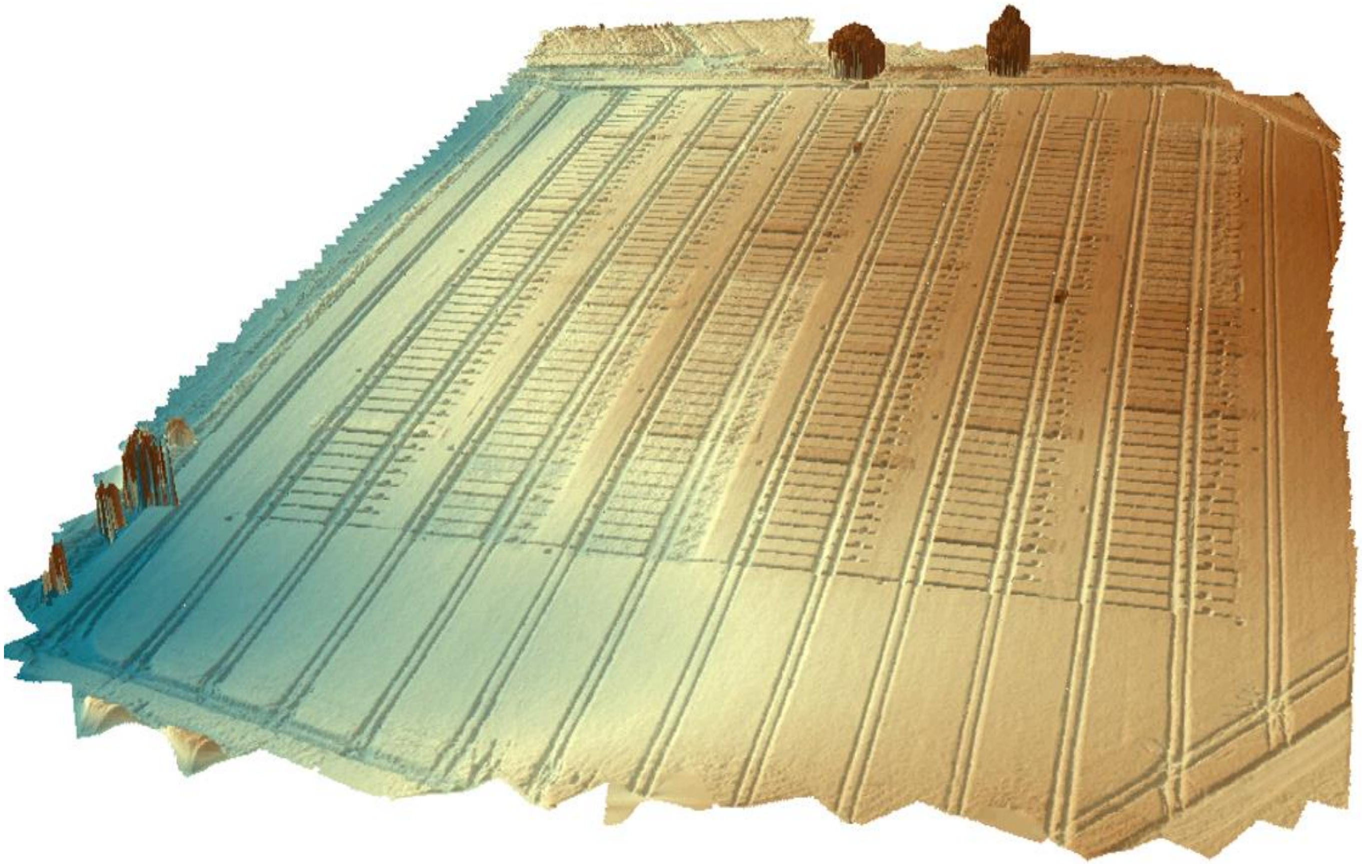
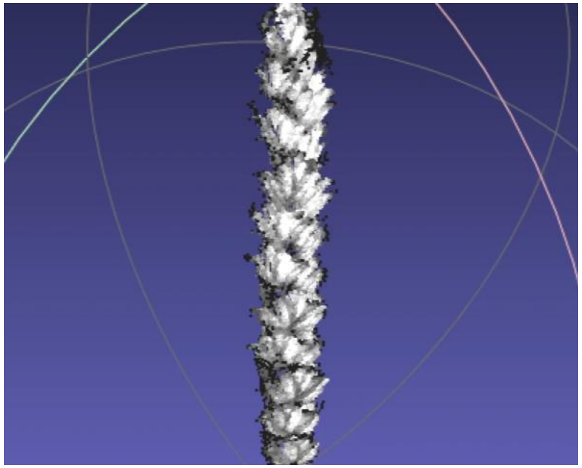


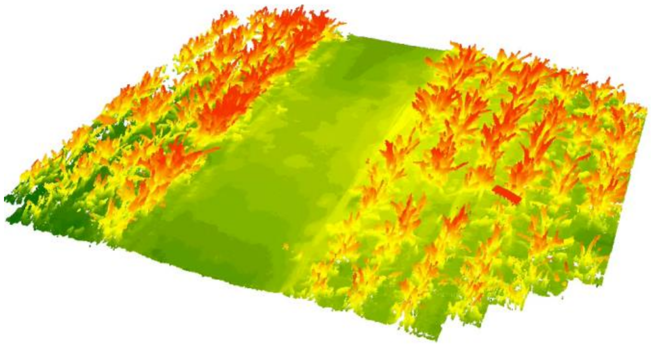
Adam Michalski

Rothamsted Research
where knowledge grows

Drone technology, robotic crop monitoring and wheat yield stability – unexpected applications of the WGIN diversity-nitrogen trials



Malcolm J. Hawkesford



WGIN Stakeholders Meeting

30th November 2016

Department for Environment Food & Rural Affairs

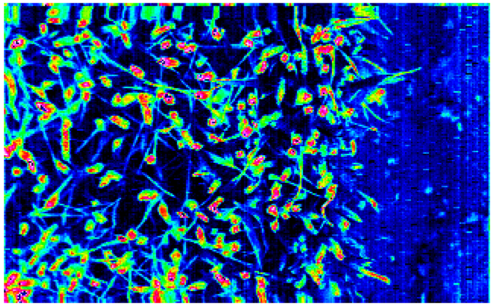
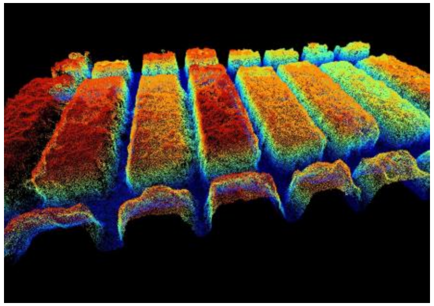
Wheat Genetic Improvement Network

BBSRC bioscience for the future

ROTHAMSTED RESEARCH

Outline

- WGIN Nitrogen-Diversity Trial
- Yield, nitrogen and NUE
- Wheat yield stability
- Testing drone-based technology
- New ground-based automated platform


Typical Diversity trial (2013)

ROTHAMSTED RESEARCH

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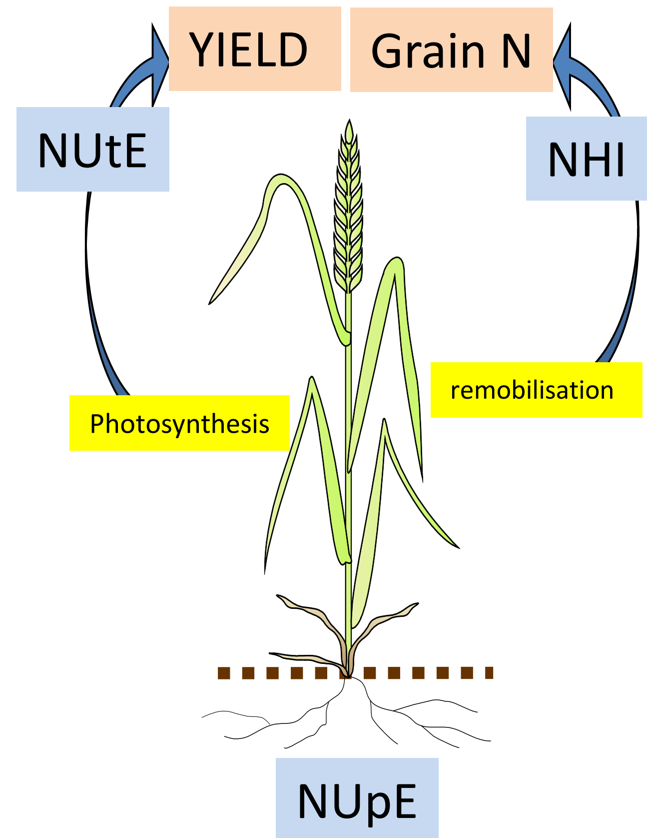
No varieties are perfect!

