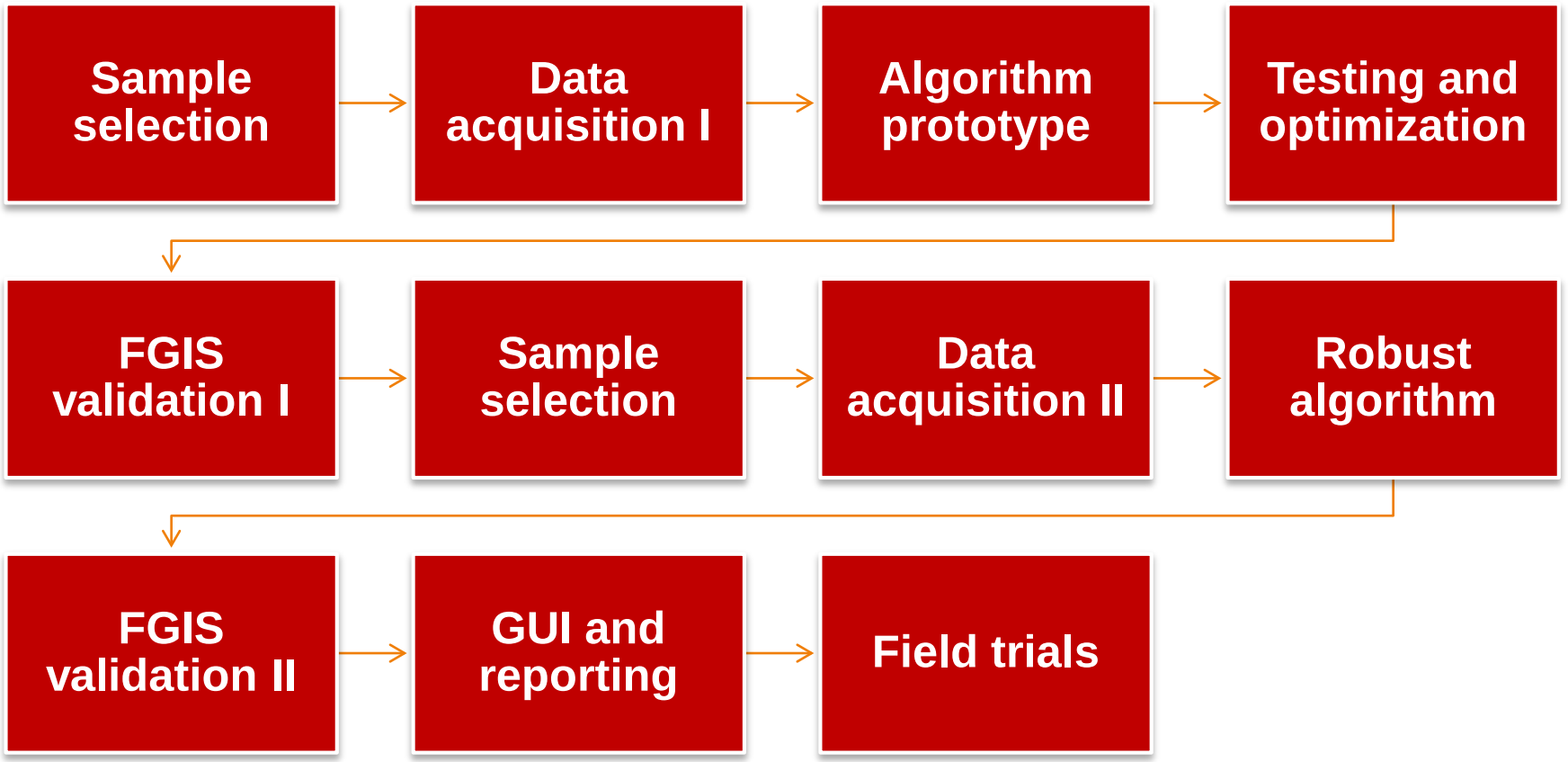
…and for each individual grain

Image	Spectra	Protein [%]	Moisture [%]	Length [mm]	Width [mm]	Area [sqmm]	Elongation Factor [-]	Prediction Index	Label
		12.23	12.34	9.21	2.45	22.58	4.58	1.02	Oat
		13.65	11.21	8.76	2.76	24.21	4.48	1.12	Oat
		11.42	12.13	7.78	2.57	20.00	3.85	1.08	Oat
		15.35	11.05	7.25	3.97	28.78	3.97	0.92	Contaminant
		12.78	10.98	11.58	3.12	36.17	4.72	1.01	Oat

