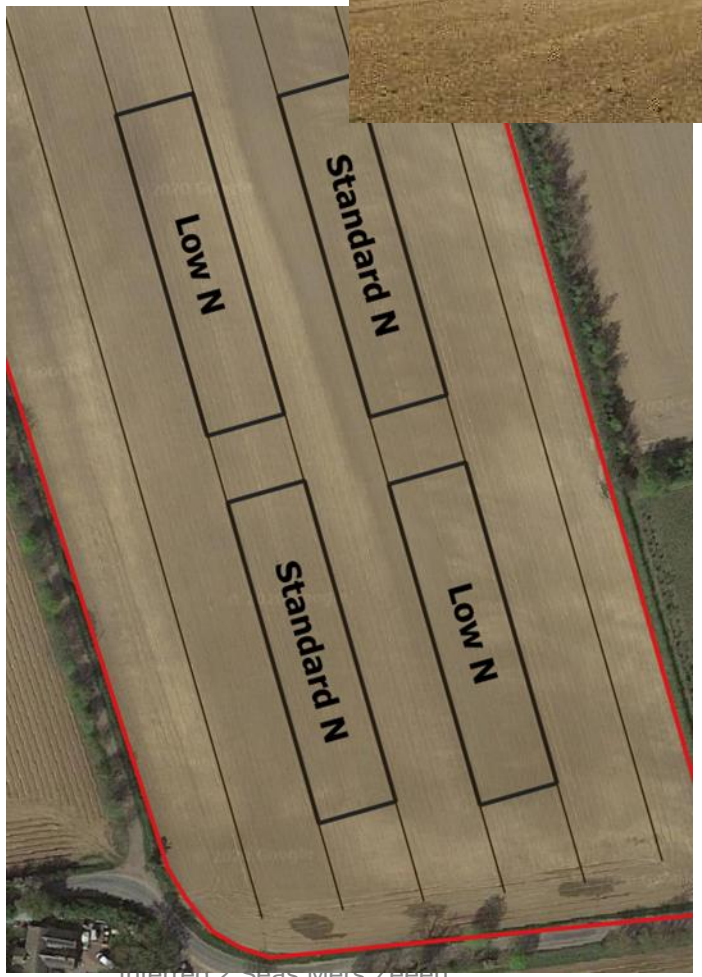
Framework conditions for innovation

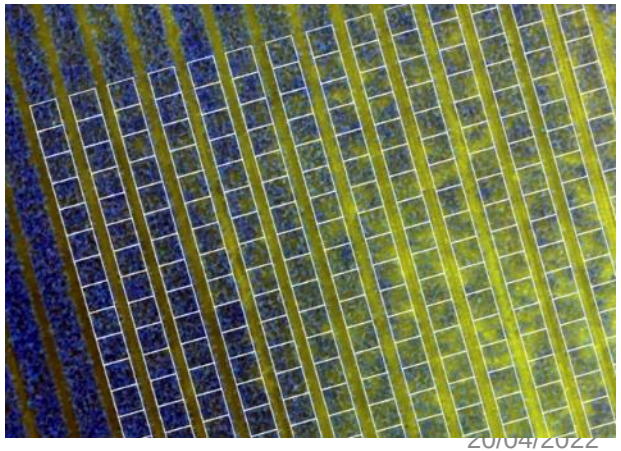
Using crop sensing data to assess field scale experiments in vegetable crops

Case studies from the INNO-VEG project on vining peas & onions

Field scale field experiments (2020 & 2021)

- Field scale farmer led experiments
- Farmers apply treatments
- Collect crop reflectance data
- Use spatial statistics to analyse data’





