



# Evaluating bean crops and yield influencing factors with Hummingbird

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Hummingbird  
Technologies

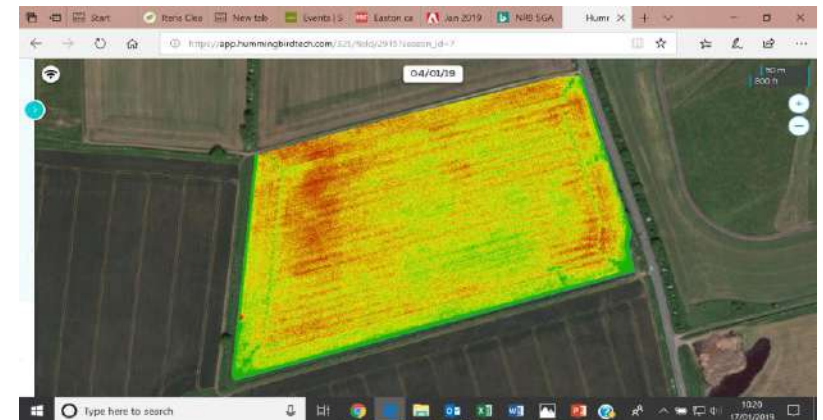


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# Objectives



- Develop bespoke remote sensing and data analytics solutions for beans and peas, using satellite and UAV imagery
- Better determine and quantify the factors that contribute to yield in beans and peas
- Provide information to growers to optimise productivity and profitability



# 7 bean Sites



- 3 Winter Bean sites
  - Oxfordshire
  - Lincolnshire
  - Cambridgeshire
- 4 Spring Bean sites
  - Bedfordshire
  - Rutland
  - Lincolnshire
  - Warwickshire
- All sites were included in the first year of the Bean Yield Enhancement Network







# Ground-truthing



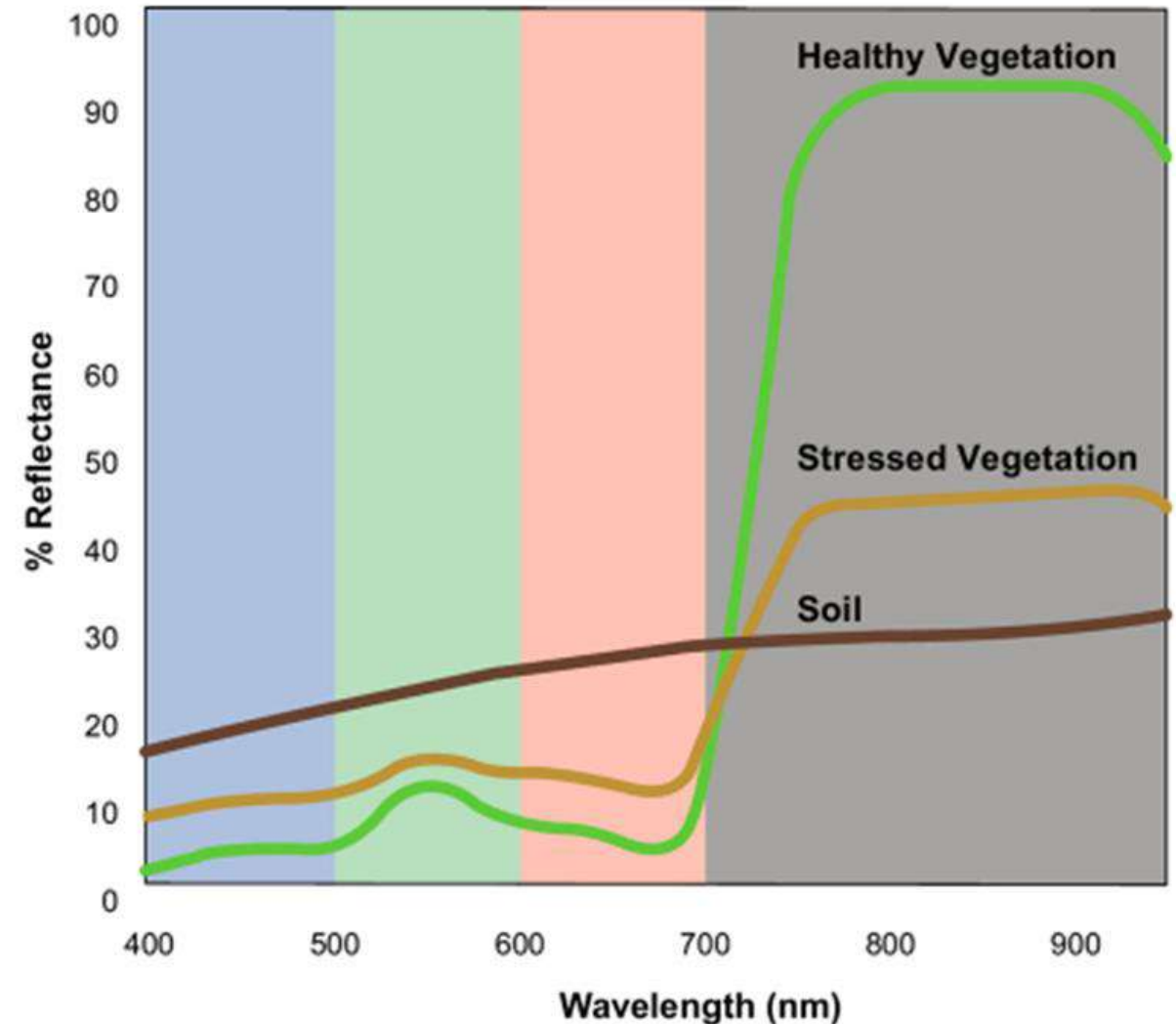
- Soil analysis – pH, P, K, Mg, Cu, B, Na, Zn, Ca, Mo, Fe, OM, S, Mn, CEC
- VESS – visual evaluation of soil structure
- Compaction
- Soil Temperature
- Soil Moisture
- Soil Texture
- Emergence counts
- Three tissue analyses at early, mid and late flower, measuring the same nutrients + N
- Pest, disease and weed assessments
- Soil temperature, moisture and crop growth stage at each visit
- Harvest samples at each point



