Imaging systems and IoT technologies for precision agriculture applications

CENSIS Vision Lab and SRUC Showcase,
King's Buildings, 9th October 2019

Developing spectral signatures for grain quality and crop phenotyping

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Leading the way in Agriculture and Rural Research, Education and Consulting

Background

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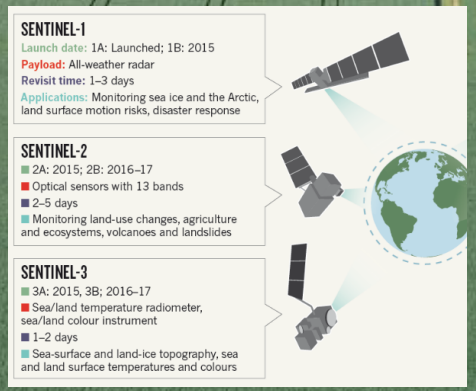
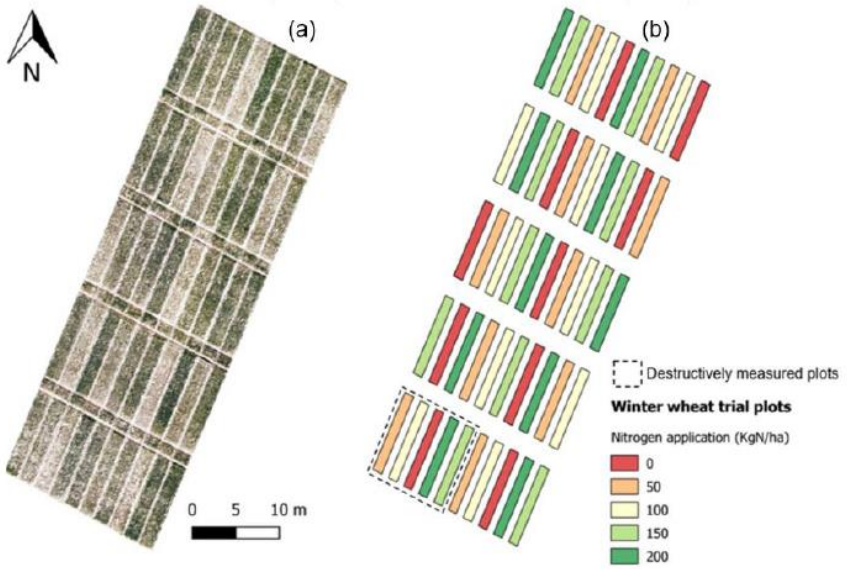
Research with UAS mounted sensors

- Novel hyper-spectral and fluorescence system
  - UAS and fixed point
  - Dual field of view
- Thermal camera
- RGB camera
- Multispectral sensor