Summary

Goal	Partial or full automatic grading of samples
Type	CRADA sharing know-how and equipment
Duration	3 years: from Feb 2016 to Feb 2019
Objectives 2016	Rice: chalkiness and broken Wheat: vitreousness

Application development flow



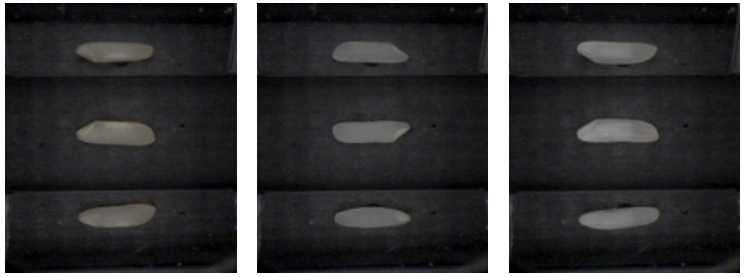
Broken classification

FGIS rule: a kernel is broken when its length is less than ¾ of the average length of the batch kernels

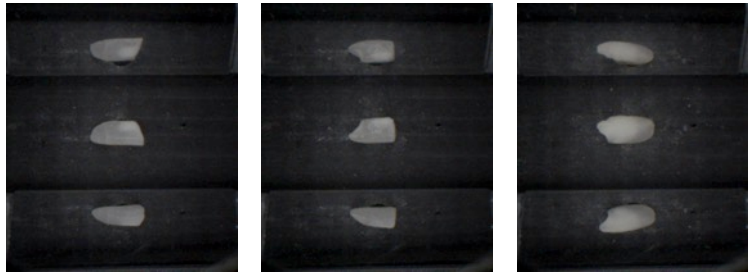
- Rice length classified in 3 categories:
  - Short
  - Medium
  - Long
- Challenge: distinguish broken kernels from kernels from shorter length categories