ROTHAMSTED RESEARCH

Variety Performance at 200 kg-N/ha (2004-08)

Variety	Code	Nabim	Years	Yield	%N	Uptake	Utilisation
Avalon	AV	1	5				
Flanders	FL	1	1				
Hereward	HE	1	5				
Hurley	HU	1	5				
Malacca	MA	1	5				
Mercia	ME	1	4				
Maris Widgeon	MW	1	5				
Shamrock	SH	1	4				
Solstice	SL	1	5				
Spark	SP	1	1				
Xi 19	XI	1	5				
Cadenza	CA	2	5				
Cordiale	CO	2	3				
Einstein	EI	2	1				
Lynx	LY	2	5				
Rialto	RL	2	1				
Scorpion	SC	2	1				
Soissons	SS	2	5				
Beaver	BE	3	4				
Claire	CL	3	4				
Riband	RI	3	5				
Robigus	RO	3	4				
Istabraq	IS	4	4				
Napier	NA	4	3				
Savannah	SA	4	4				
Paragon (spring)	PA	1	5				
Chablis (spring)	CH	2	1				
Arche	AR	F	1				
Batis	BA	G	5				
Caphorn	CP	F	1				
Cappelle Desprez	CD	F	1				
Enorm	EN	G	1				
Isengrain	IG	F	1				
Monopol	MO	G	5				
Opus	OP	G	1				
PBis	PB	G	1				
Petrus	PE	G	1				
Sokrates	SK	G	5				
Zyta	ZY	P	1				

Upper-Q
Inter-Q
Inter-Q
Lower-Q



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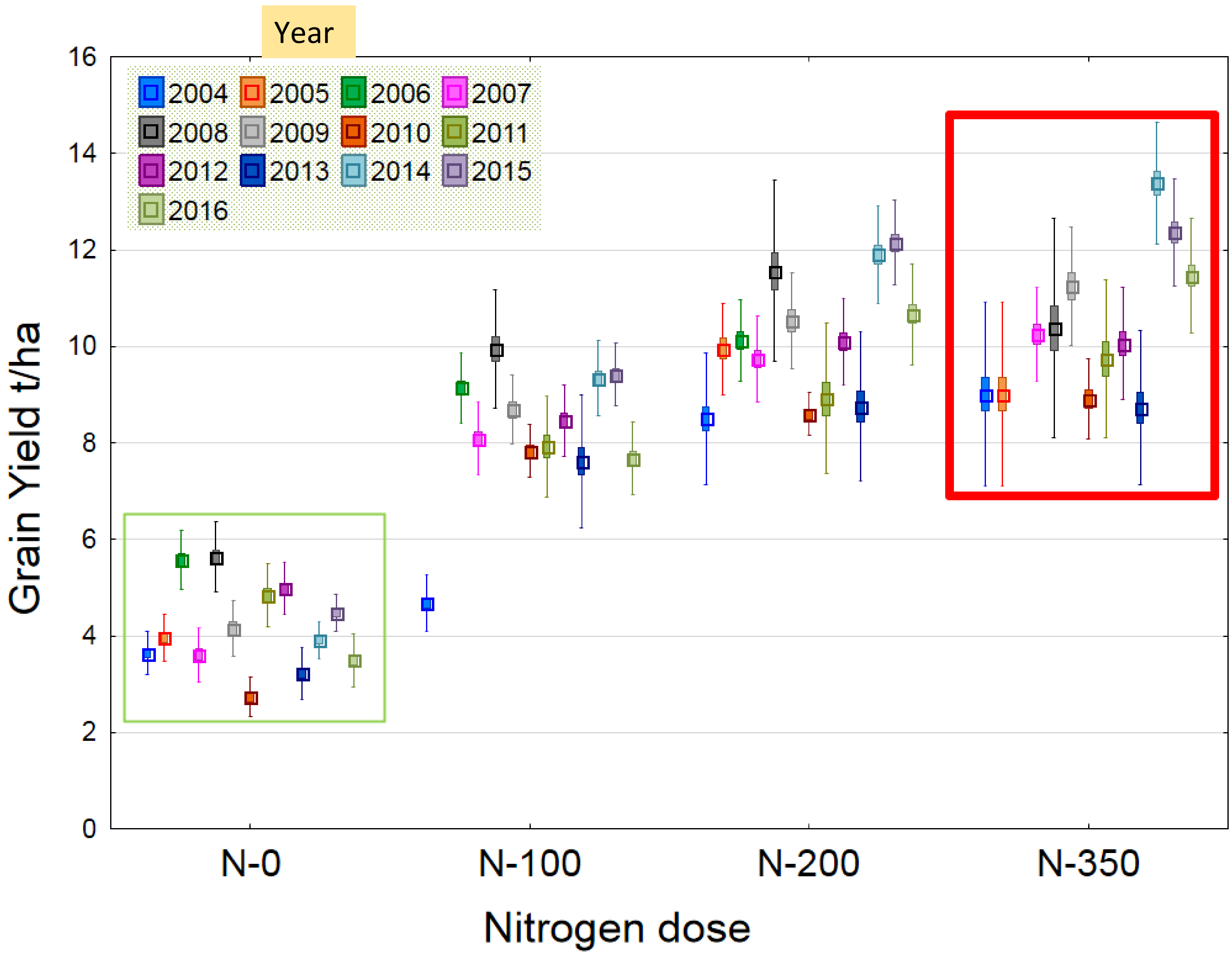
The influence of nitrogen dose on yield variability

ROTHAMSTED RESEARCH



WGIN Stakeholders 2016

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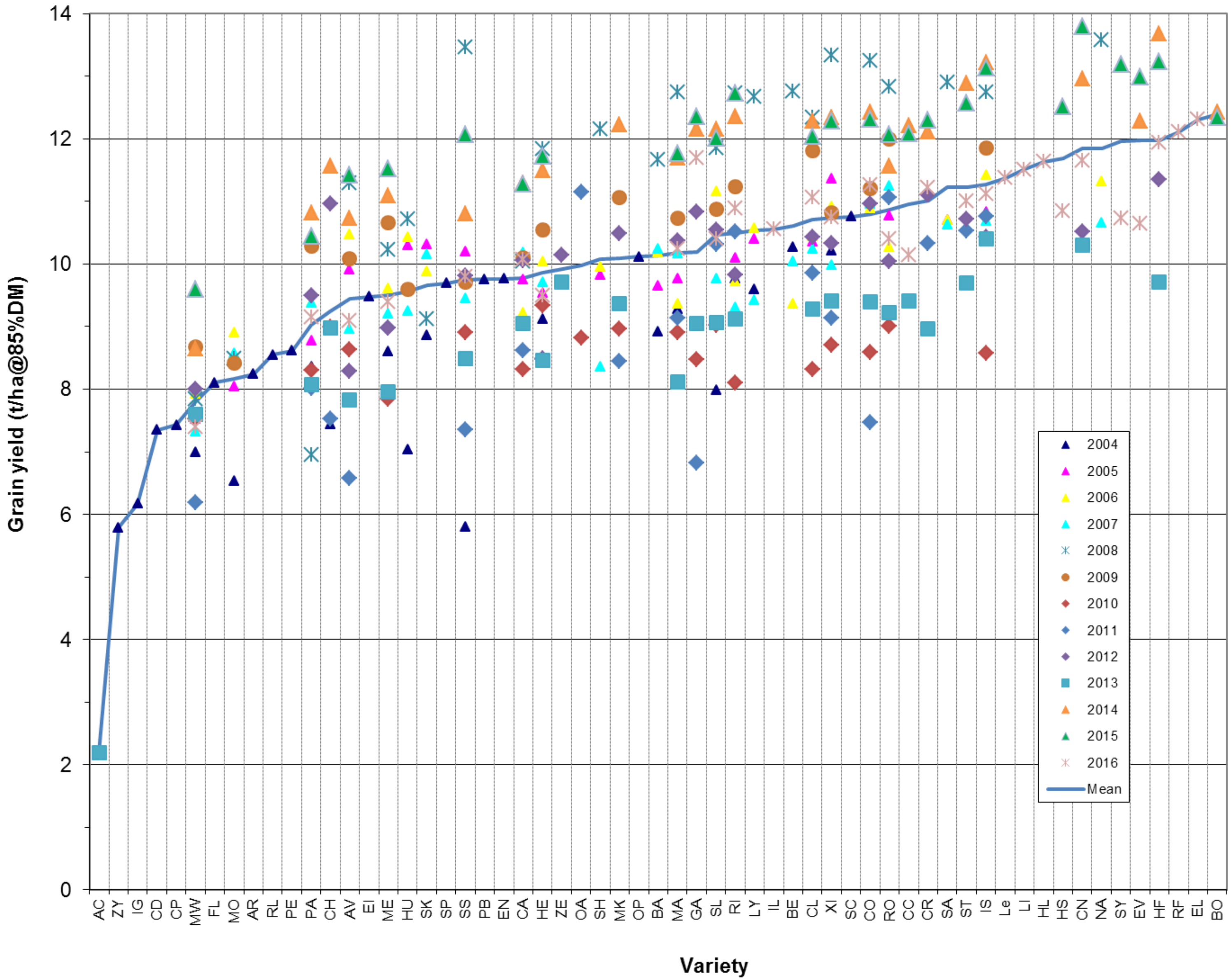
Yield stability: variety yields (200 kgN/ha) 2004-16