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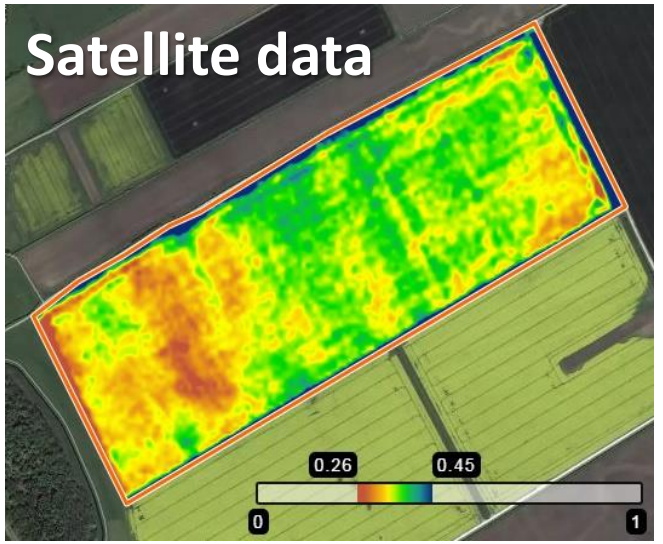
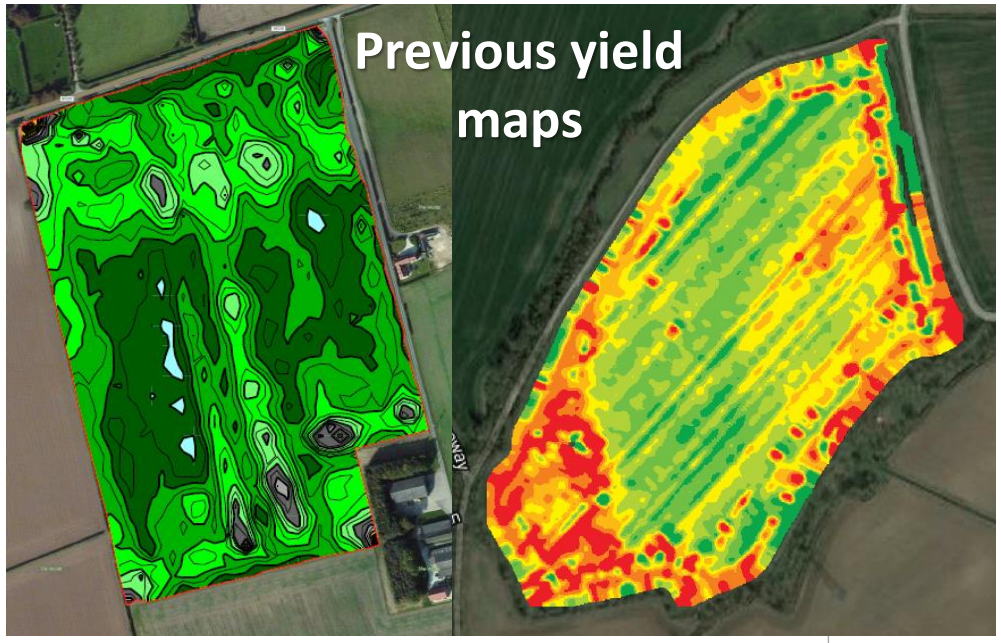
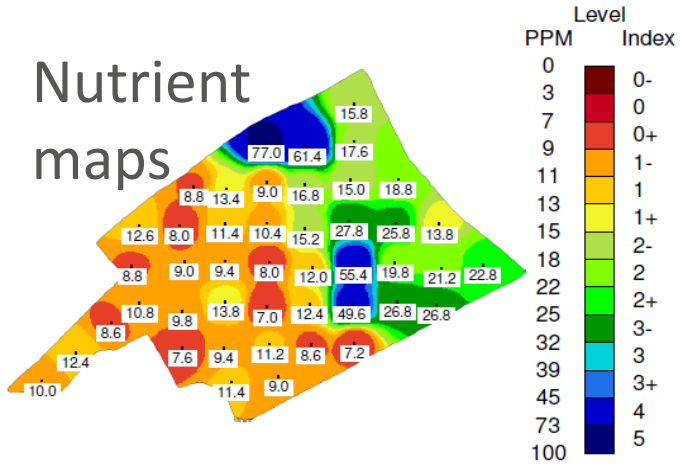
Field choice

- Even fields give more precise results
- Variation across the tramlines is acceptable
- Variation in line with the tramlines is a problem







Trial design

- Avoid confounding treatments with underlying variation
- Best to test fewer treatments
- Replication improves precision / confidence