Broken classification

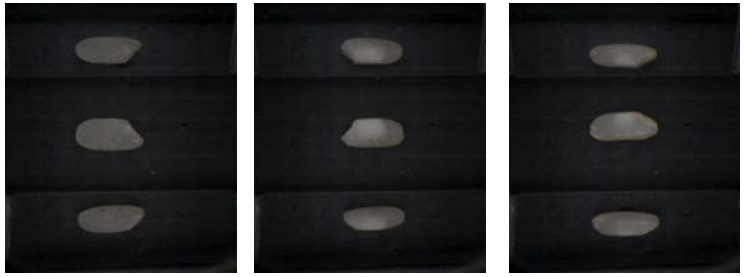
LONG



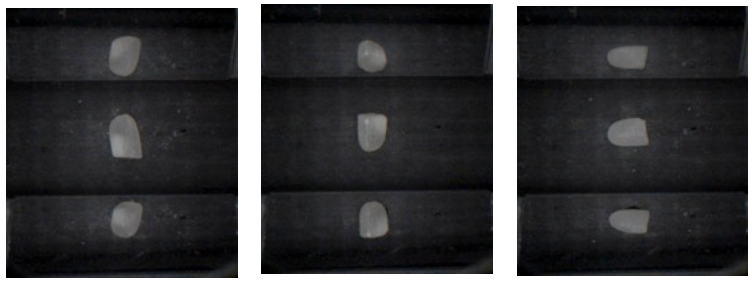
LONG BROKEN



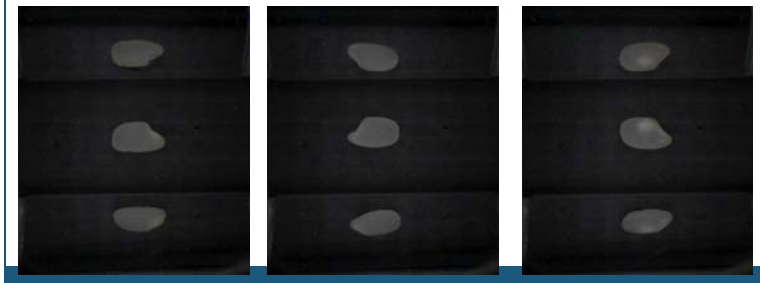
MEDIUM



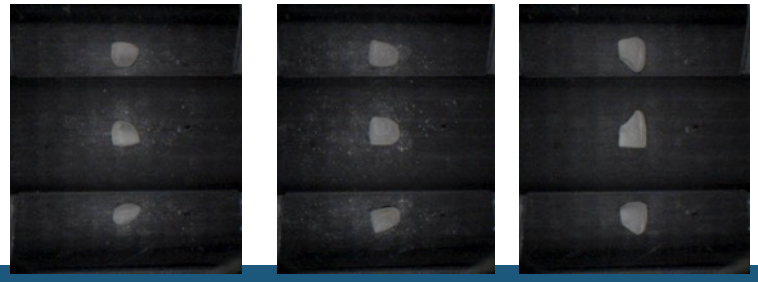
MEDIUM BROKEN



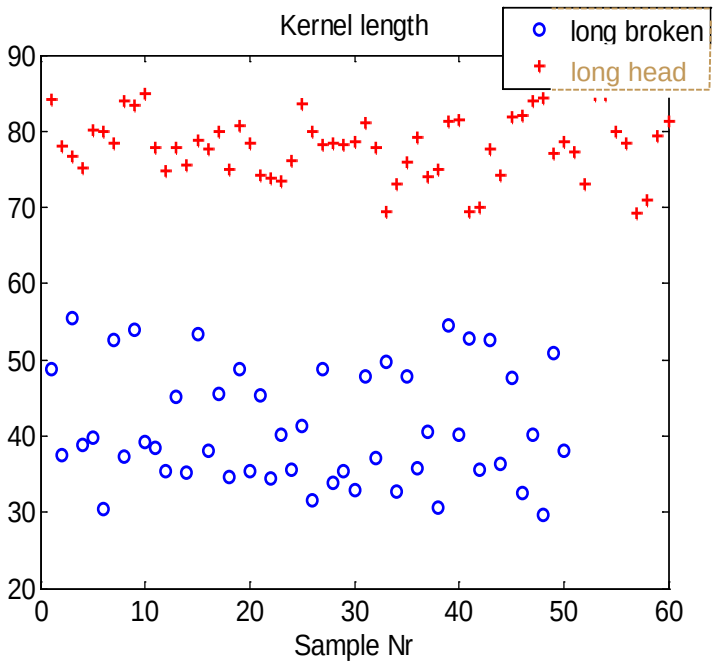
SHORT

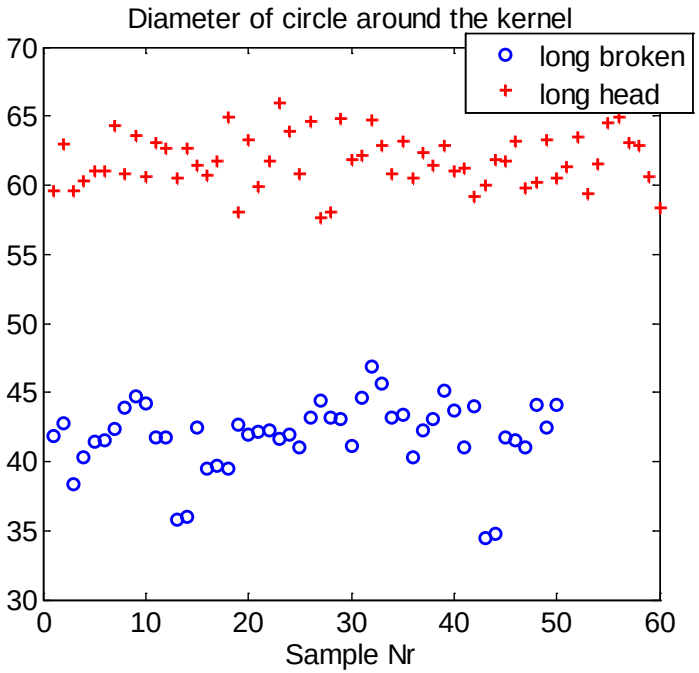


SHORT BROKEN



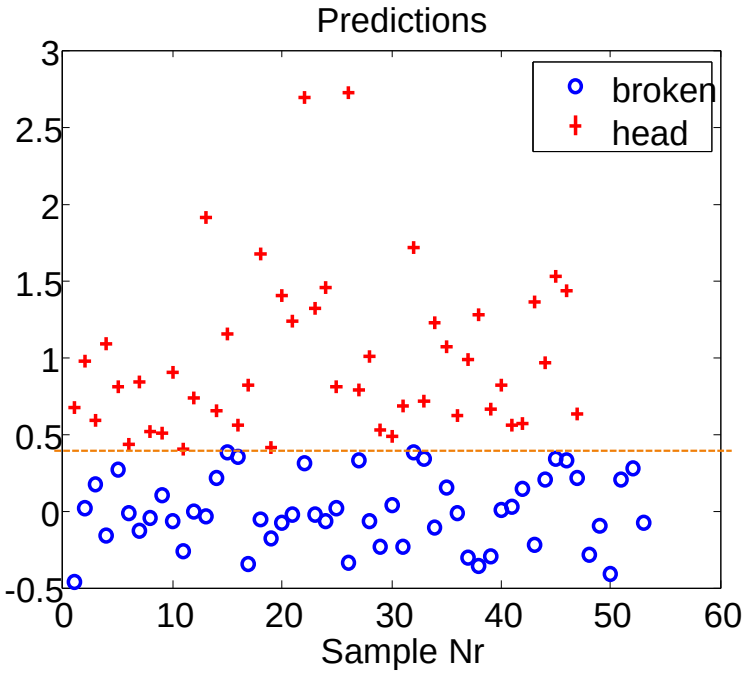