# Normalised Difference Vegetation Index (NDVI)

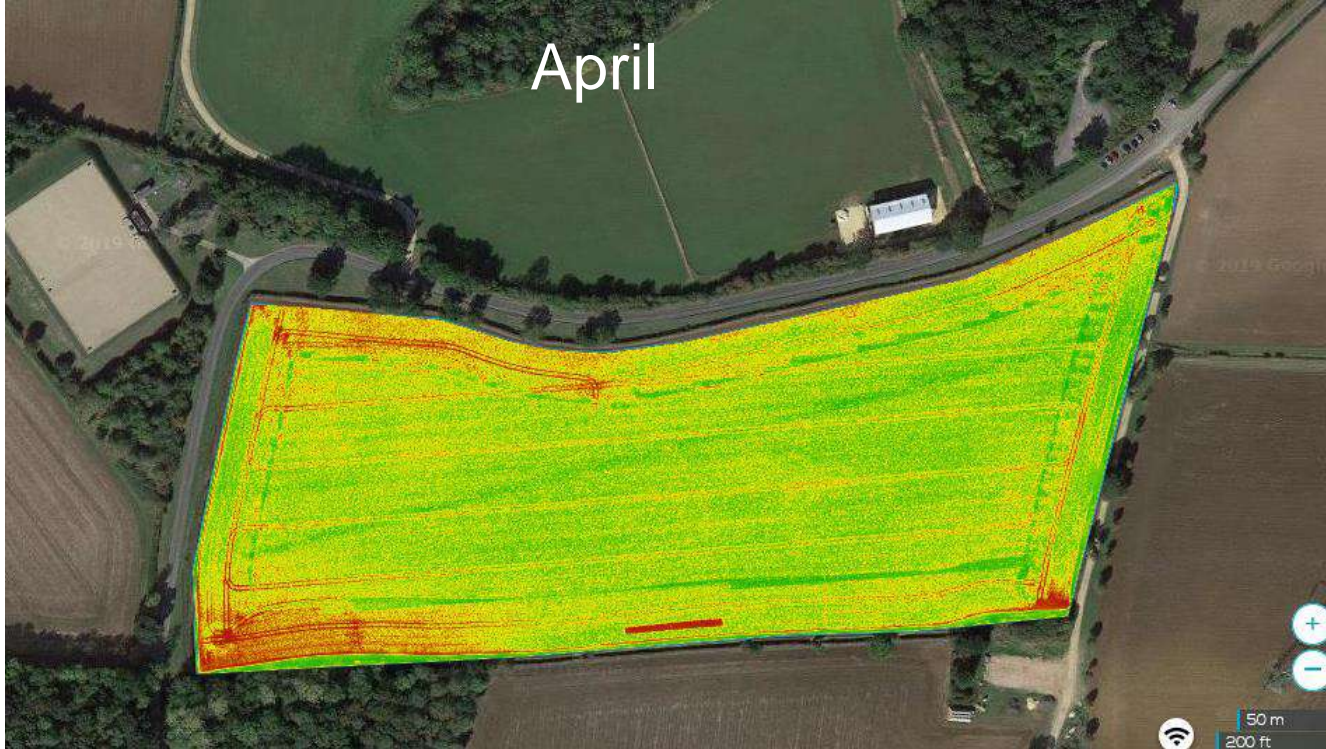


- $NDVI = (NIR - RED) / (NIR + RED)$
- NIR = Reflection in the near-infrared spectrum
- RED = Reflection in the red range of the spectrum
- NDVI can be used as a measure of the state of plant health based on how the plant reflects light at certain frequencies
- Chlorophyll strongly absorbs visible light, and the cellular structure of the leaves strongly reflect near-infrared light