Two test treatments interspersed with farm standard

Case study 1: Onions

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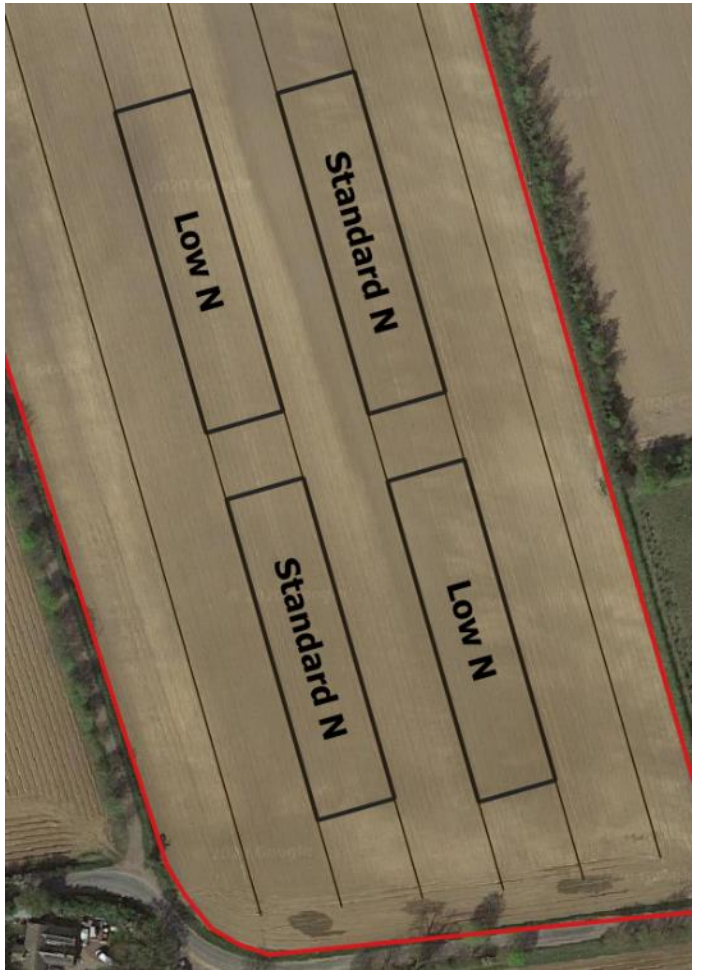
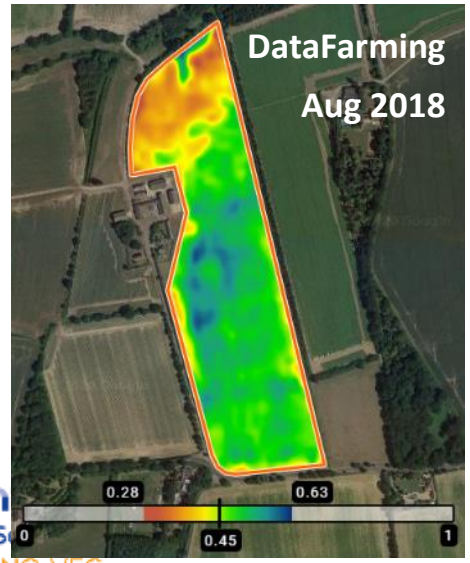
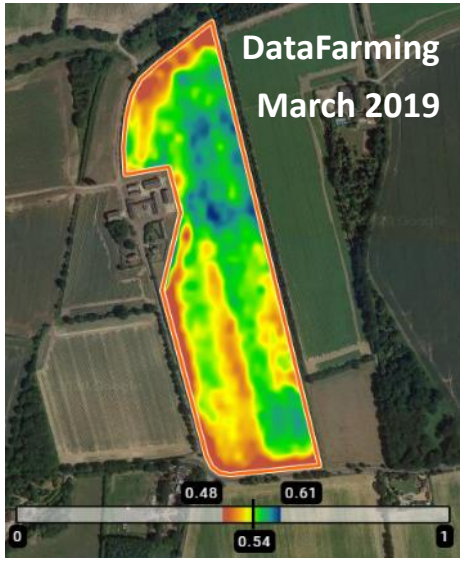
- Research question: impact of N fertiliser rate
- Trial design:
  - Two replicated N rate treatments
  - Trial focused in south end of field as more even



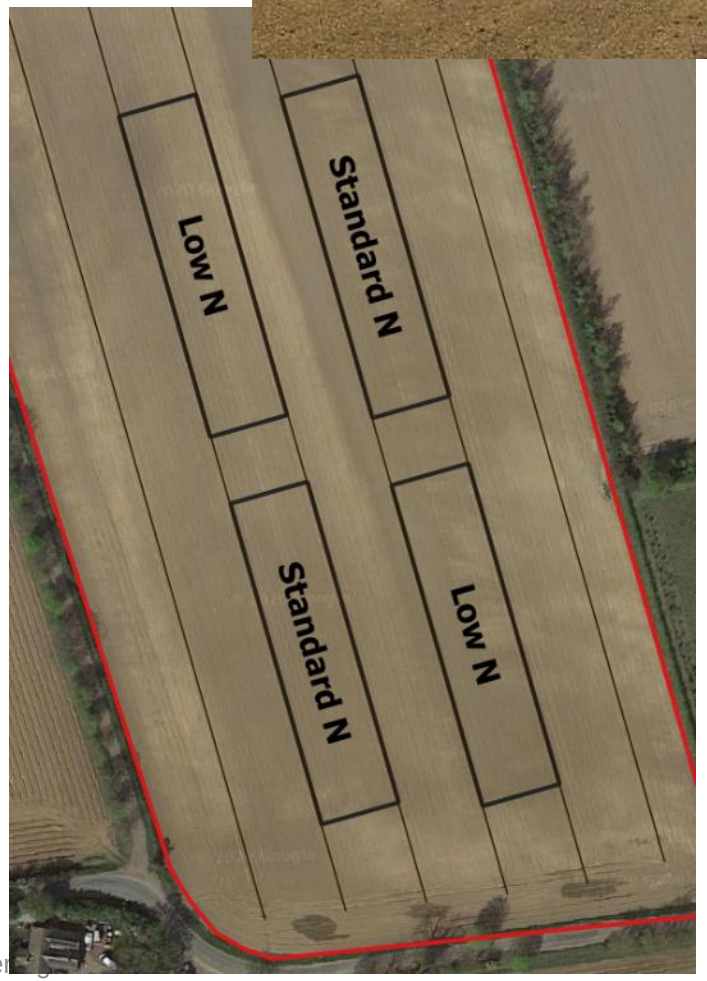




Onions – treatment application

- Two treatments
  - Standard N – Farm standard rate 130 kg N/ha
  - Low N – reduced rate of 40 kg N/ha
- Treatments applied to plots 24 x 100 m