ROTHAMSTED RESEARCH

WGIN Stakeholders 2016

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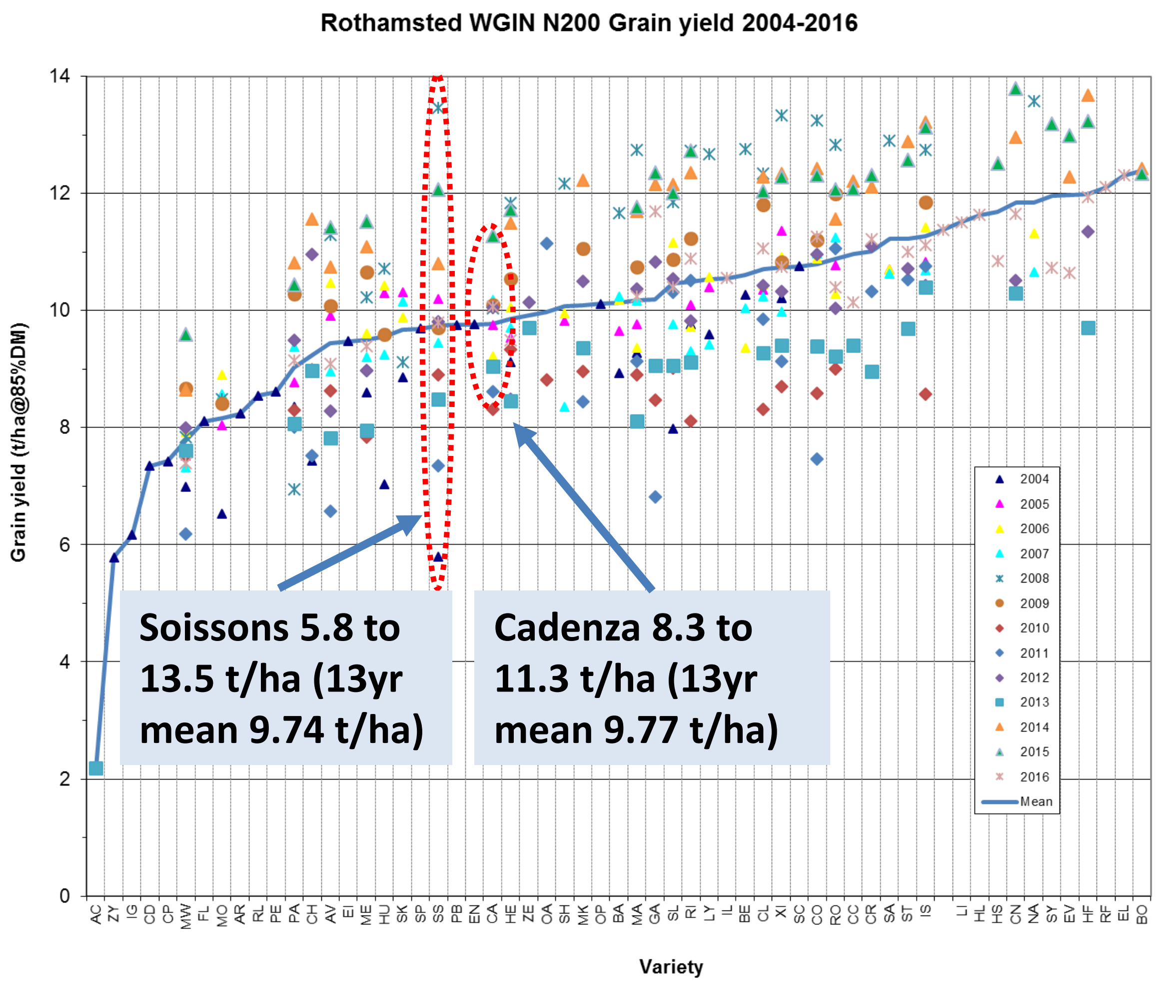
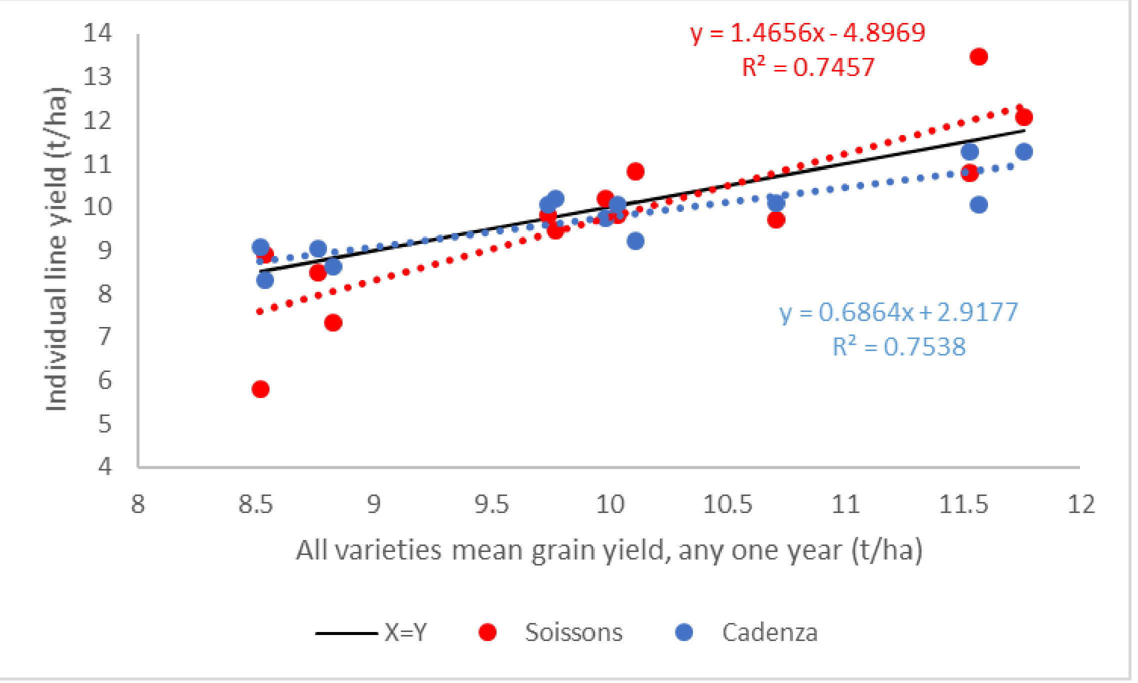
WGIN Grain yields