April



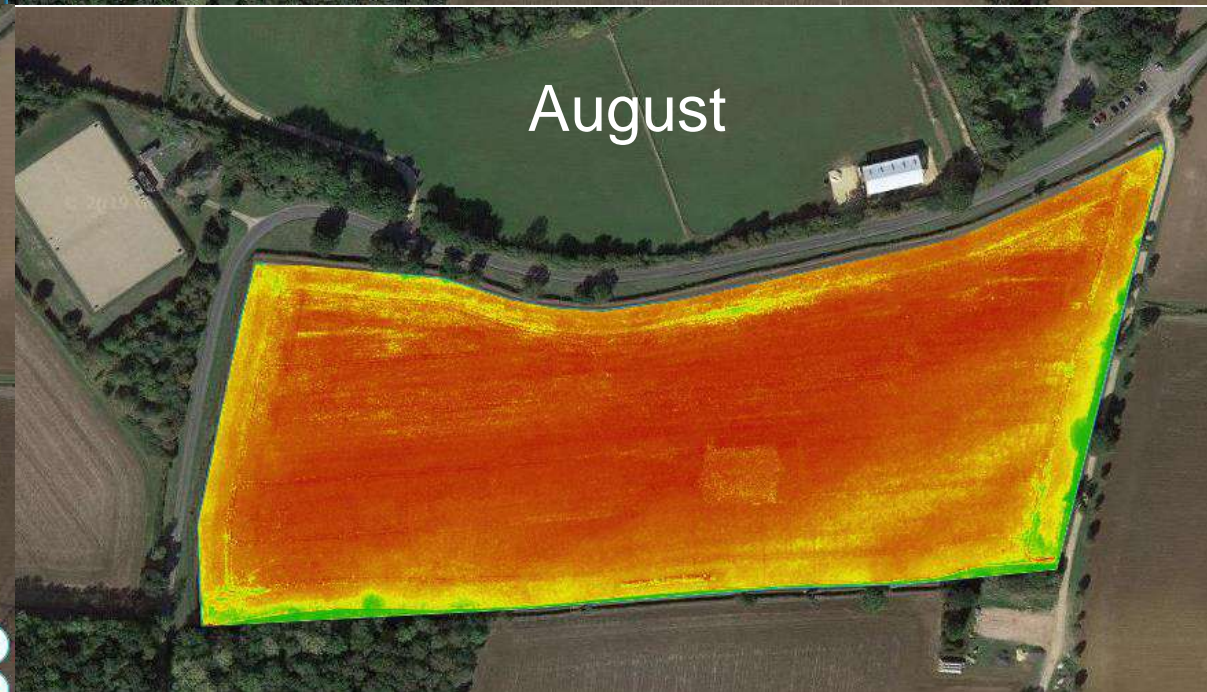
June



May



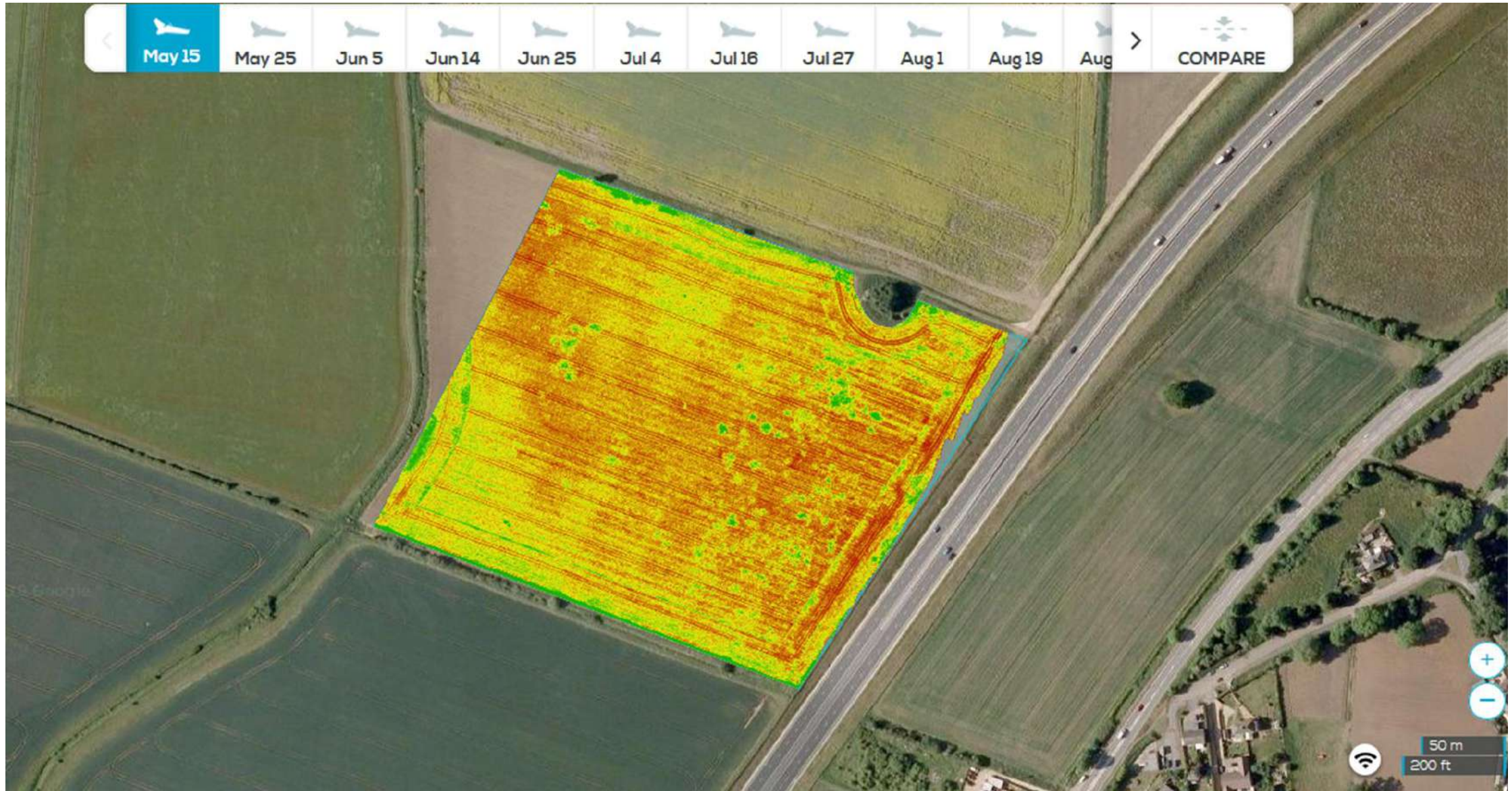
August





# NDVI Weed mapping potential

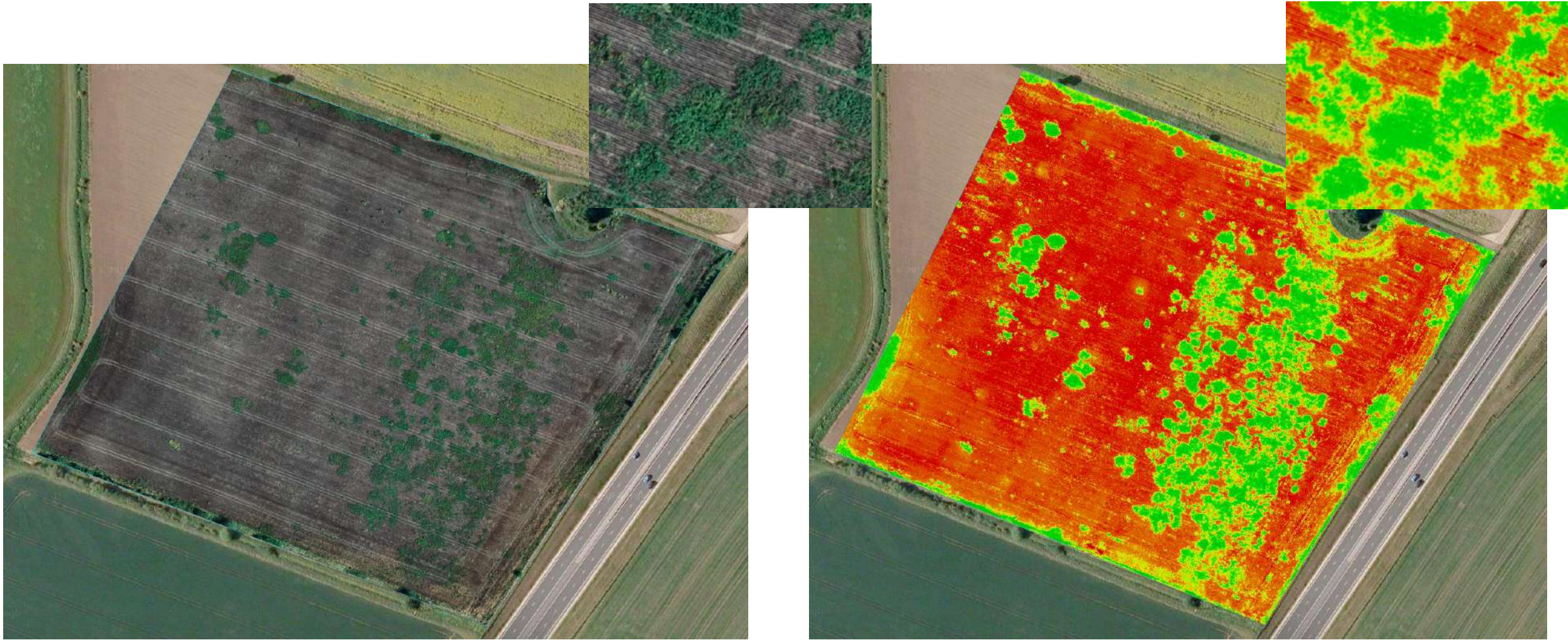