Treatment	Nitrogen rate (kg N/ha)	Application timing (kg N/ha)		
		T1 (21-Apr)	T2 (14-May)	T3 (12-Jun)
Low Nitrogen	40	40	0	0
Farm Standard Nitrogen	130	40	50	40



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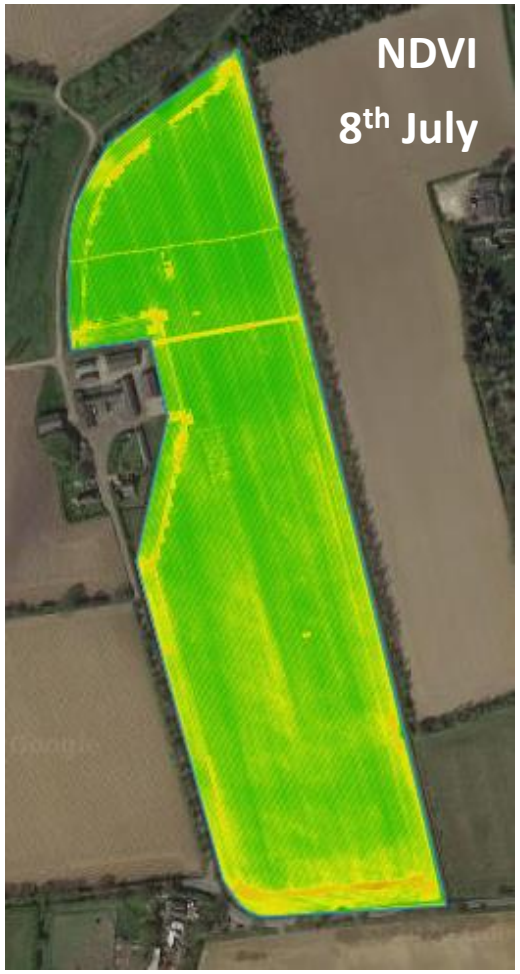
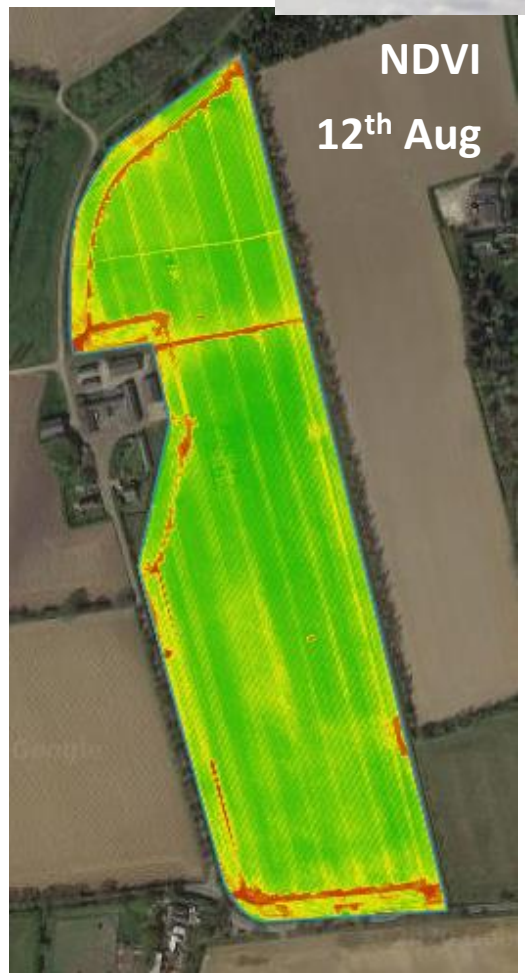
Onions – new drone imagery

- Multispectral images supplied for 8th July and 12th August
  - 5 wavelengths from MicaSense Red Edge drone mounted sensor
- Low N areas visible as lower NDVI