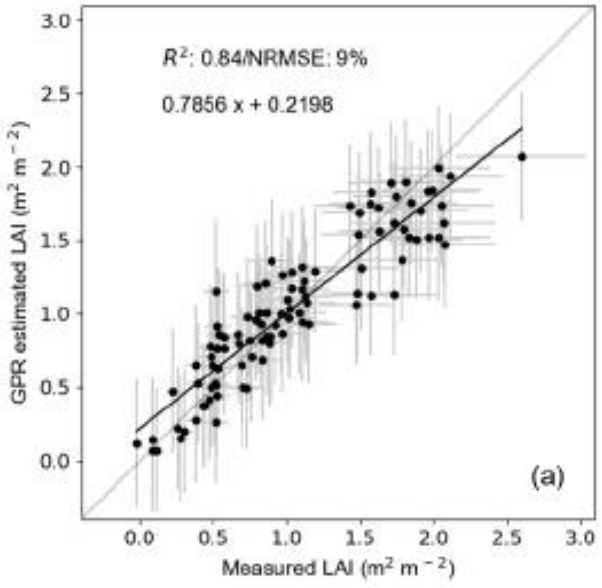
Satellites and data processing

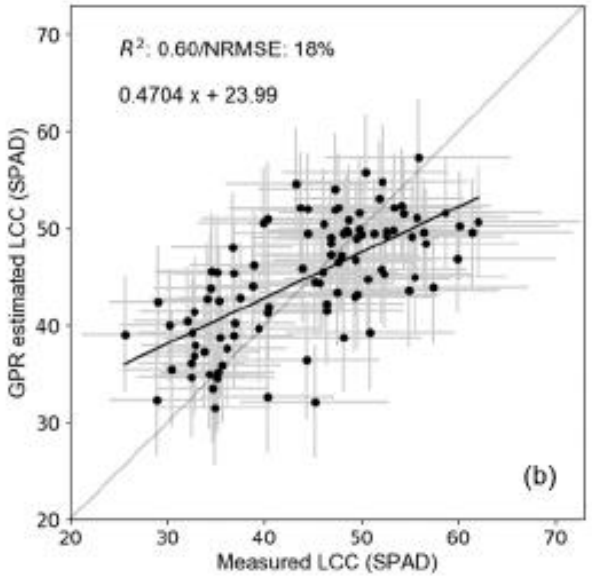


Crop growth and development



Without uncertainty											
Number of bands	AIC	R^2 (SD)	NRMSE (%; SD)	Wavelength (nm)							
											CCC
8	1112	0.92 (0.01)	7.7 (0.2)	490	560	665	705	740	783	842	865
7	1112	0.92 (0.01)	7.8 (0.3)	490	560	705	740	783	842	865	
6	1097	0.92 (0.00)	7.5 (0.1)	560	705	740	783	842	865		
5	1102	0.92 (0.01)	7.7 (0.4)	705	740	783	842	865			
4	**1087**	**0.92 (0.00)**	**7.4 (0.1)**	**705**	**740**	**783**	**865**				
3	1130	0.91 (0.02)	8.4 (0.7)	740	783	865					
2	1129	0.91 (0.02)	8.4 (0.7)	740	783						
1	1332	0.66 (0.13)	16.1 (3.2)	783							

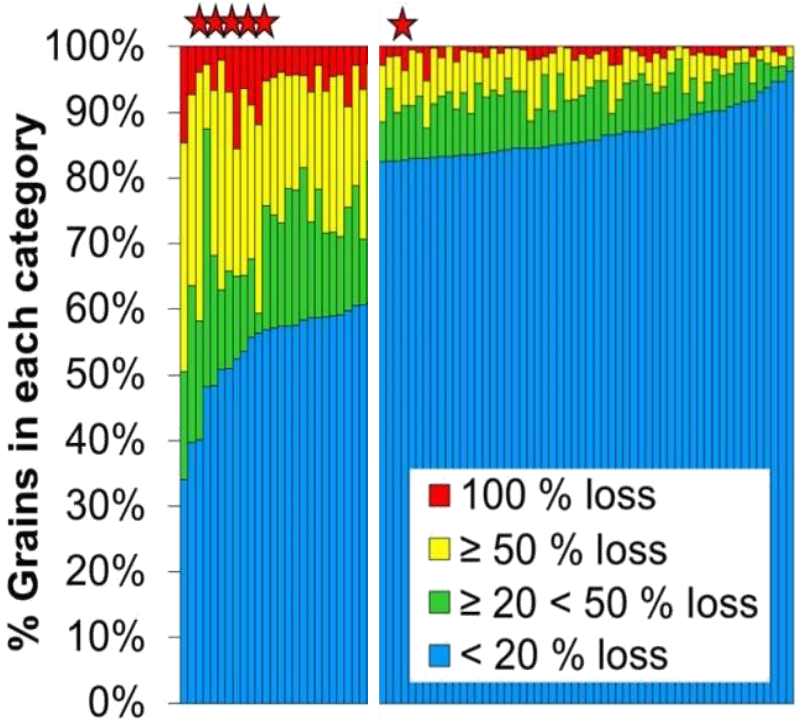




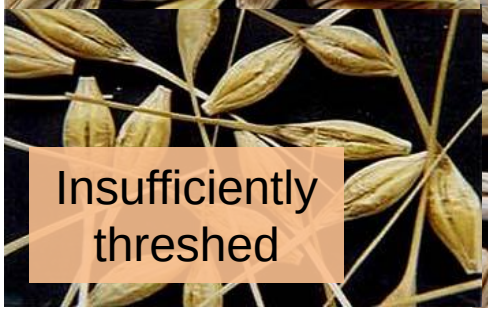
Andrew Revill, Anna Florence, Alasdair MacArthur, Stephen Hoad, Robert Rees and Mathew Williams. 2019. The value of Sentinel-2 spectral bands for the assessment of winter wheat growth and development. *Remote Sensing*,11