## Flight 15<sup>th</sup> May 2019





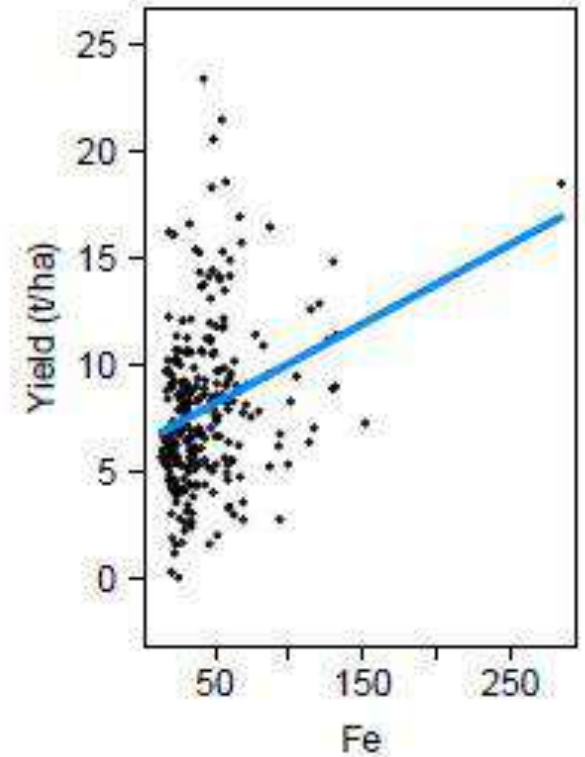
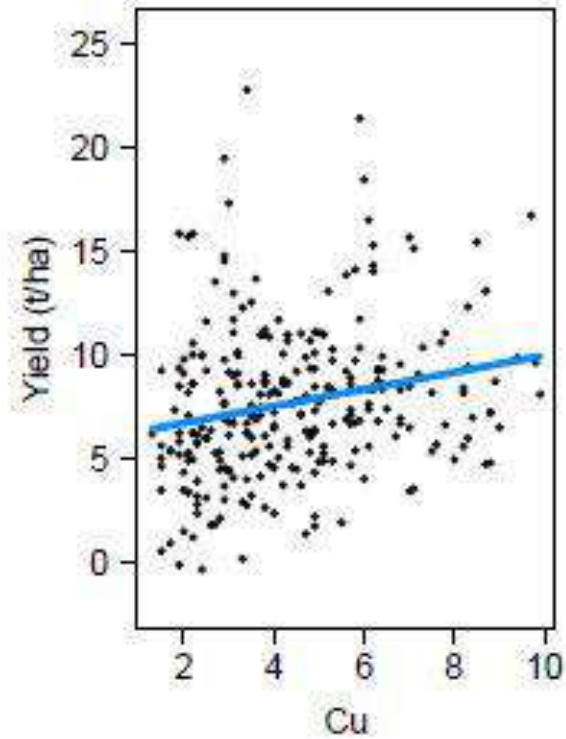
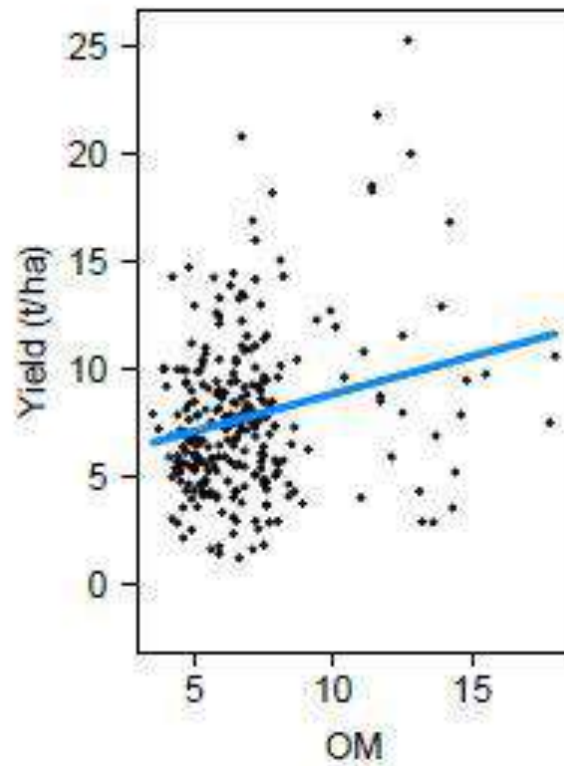
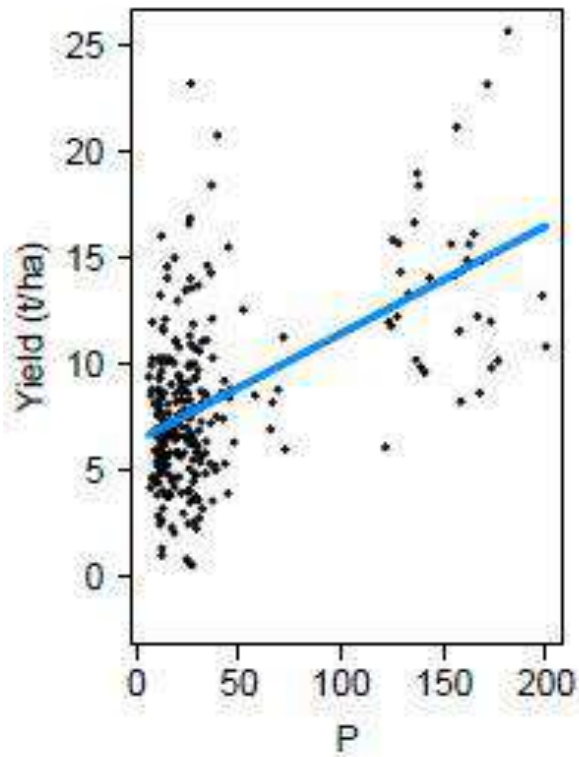
# NDVI Weed Mapping Potential