Broken classification: same LENGTH class





- Combining length and shape parameters
  - Broken kernels from the same length category of rice can be distinguished with an accuracy of 99%

Broken classification: mixed LENGTH classes



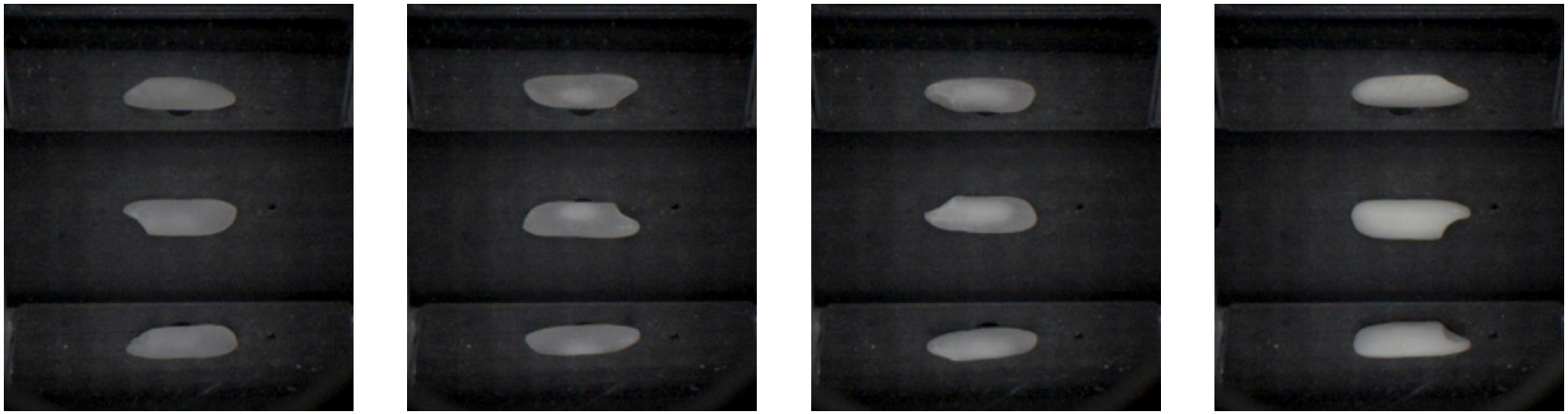
- Classification accuracy > 95%, i.e. 4% lower
- Repeatability > 97%