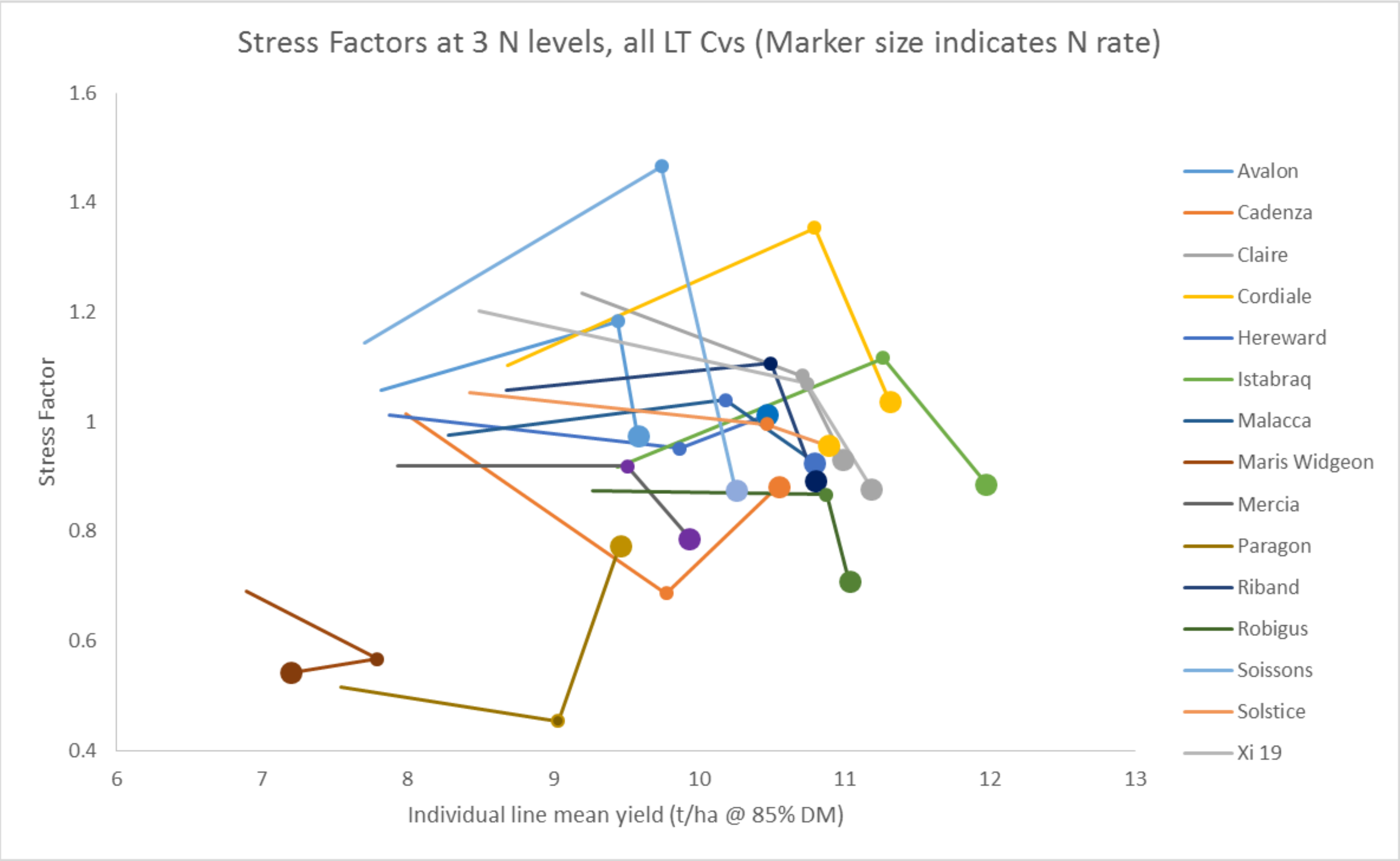


Stress index – indicator of yield variability

- Calderini and Slafer, 1999, Euphytica 107, 51-59.
- Plot individual line yield against mean of all varieties for each year
- The slope is the measure of stability or **the stress factor**
- A variety with yields equal to the mean of all varieties in all years will have a slope of 1
- Cadenza shows low responsiveness to the environment (**stable**), slope < 1
- Soissons shows high responsiveness to the environment (**unstable**), slope > 1



The stress factor is influenced by N



Drone technology: high throughput plot phenotyping

ROTHAMSTED RESEARCH

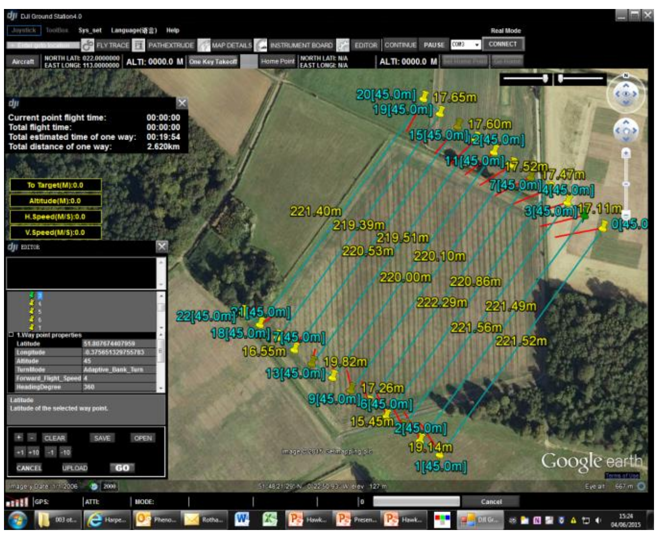


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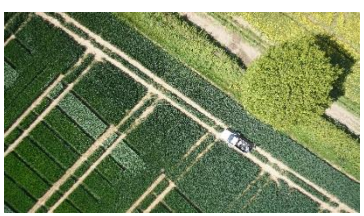
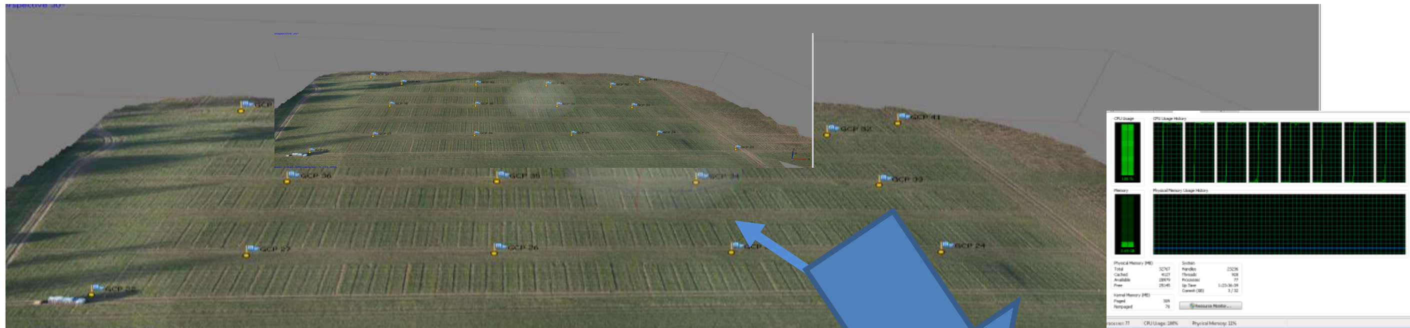
Image processing







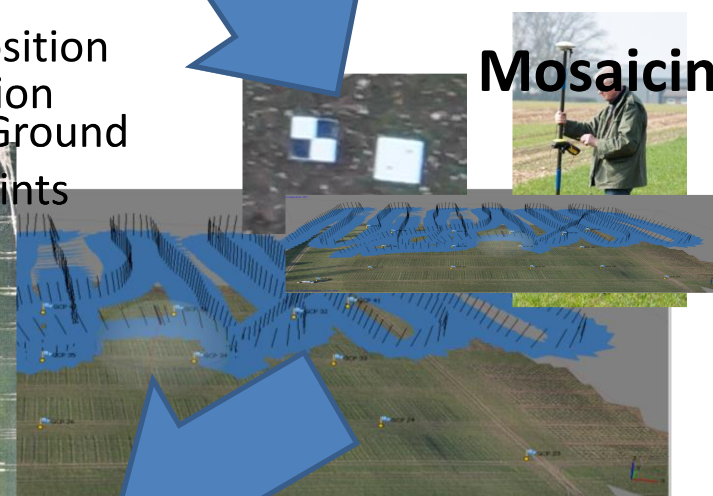
Geolocation



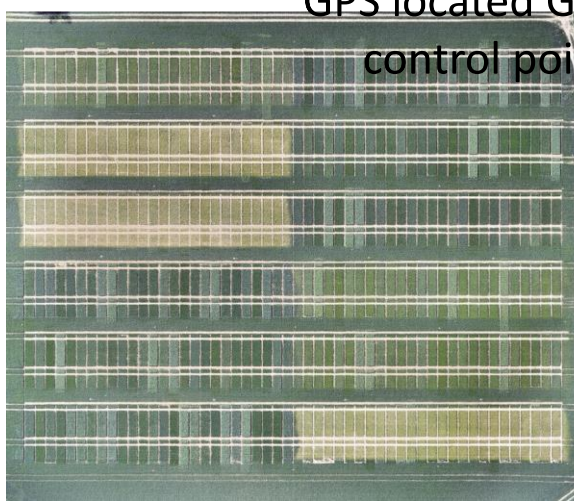
Automatic calaculation of position of each image