## Pre-harvest flight



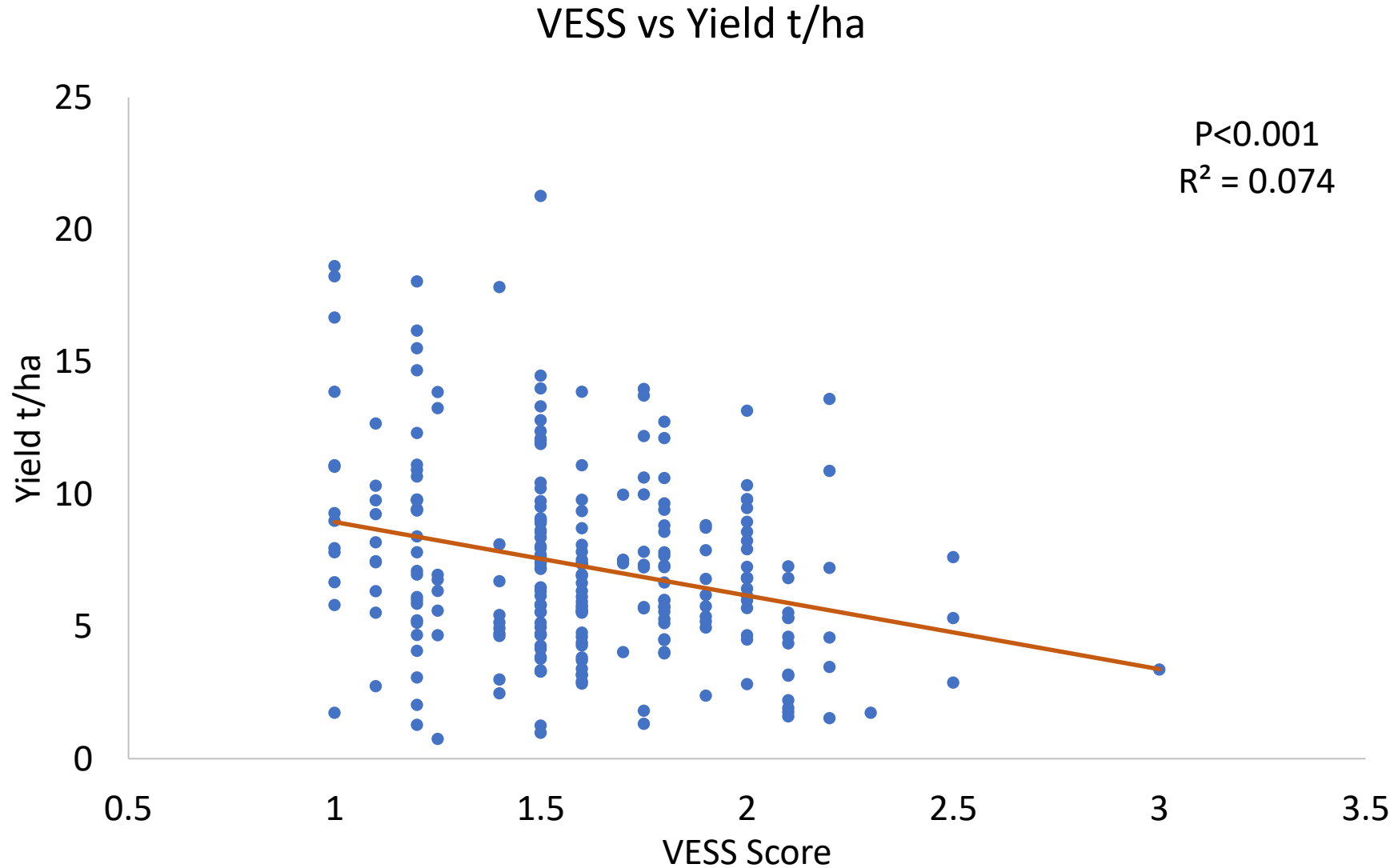


# Soil analysis vs Yield

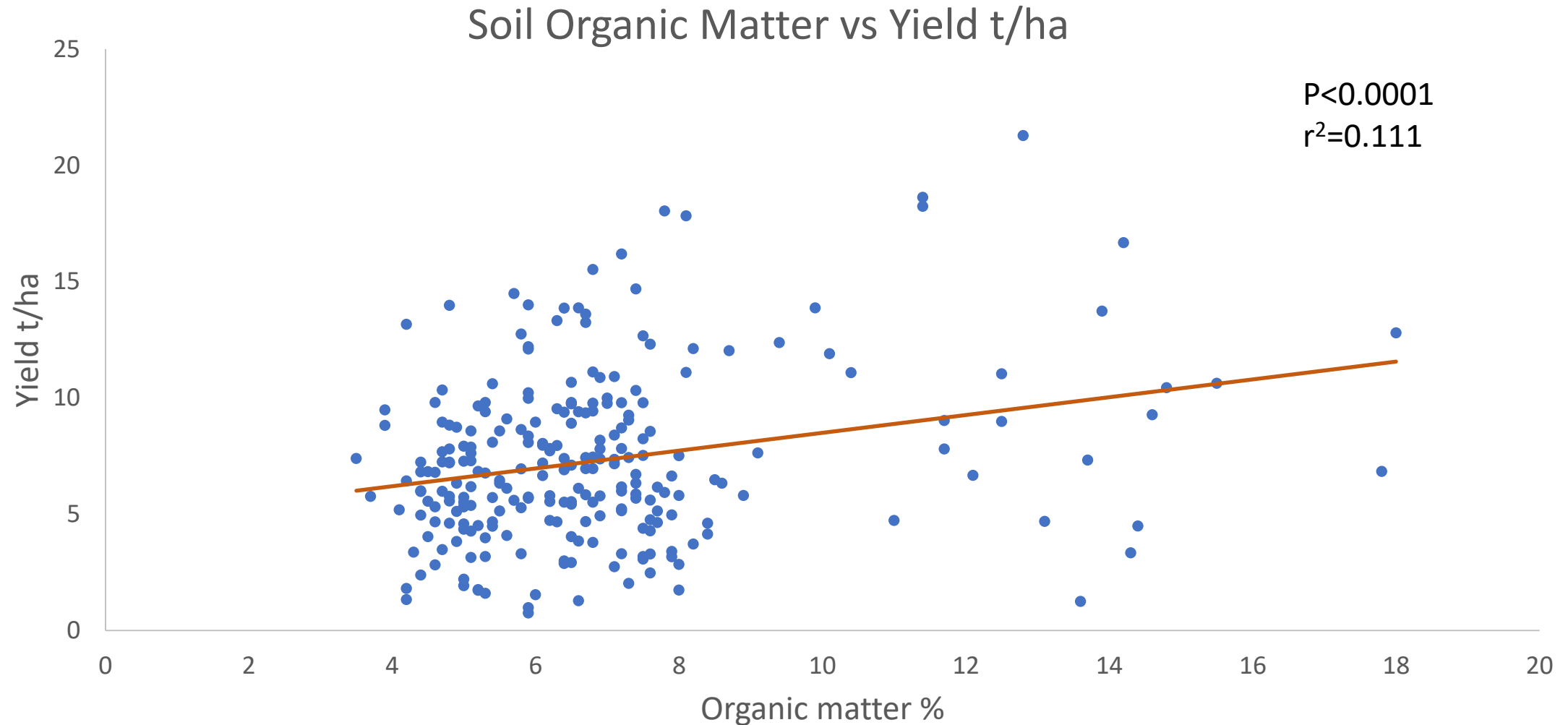




# VESS -Visual evaluation of soil structure



# Organic matter vs Yield





A vertical photograph on the left side of the slide shows a soil profile. A metal probe is inserted into the ground, passing through a dark, crumbly topsoil layer and a lighter, more compact subsoil layer. The soil is brown and appears to be a loam or silt loam.

# Organic Matter

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- Holds on to K, Ca and Mg
- Maintains micronutrients in a form readily available to the plant Zn, Cu and Mn
- Provides nutrition for micro-organisms
- Retains water and improves soil structure



# Ways to increase OM

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- Returning crop residues to soil
- Farmyard manures or similar
- Cover Crops
- Half of the Bean Yen entrants applied some form of OM and none used cover crops.