Chalkiness classification

FGIS rule: a kernel is chalky if > 50% chalkiness

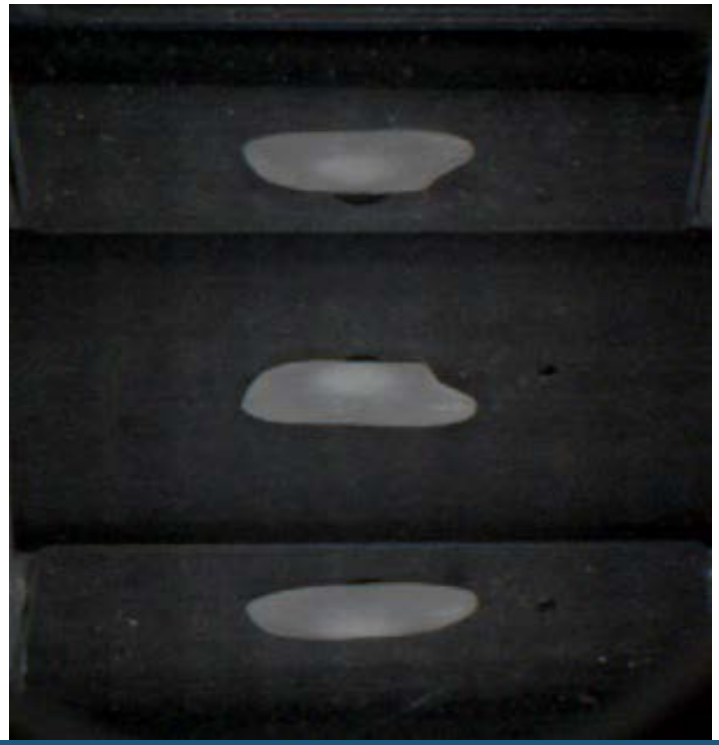
- Rice classes of chalkiness:

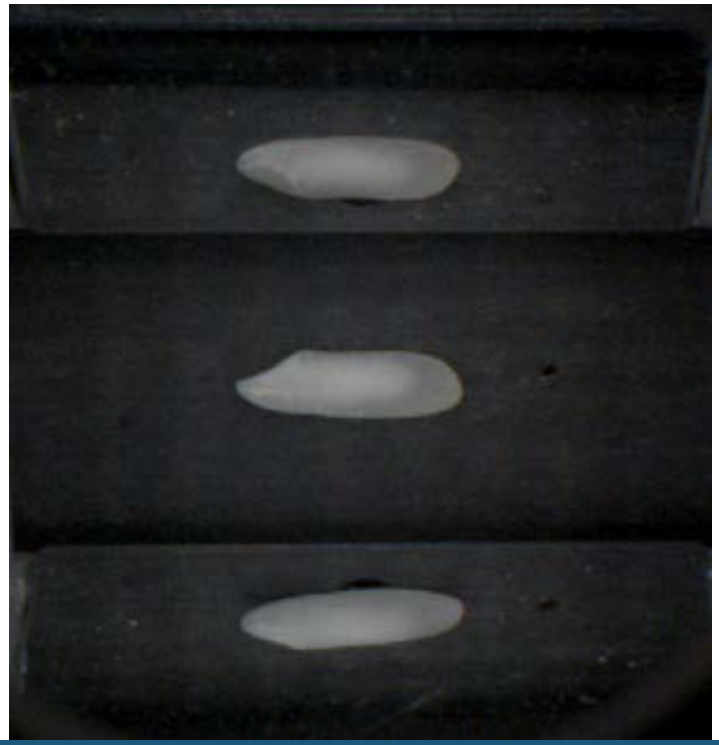
Class 1 0-10%	Class 2 11-25%	Class 3 25-50%	Class 4 50-100%



How to validate?

- Challenge: comparison of QSorter results with official visual method





Chalkiness: preliminary results

Predicted

Real	Class 1	Class 2	Class 3	Class 4
Class 1	19	1	0	0
Class 2	2	18	0	0
Class 3	0	0	18	2
Class 4	0	0	2	18

- Accuracy with Artificial Neural Network algorithms:
  - > 90% if 4 classes, i.e. 0-10%, 11-25%, 26-50%, 51-100%
  - > 95% if 2 classes, i.e. 0-50%, 51-100%

Conclusions and Next Steps

- Complete infrastructure setup
- Grading software tool to support image grading
- Proper representation of sample variety
- FGIS validation I for all properties
- Algorithms robustness
- FGIS validation II for all properties
- Field trials

Questions?