Mosaicing

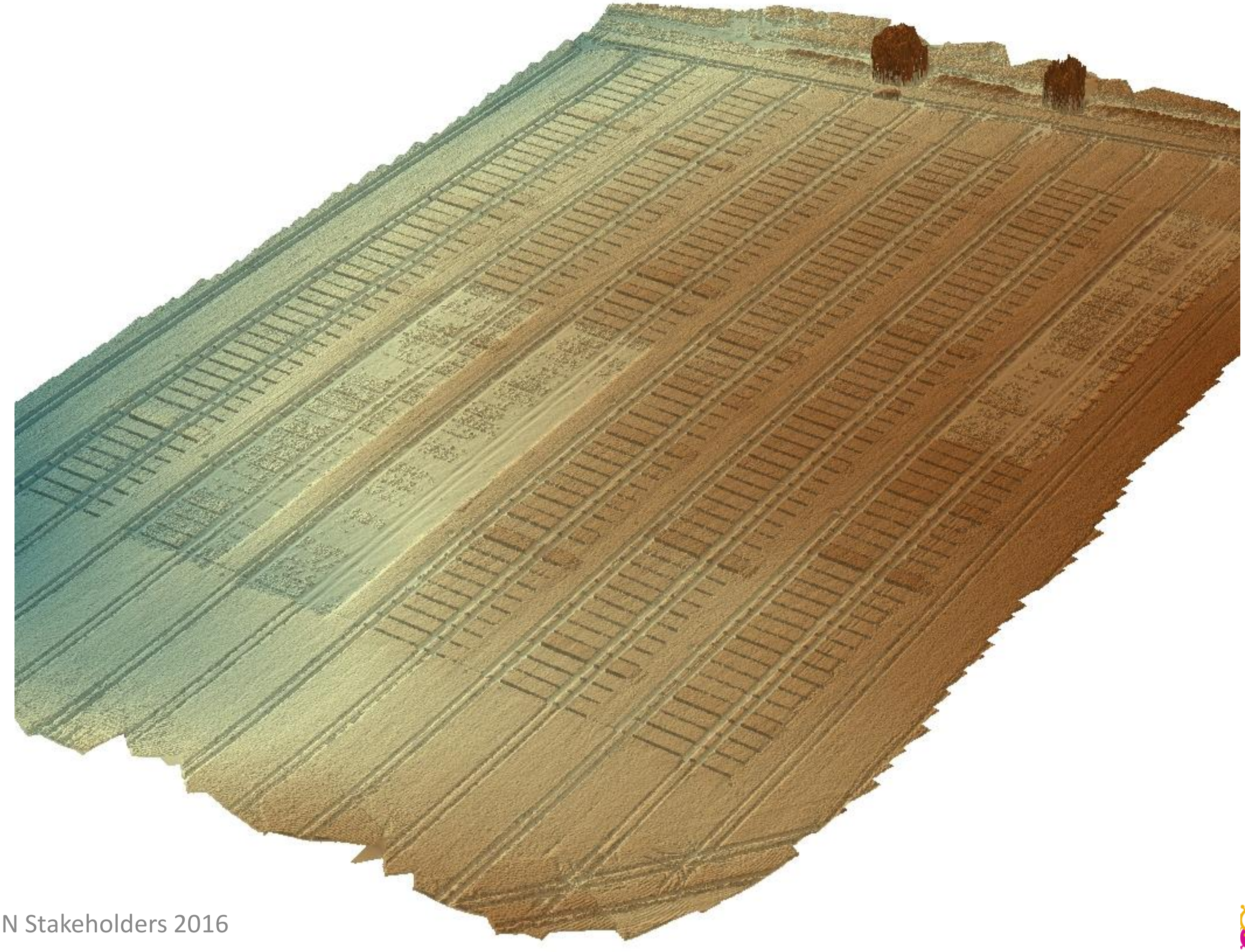
GPS located Ground control points



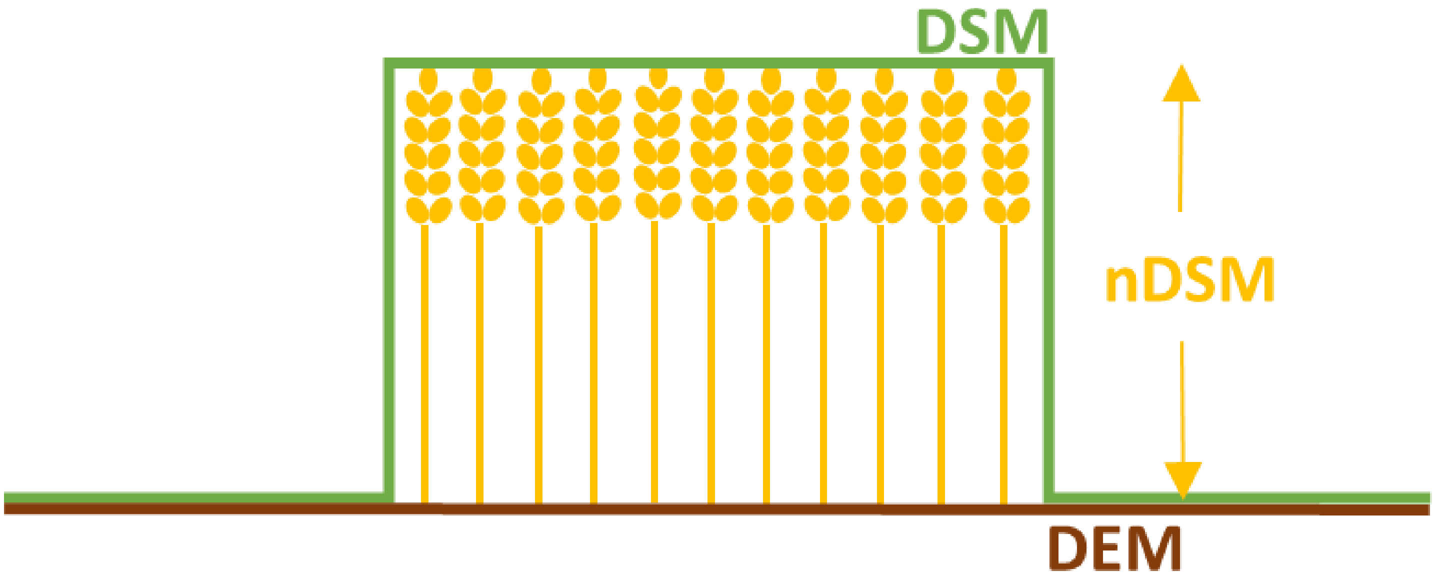
Final **geolocated orthomosaic** at 1cm resolution