# Bean Yen



- All seven Hummingbird sites included in Bean Yen
- New in 2019, also looking for committed growers for 2020
- Some trends from this data
  - Bruchid – small data set. WB difficult to gain any control from spraying, SB some control using 3 sprays.



# Potential yields for beans



- Maximum green area index and light interception
  - 63% annual radiation for winter beans
  - 55% annual radiation for spring beans
- Radiation Use Efficiency 1 t/TJ
  - Compared to 1.4 t/TJ for cereals
- Maximum rooting depth to 1m
  - Compared to 1.5 m for cereals
- Water use efficiency 4g/litre
  - Compared to 5g/l for cereals
- Max harvest index 60%





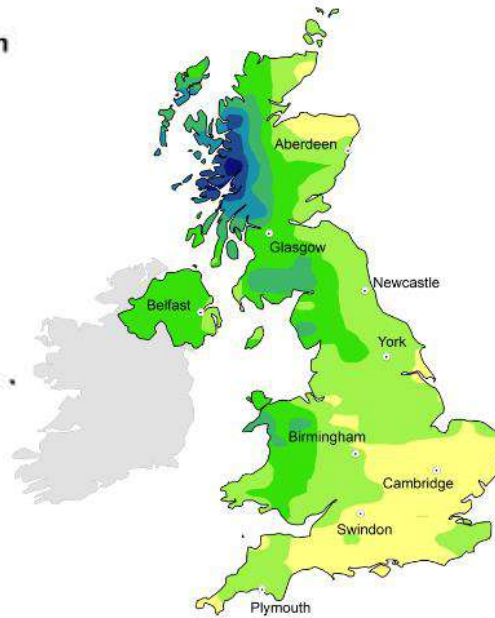
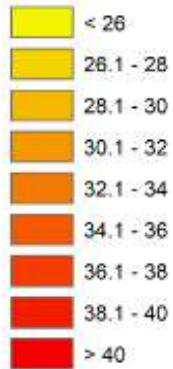
# Potential yields (t/ha) climatic average



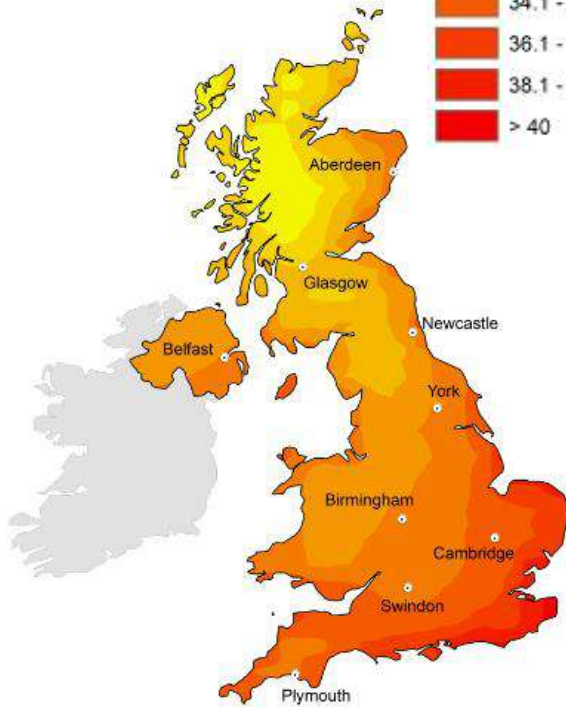
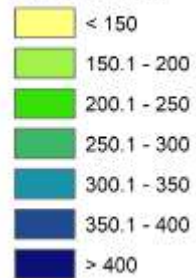
## Winter beans (silt soil)

## Spring beans (Silt soils)

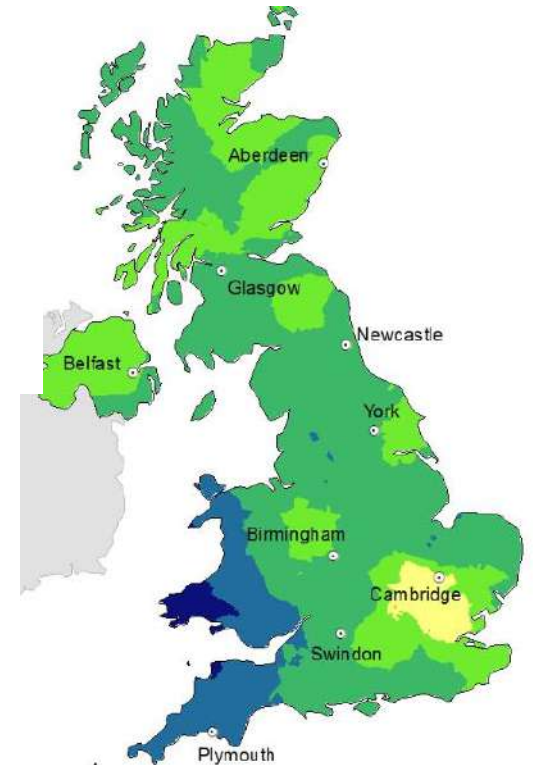
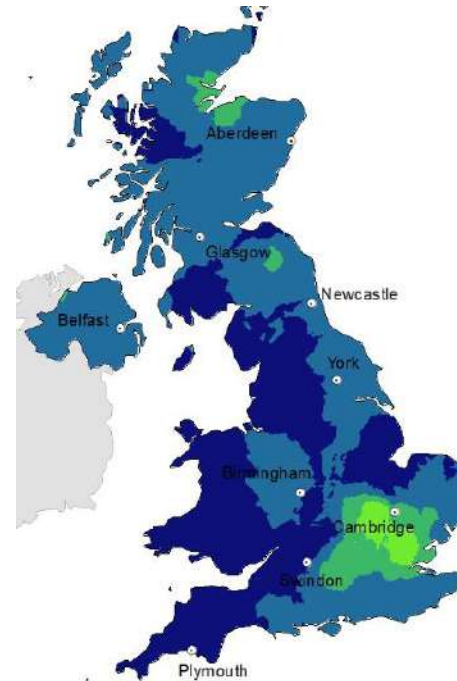
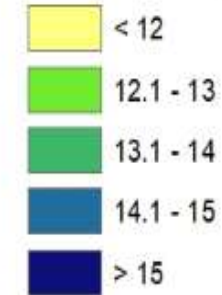
### Solar radiation