Grain assessment

SRUC-MAGB Grain Skinning Protocol



Source: http://www.ukmalt.com/reasons-rejection



Current and new lab based systems

NIR systems e.g. Infratech

Moisture, protein, oil, test weight, starch, wet gluten, and fibre

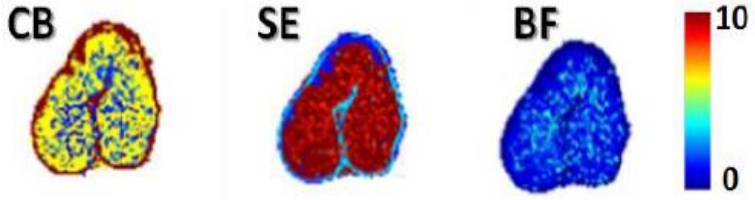
https://www.fossanalytics.com/

Multispectral imaging e.g. VideometerLab 4

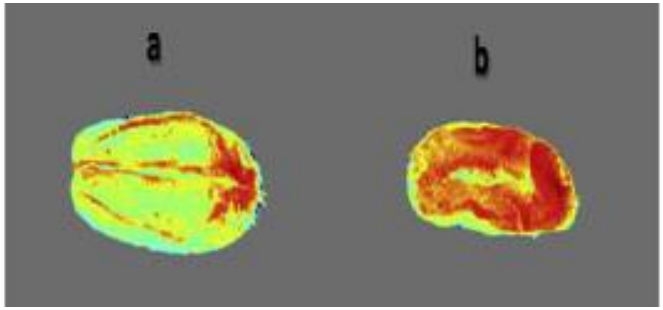
Determination of surface colour, texture, shape, size and chemical composition

https://analytik.co.uk/

Multispectral imaging in seed analysis



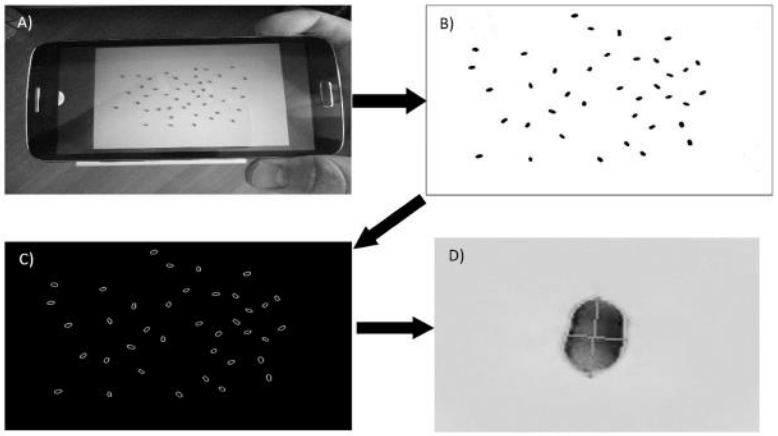
Different flour extracts according to location within grain tissues