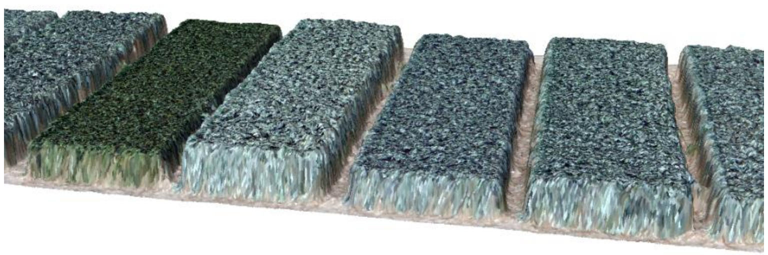


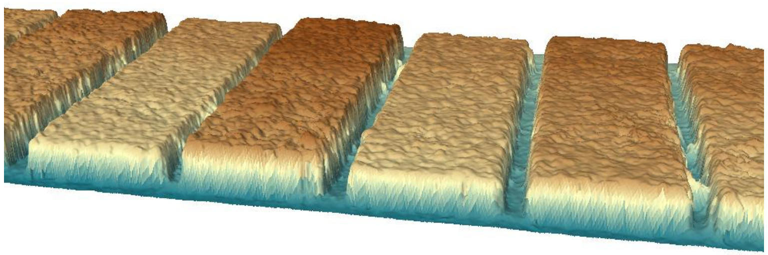
Height: create models from 800 photos



Plot heights from drones

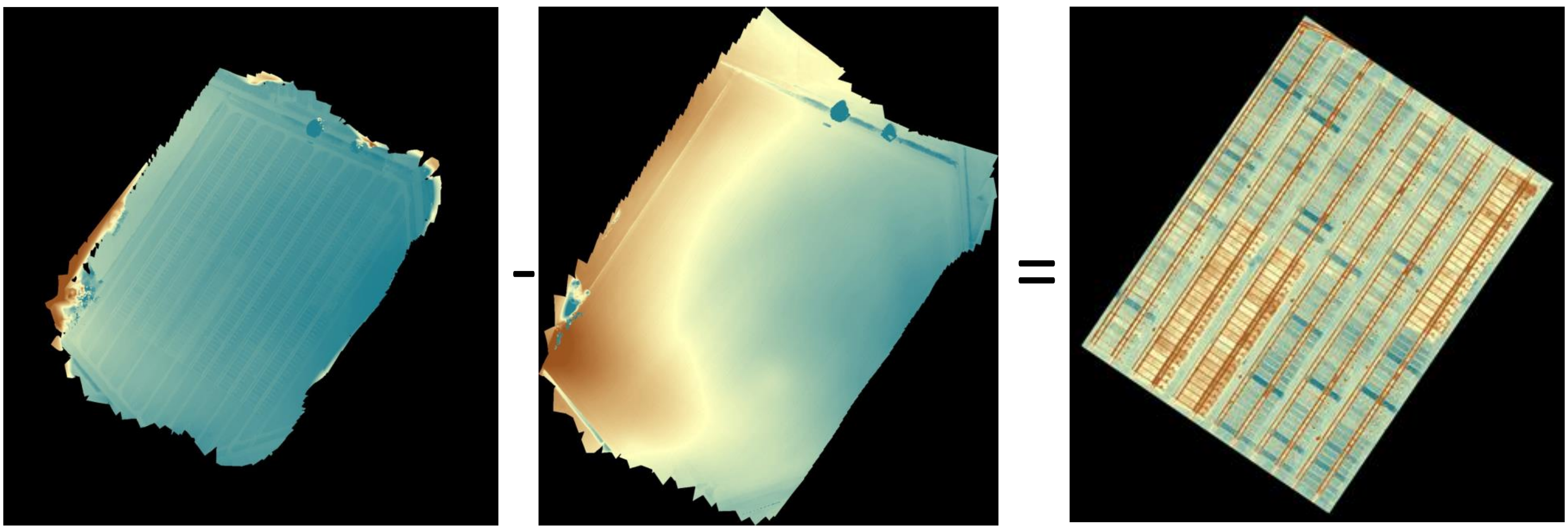






Processing

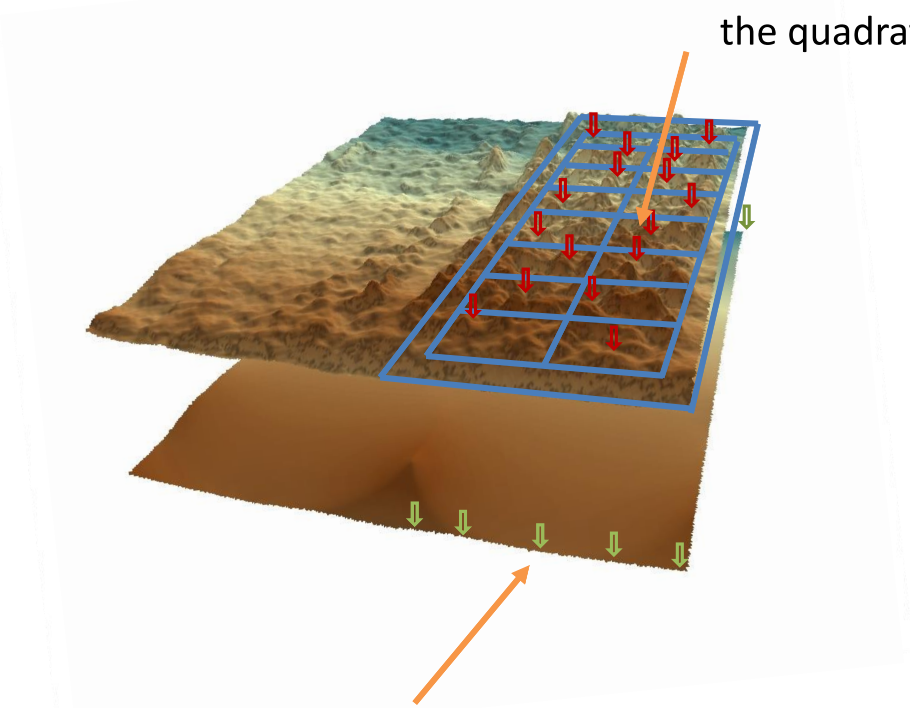
To create the Crop Surface Model subtract the bare ground DEM from the new DEM.



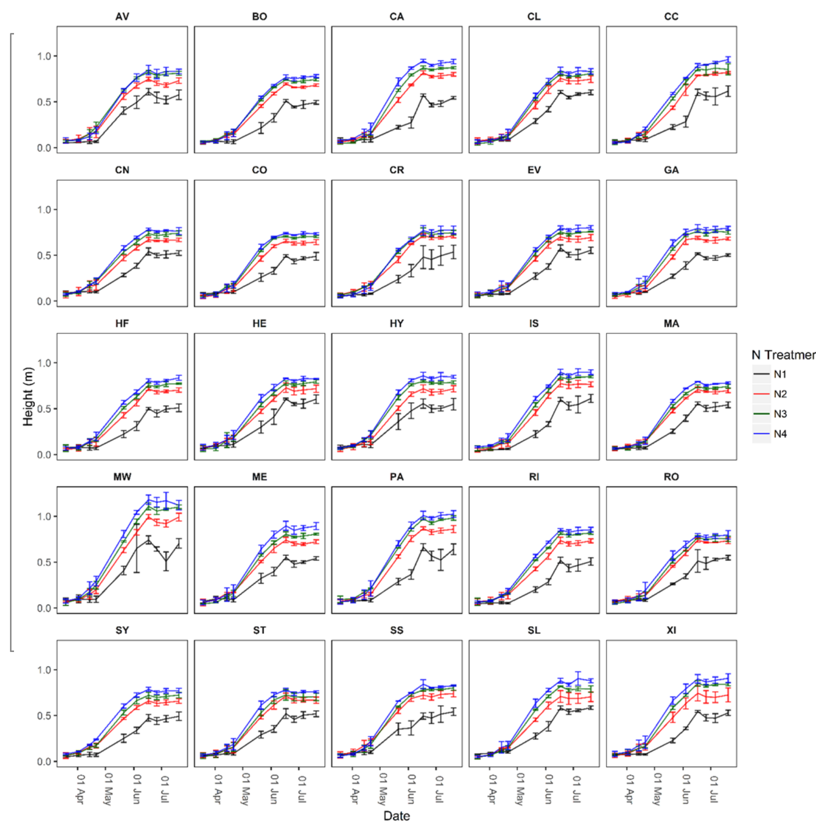
Measuring growth – Crop height

Centre of plot divided into 1m^2 quadrats

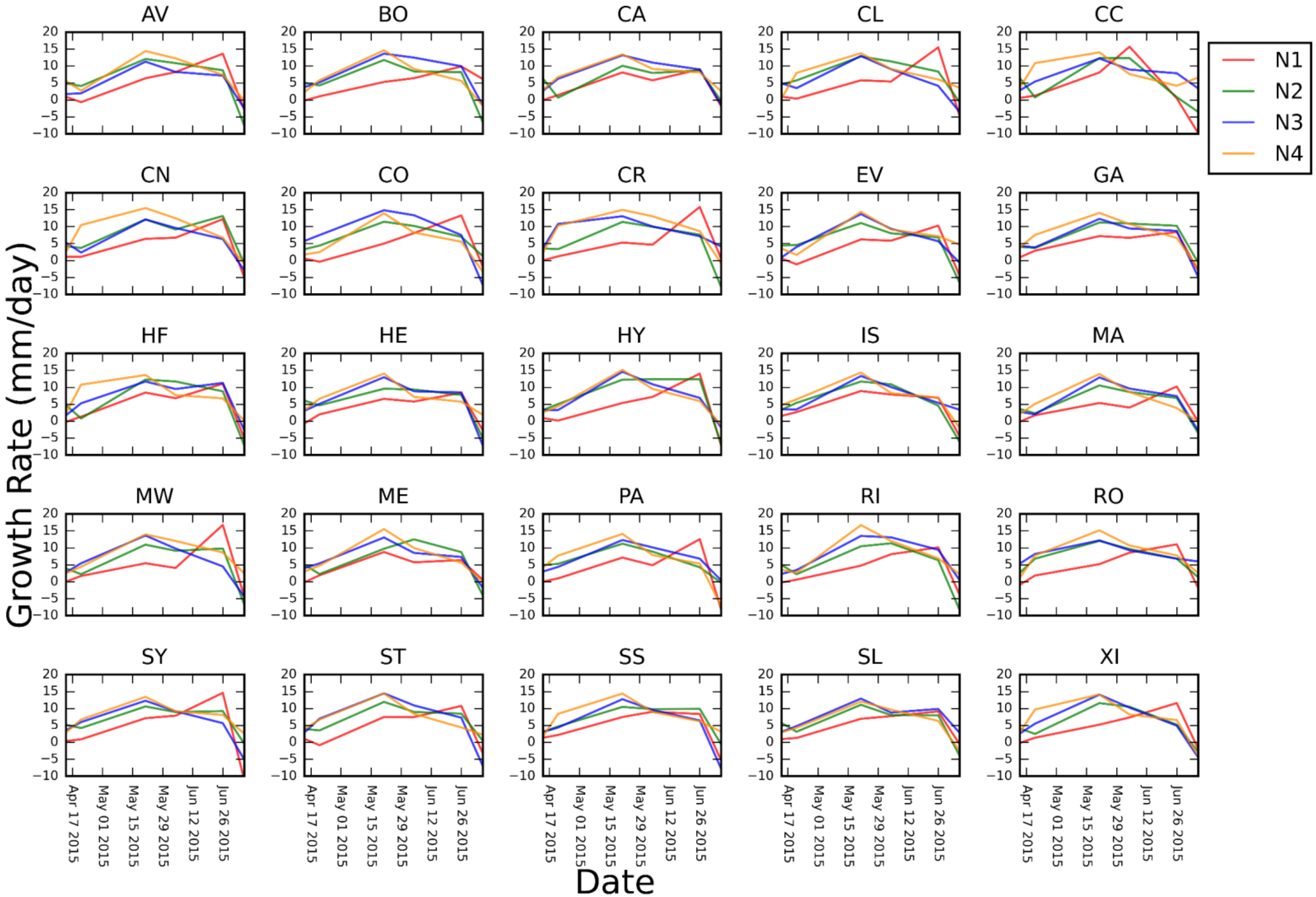
Maximum height within each quadrat extracted and then meaned across the quadrats