### Summer rain



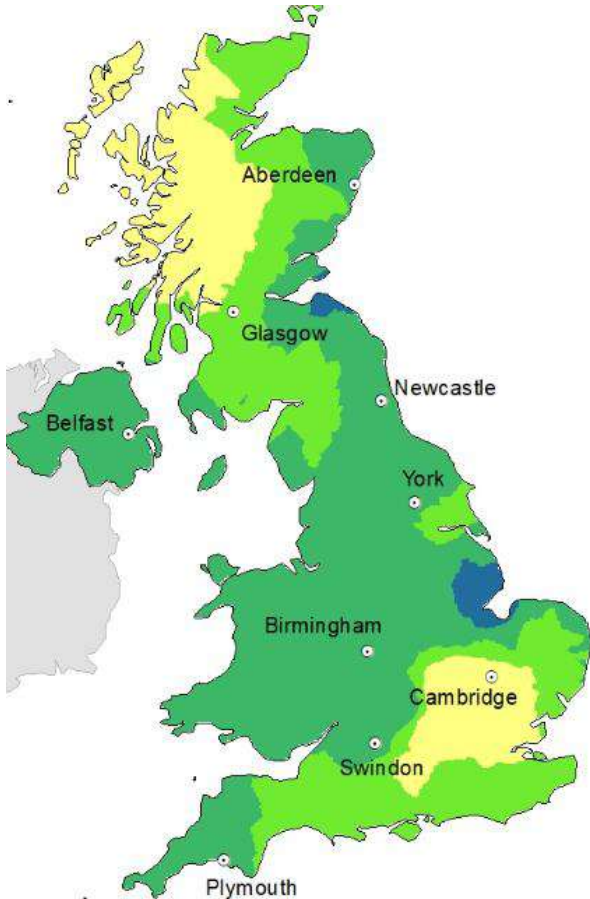
### t/ha (15% mc)



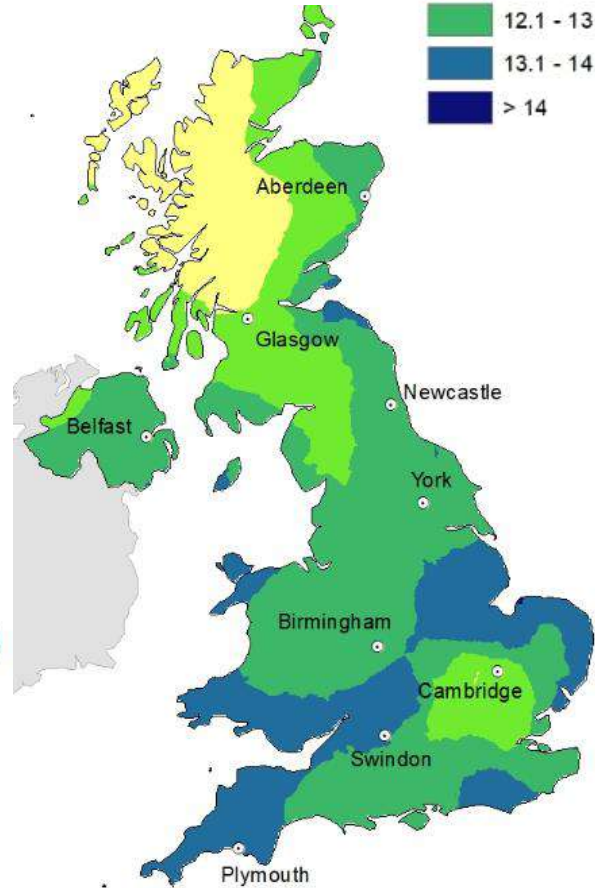
# Potential yields (t/ha) 2019



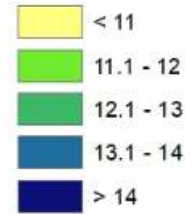
**Spring beans**  
(Sandy soils)



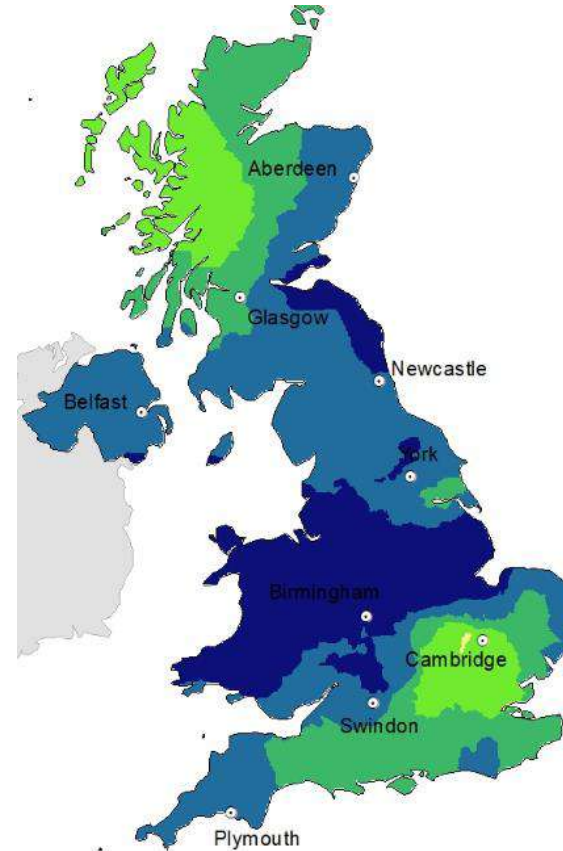
**Spring beans**  
(Silty soils)



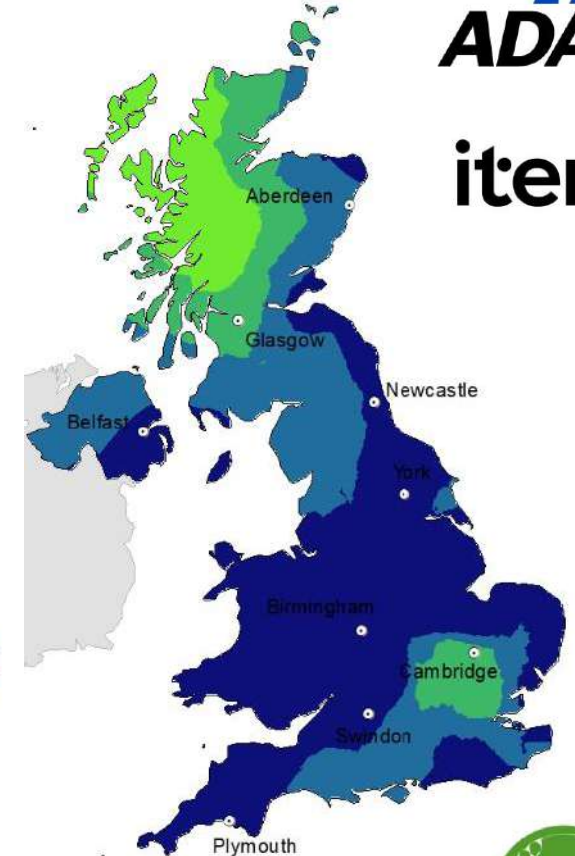
t/ha (15% mc)