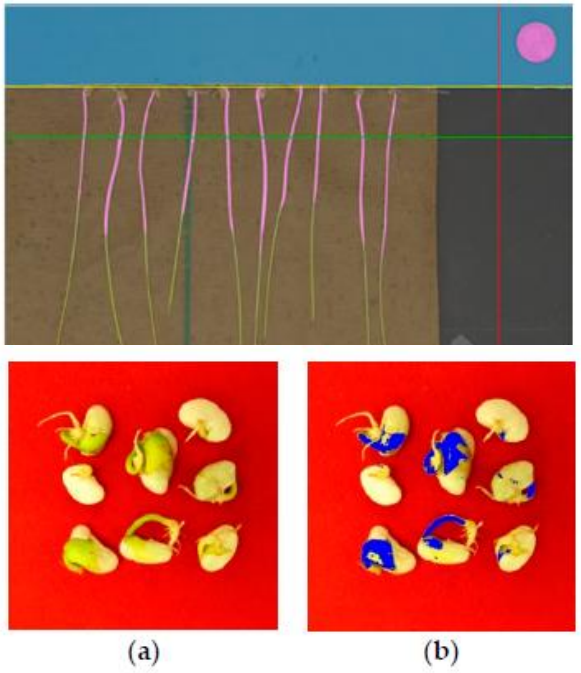
Wheat genotypes (a resistant and (b) susceptible to *Fusarium*

El Masry et al. 2019. Recent Applications of Multispectral Imaging in Seed Phenotyping and Quality Monitoring – An Overview. *Sensors*, 19. https://doi.org/10.3390/s19051090

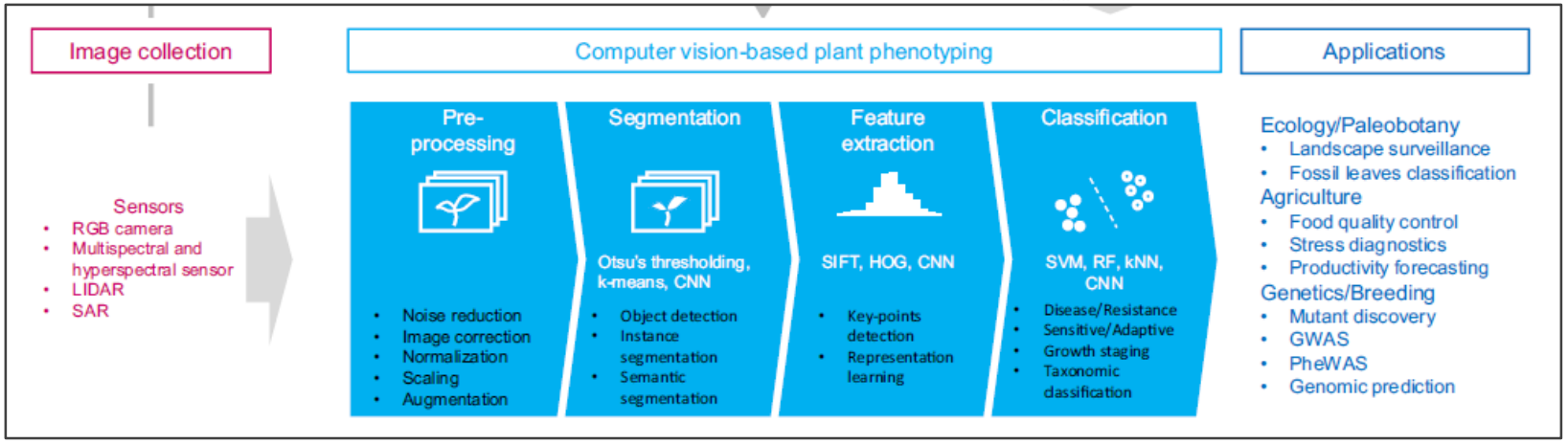
Towards lab and field phenotyping



Komyshev et al. 2017. Fig. 1. Evaluation of the SeedCounter, A Mobile Application for Grain Phenotyping. *Frontiers in Plant Science,* 7: 1990.



From Zhang et al. 2018. Figs. 1 and 4. High-Throughput Phenotyping of Seed/Seedling Evaluation Using Digital Image Analysis. *Agronomy*, 8.