Ground height data extracted from bare ground border adjacent to plot, meaned across several data points



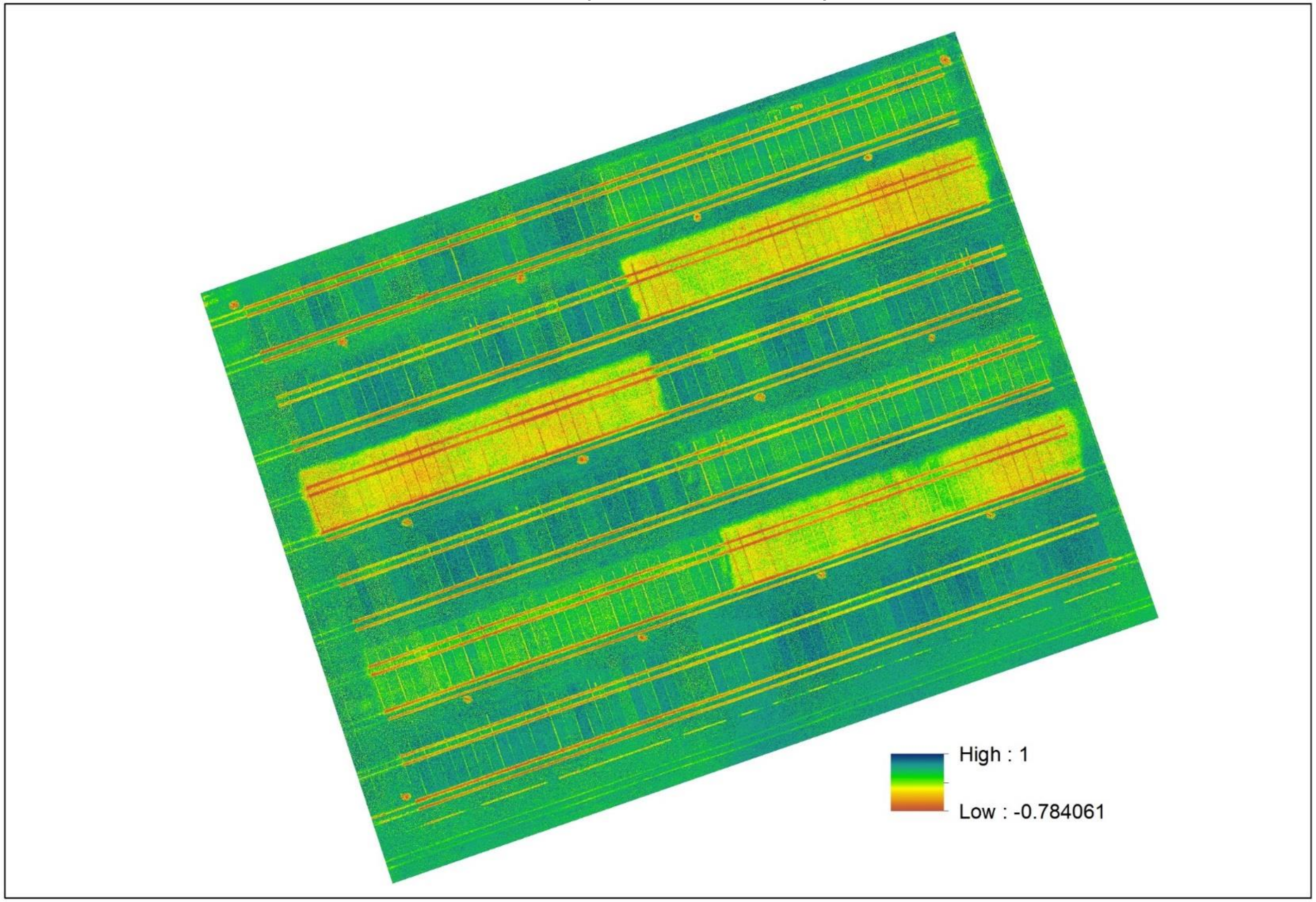
Growth rates



Plot canopy indices - NDVI

ROTHAMSTED RESEARCH

From RGB + modified (NIR sensitive) RGB cameras



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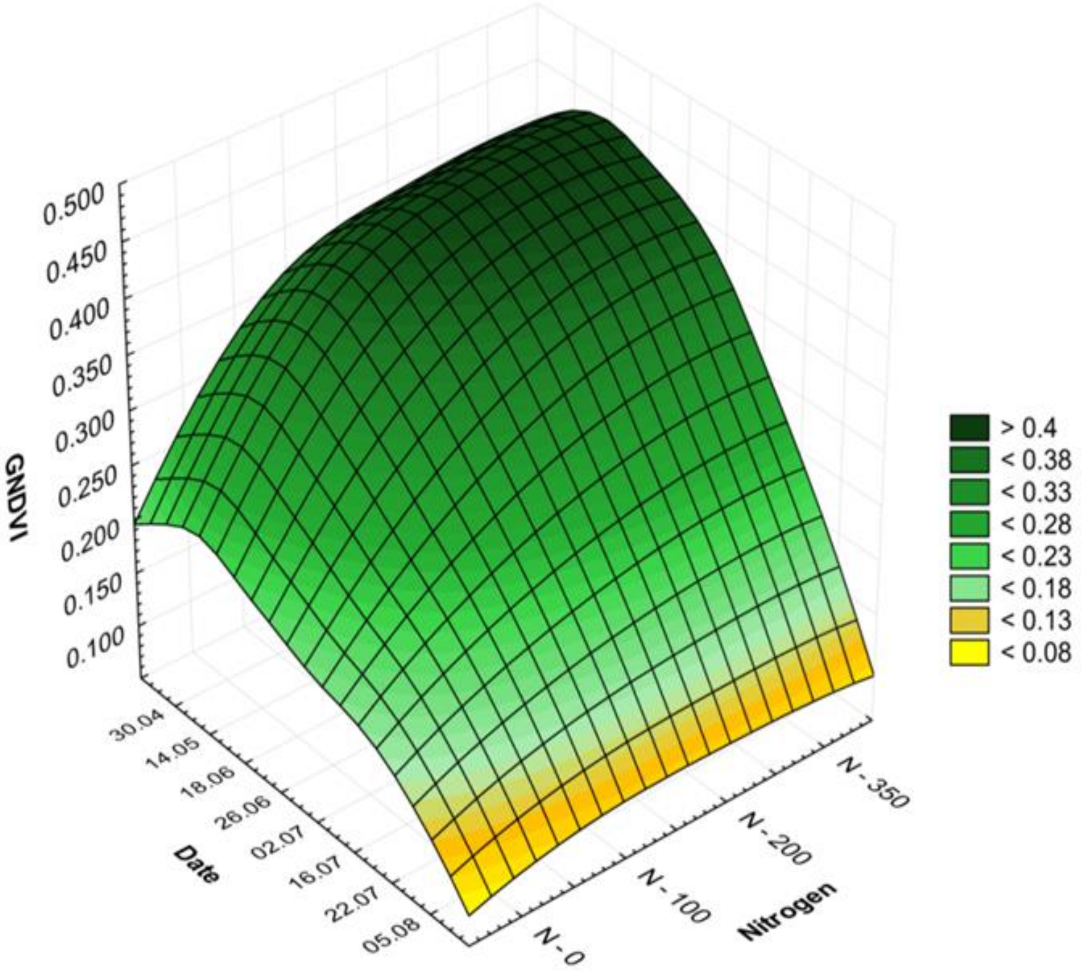
NDVI, senescence and crop maturation