**Winter beans**  
(Sandy soils)



**Winter beans**  
(Silty soils)



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# Summary of YEN results 2019



- **Bean YEN Yields 2019:**

- Entries from 20 fields, 9 winter crops, 11 spring crops
- Average field yield 5.5 t/ha
  - 5.8 t/ha for winter crops
  - 5.3 t/ha for spring crops
- Average yield potential was 13.3 t/ha
- Average potential yield achieved was 42%

- **National Data:**

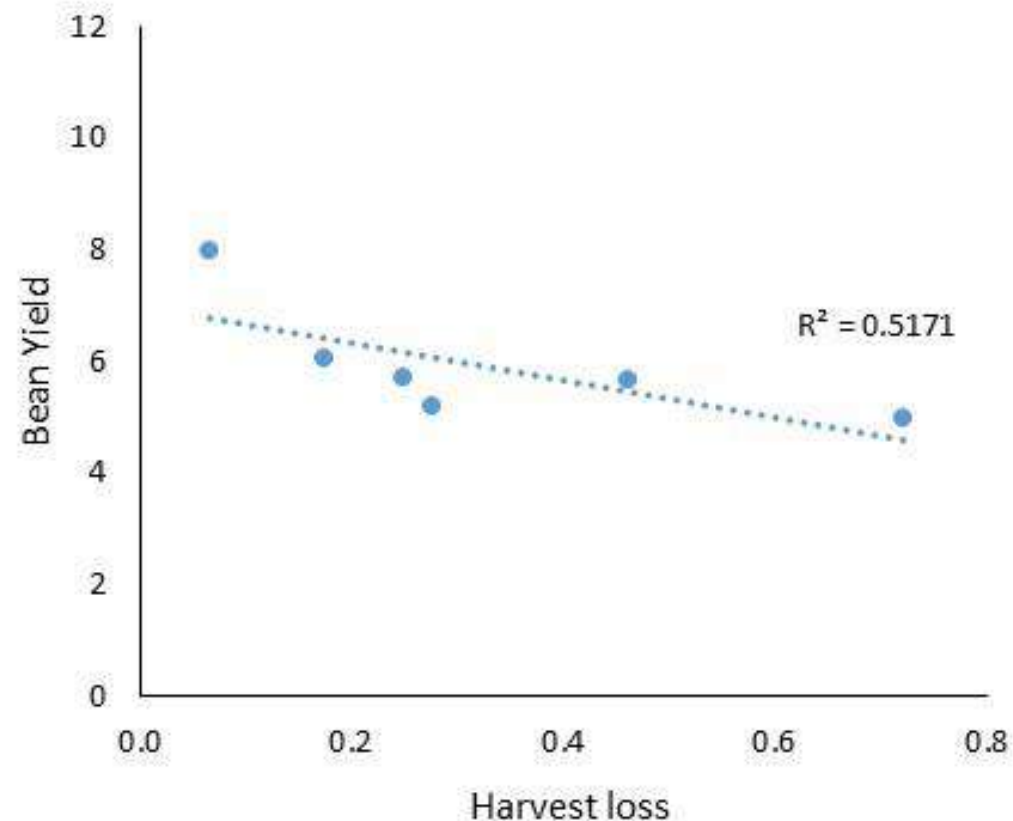
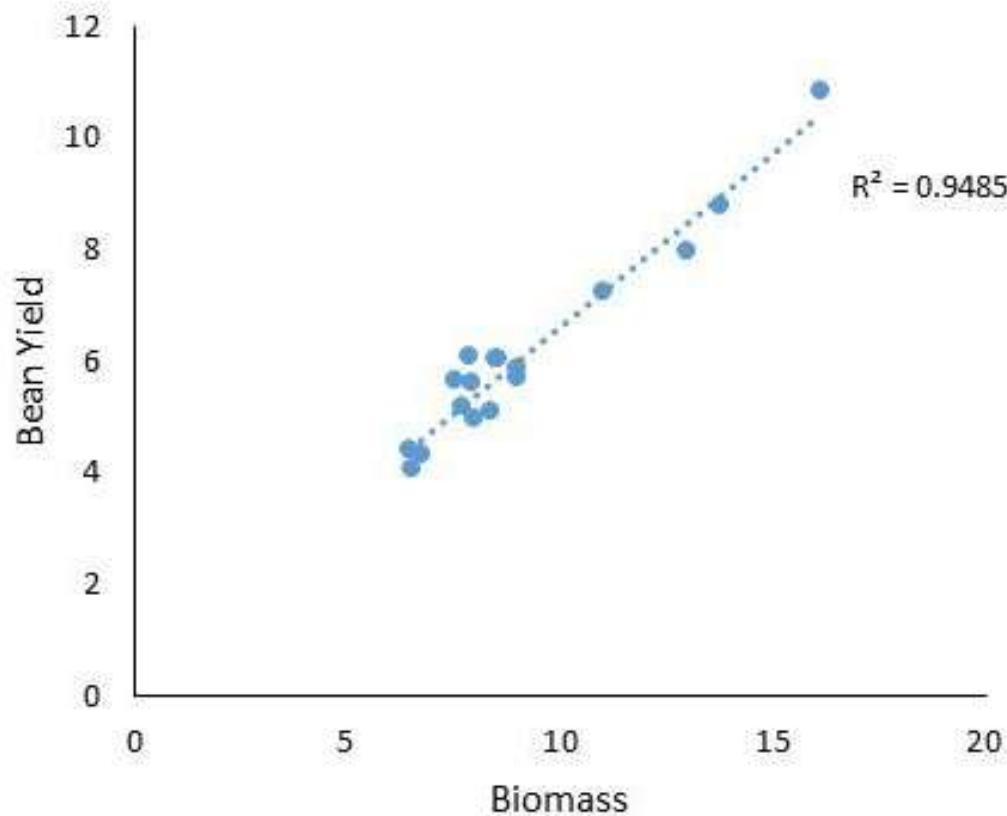
- RL average yields winter beans 5t/ha in 2019 (Tundra and Wizard)
- RL average yields spring bean varieties 5.2 t/ha in 2019 (Lynx and Vertigo)
- Average yield of bean crops 2015 – 2019 3.85 t/ha (Eurostat data)



# Relationships with yield



- Greater biomass = greater yield
- Higher yielding crops tended to have fewer losses at harvest, and harvest losses were generally low







# Next steps for 2020



- Design trials to test theories about organic matter, and VESS.
- We would like winter bean sites for 2020 even if they were drilled in January
- Continue with another year of data on predominately spring cropping

# Thank you



- Hummingbird Technologies
- Innovate UK
- Growers who participated in 2019
- PGRO Staff
- ADAS
- NRM laboratories
- Syngenta
- Sponsors of Bean YEN