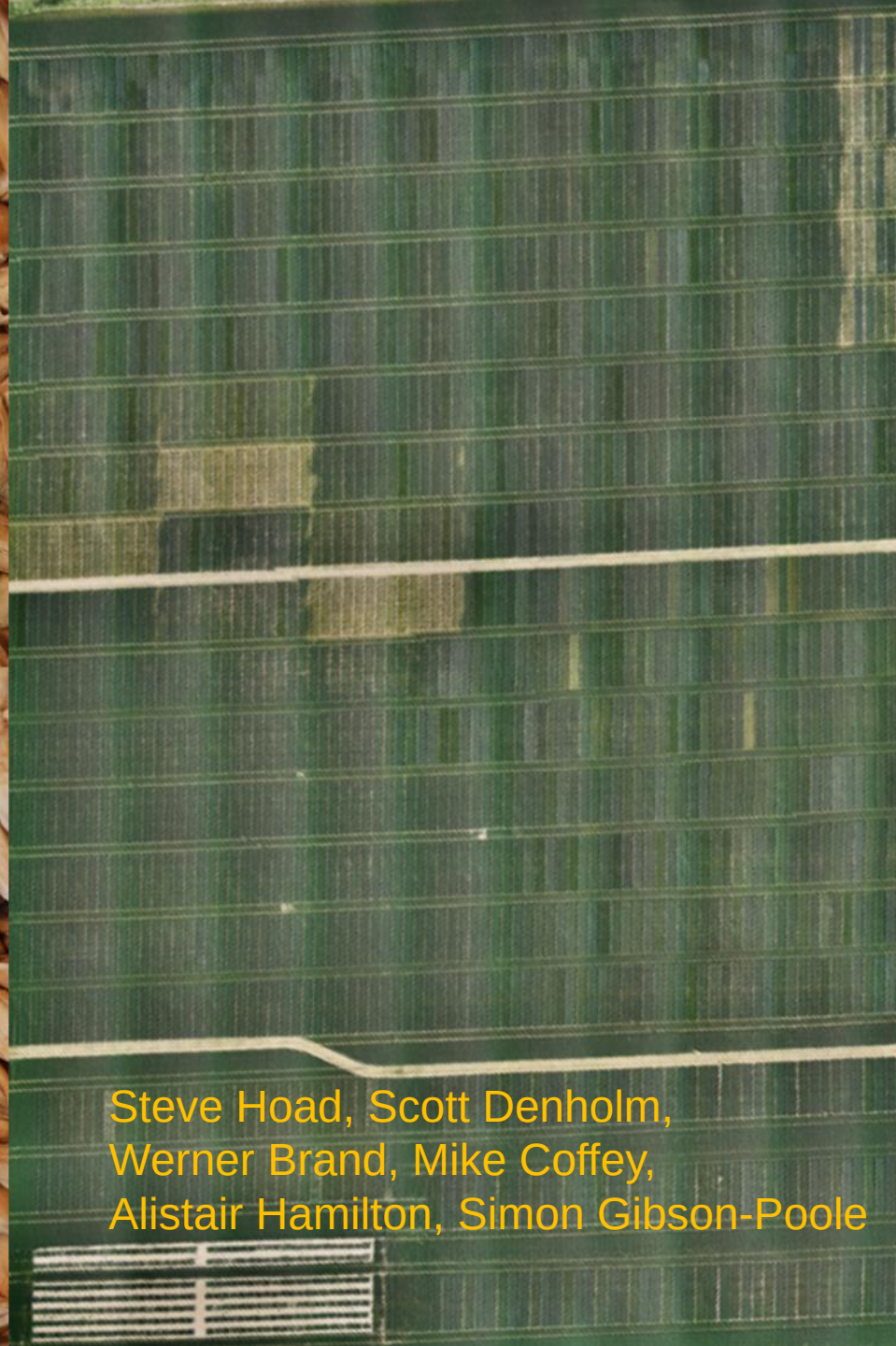


Modified from: Mochida et al. 2018. Fig. 1. Computer vision-based phenotyping for improvement of plant productivity: a machine learning perspective. *GigaScience,* 8: 1–12.

New approaches to grain and crop phenotyping

Crop and grain signatures using multi- and hyper-spectral imaging and machine (deep) learning in order to:

- Working at field and lab scale
- Phenotype crop plants e.g. winter wheat
- Characterise plant and seed health
- Create a new generation of analytical services and consultancy
- Advances in crop breeding



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Werner Brand, Mike Coffey,
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