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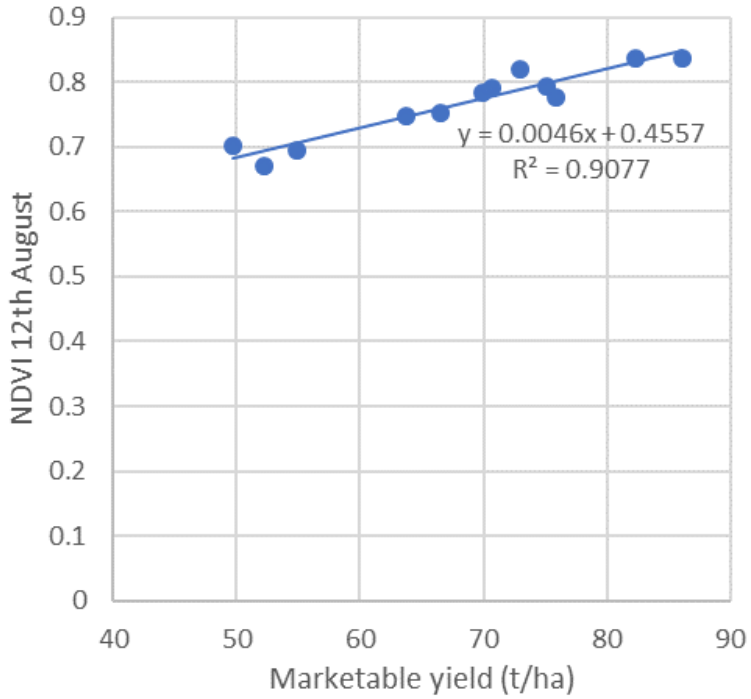
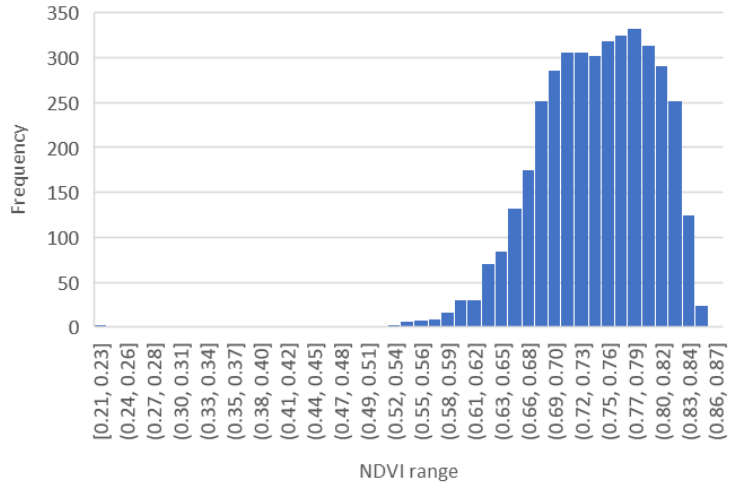
Onions – ground truthing

- 12 yield validation plots (3 per plot); 1 bed x 8m
- Sampled mean MS bands for each sample plot
- Calculated VIs from averaged MS bands
- Correlated VIs with marketable yield

	1st flight (8 July)	2nd flight (12 Aug)
NDVI	0.89	0.91
MCARI2	0.75	0.82
Clgreen	0.90	0.87
Clrededge	0.87	0.84
MTCI	0.84	0.50
NDRE	0.89	0.86
REIP	0.89	0.48



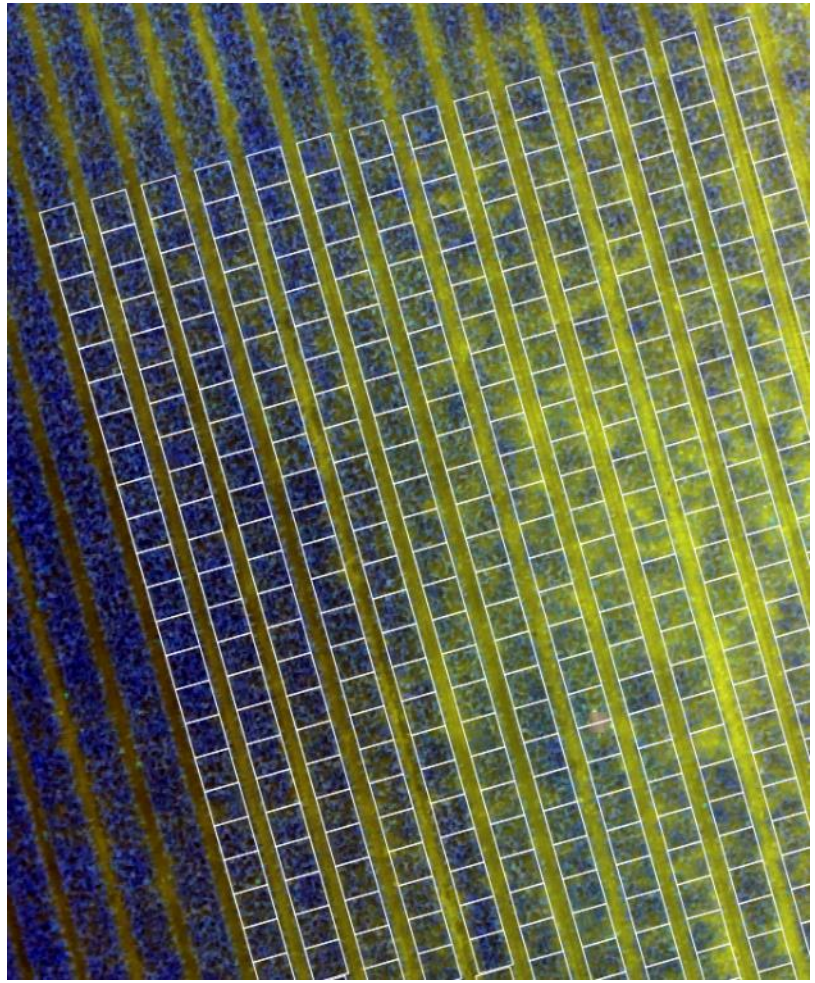


Onions – data processing

Agronomics analysis requires point data (<12,500 points)