Adam Michalski and Grzegorz Kulczycki

Robotic crop (trial) monitoring: ground based deep phenotyping

ROTHAMSTED RESEARCH

- High throughput – **automated**
- **24/7** operation
- High **spatial** and dense **temporal** information capture
- **Range of sensors** to measure crop/individual plant growth, development and health
- **Mini-WGIN trial**

BBSRC bioscience for the future

Ear counts, developmental stages etc

ROTHAMSTED RESEARCH

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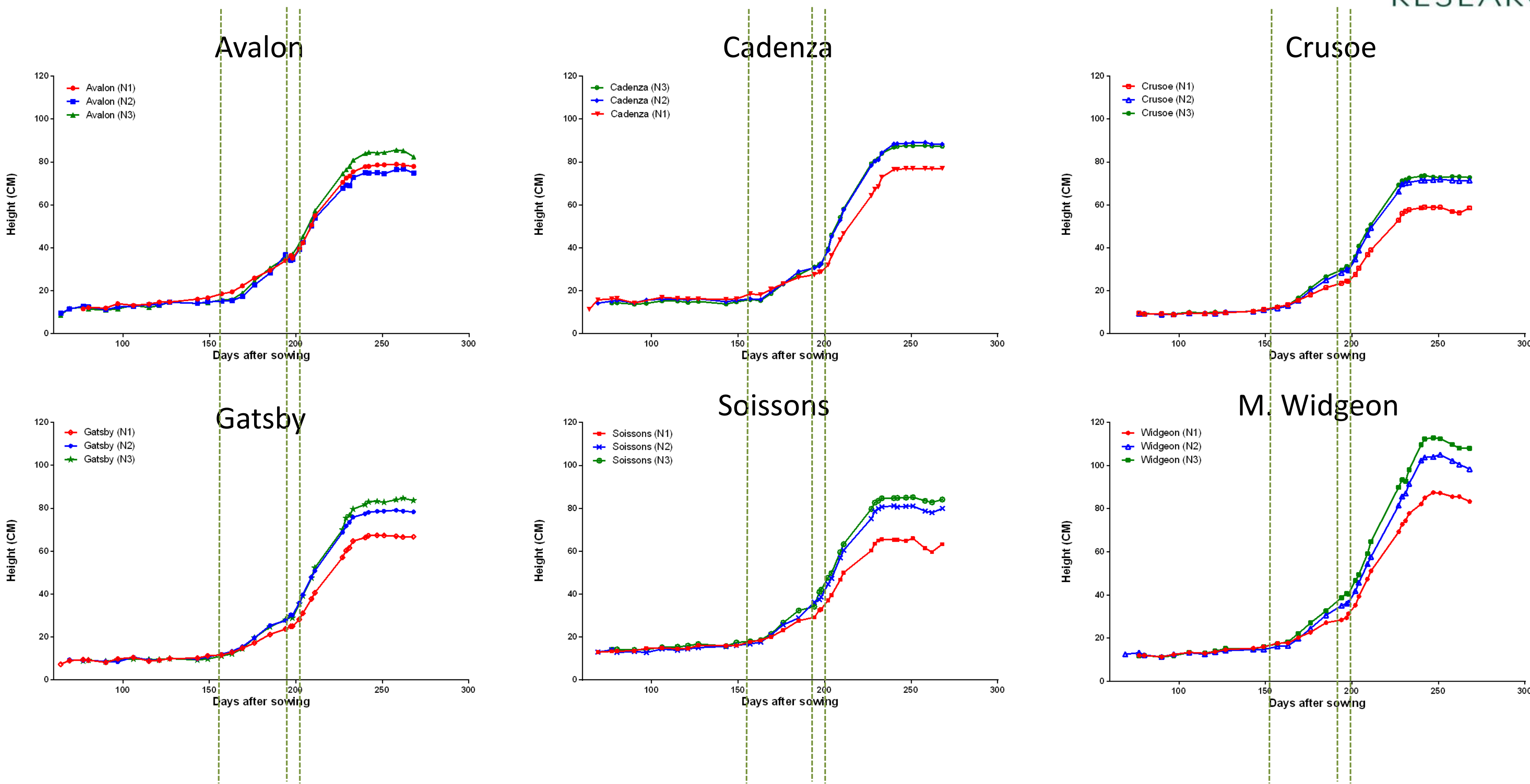
Crop height determination from laser imagery

ROTHAMSTED RESEARCH



0kg/ha N 100kg/ha N 200kg/ha N

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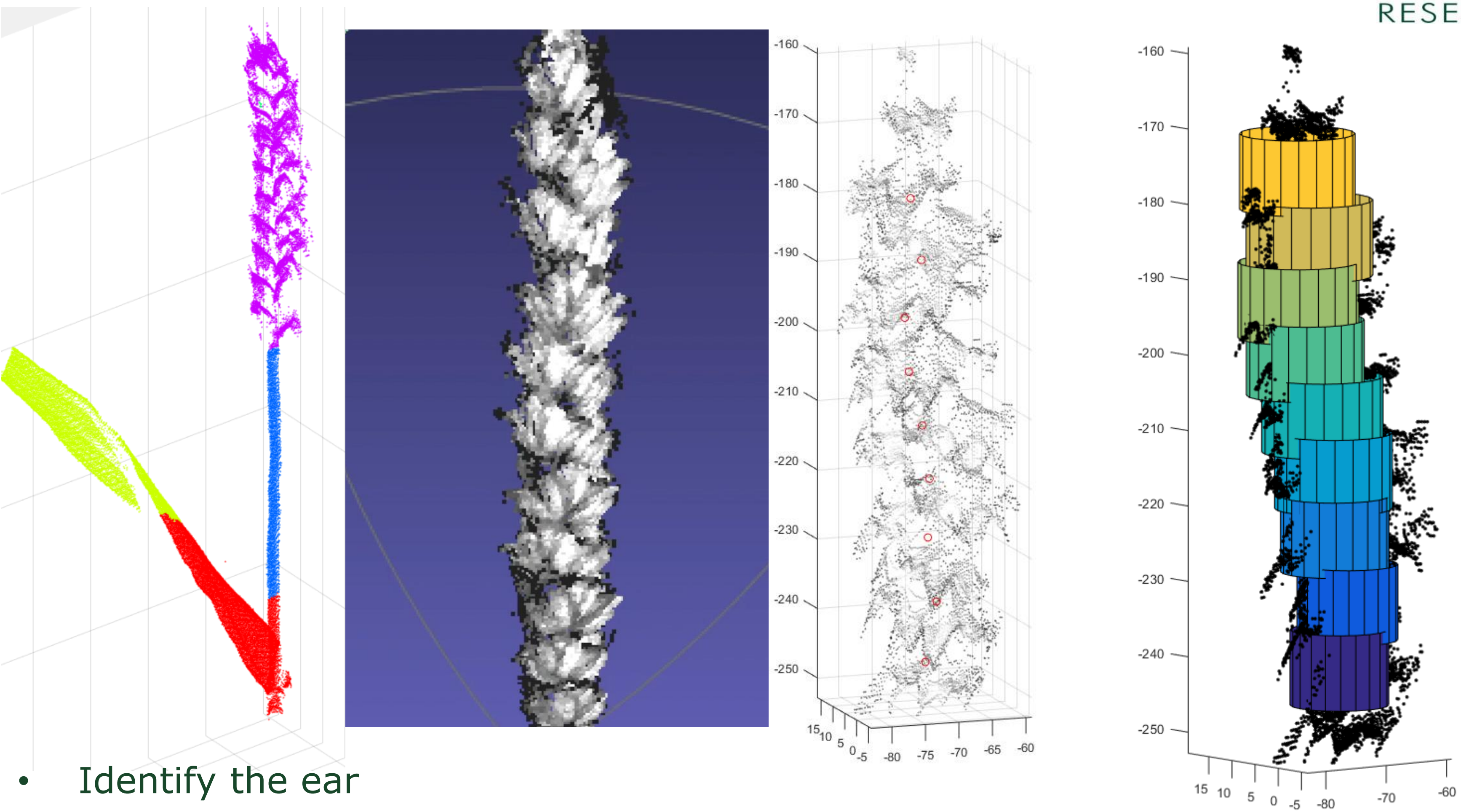
Ear Growth Measurement



- Identify the ear
- Segment
- Polar coordinates and radius

Thanks

- **WGIN team: Peter Shewry, Kim Hammond-Kosack, Simon Griffiths**
- RRes Farm
- Peter Barraclough, Andrew Riche, Peter Buchner, Saroj Parmar, Yongfang Wan, Caihong Bai, Astrid Grün, Nick Evens, George Savill, March Castle, David Steele, Adam Michalski
- Pouria Sadeghi, Kasra Sabermanesh, Nicolas Virlet
- Grzegorz Kulczycki (U. Wroclaw)
- Martin Wooster and Fenner Holman (King’s College, London)