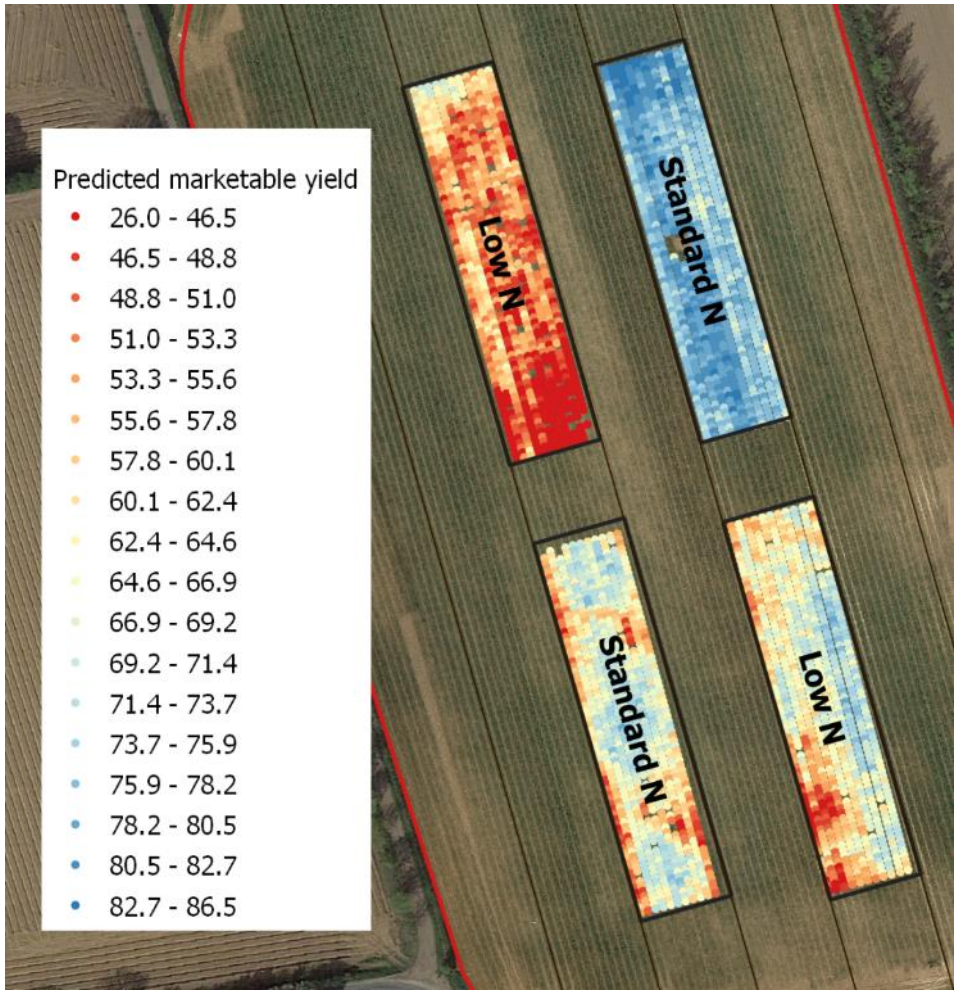
Crop grown in beds 1.5m wide with 0.5m gaps

1. Created grid of cells 1.3m wide x 1.3m long
2. Placed cells along beds, avoiding bare soil
3. Mean values for each wavelength calculated for each cell, then converted to points
4. Vegetation indices calculated from averaged data



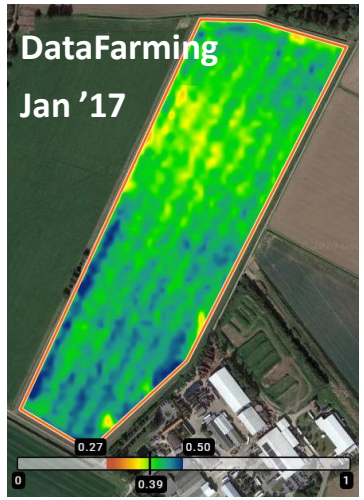
Onions – trial results

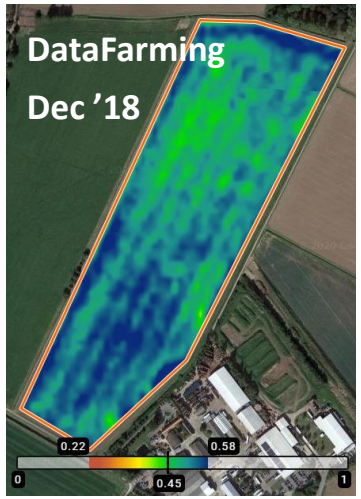
- Predicted yield map created from NDVI (second drone flight), according to correlation with sample plot yields.
  - Average yield at standard N: 71.2 t/ha
  - Yield benefit of standard N rate over low rate: 12.9 t/ha ± 1.4 (95% confidence interval)
- Vegetation indices also analysed directly
  - All VIs from both flights significantly higher for standard N rate than low rate



Case study 2: vining peas

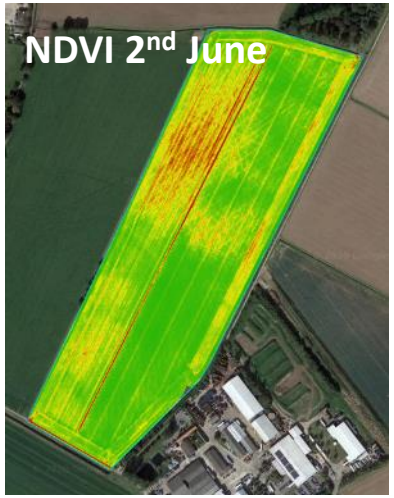
- Research question: impact of starter fertiliser
- Five unreplicated fertiliser treatments
- Plots one tramline (36m) wide
- RGB and NDVI images of previous crops show persistently poor area in NW corner

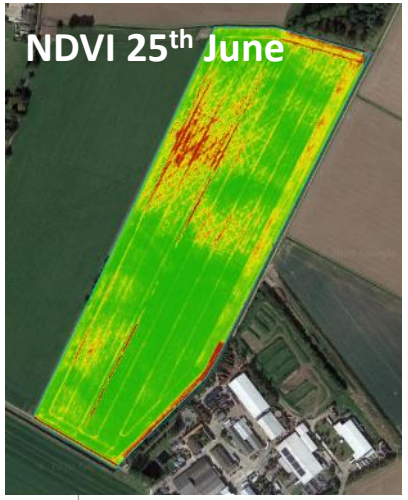




Vining peas – new drone imagery

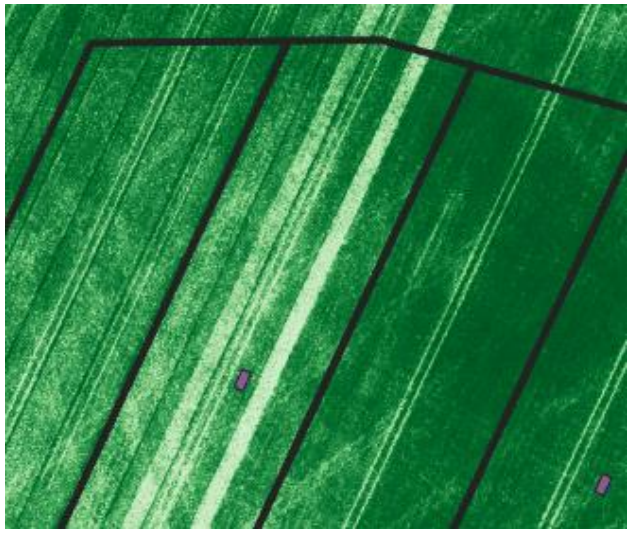
- Poor patch in northwest corner persisted in 2020
- Additional variation not noted in previous crops: low NDVI coinciding with treatments 1 & 2
- Multispectral images 9th June and 25th June included reflectance at five wavelengths



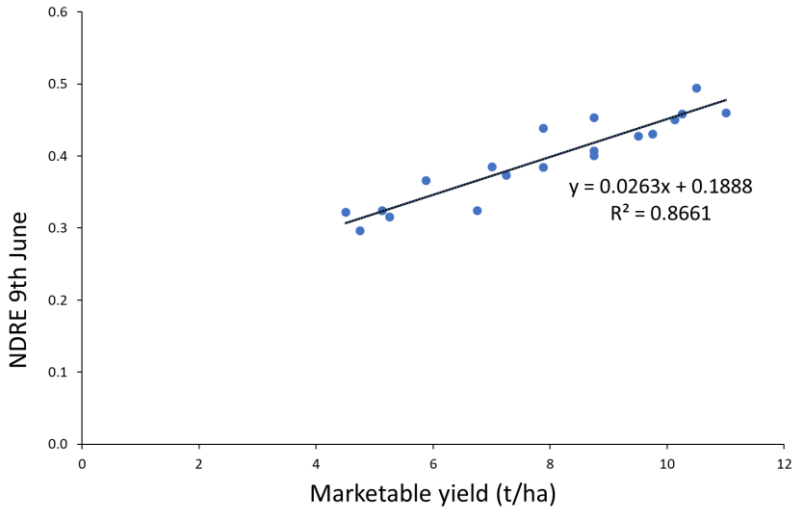


Vining peas – ground truthing

- 20 yield validation plots (4 per treatment); 2m x 4m
- Sampled mean MS bands for each sample plot
- Calculated VIs from averaged MS bands
- Correlated VIs with sample plot marketable yields



	1st flight (9 June)	2nd flight (25 June)
NDVI	0.86	0.70
MCARI2	0.83	0.77
Clgreen	0.85	0.71
Clrededge	0.85	0.71
MTCI	0.81	0.67
NDRE	0.87	0.70
REIP	0.85	0.62



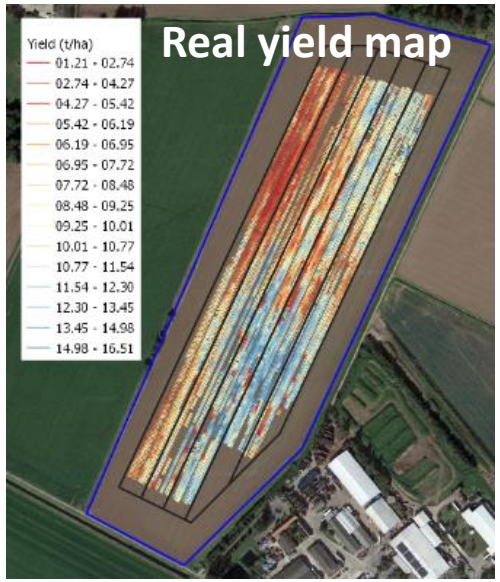
Vining peas – trial results

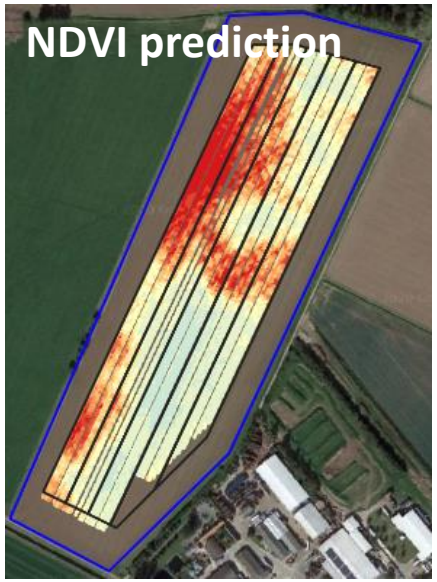
- Yield map supplied by farmer, using fleet of bespoke yield mapping viners.
- Predicted yield maps created from NDRE and NDVI (first drone flight), according to correlations with sample plot yields.
- Results very similar, but far more precise with predicted yields

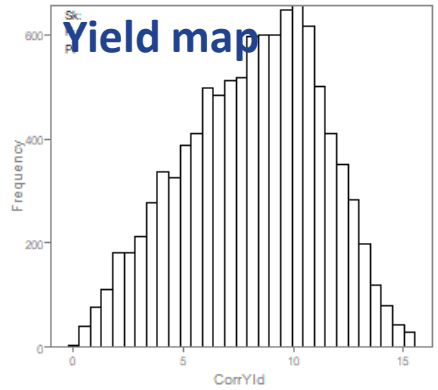
	Yield from yield map	
Treatment	Mean	Modelled difference from trt 3, with 95% confidence interval
1		-3.29 ± 1.44
2		-1.25 ± 1.35
3	9.76	
4		0.41 ± 1.31
5		0.03 ± 1.39

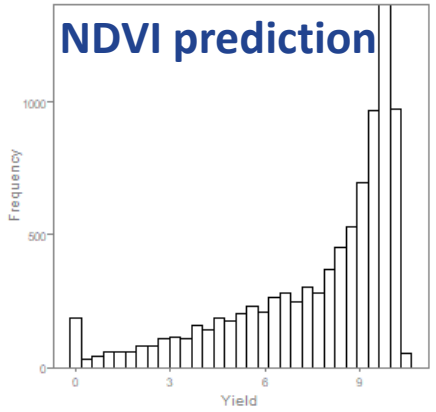
Vining peas – real vs predicted yield maps

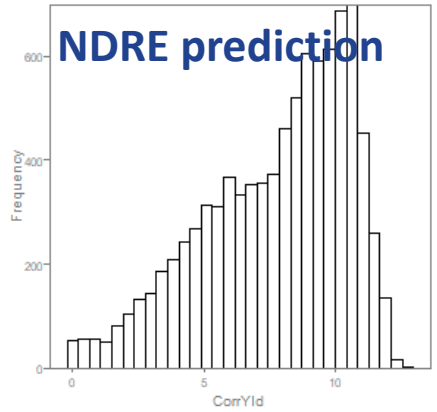
- Real yield map may overestimate field average, as data cleaning removes wheelings, poor patches, etc.
- NDVI prediction underestimates high yields due to saturation.
- NDRE prediction appears closest to real yield map.











Conclusions

- Crop reflectance data can correlate well with marketable yield
- Field scale experiments can be assessed accurately and efficiently using remote sensing data and Agronomics statistics
- Trials should be laid out with reference to underlying soil variation
- Treatments should be replicated where possible
- Project is developing a '*Framework for farmer led research*'

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Thank you

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