



# INNO-VEG: Use of crop sensing in field vegetable and potato crops

Thursday 26th January 2023



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# Agenda



- Introduction to the INNO-VEG project  
John Williams, ADAS
- Theory and practice: how to make use of crop sensors in field vegetable and potato crops  
Lizzie Sagoo, ADAS
- Analysis of field scale crop reflectance data using ADAS Agronomics data analysis methods  
Susie Roques, ADAS
- HMC: Yield mapping & crop sensing  
Jack Harris, HMC Peas
- INNO-VEG Facts & Figures  
James Dowers, ADAS
- Close and lunch

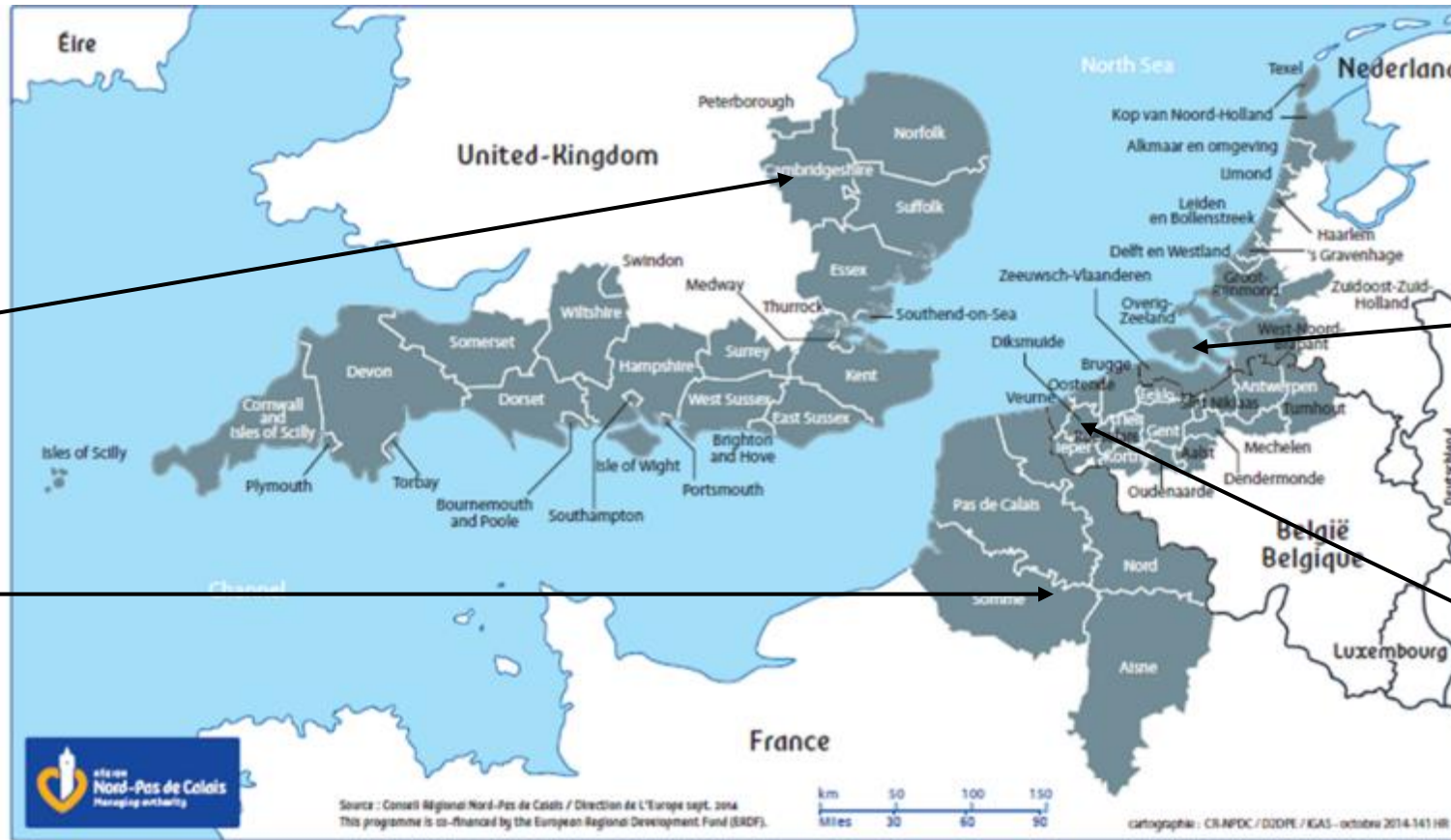


# Introduction to the INNO-VEG project

John Williams, ADAS

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# INNO-VEG – Increasing the speed & uptake of innovation in the field vegetable & potato sectors



## Project objective

- To increase the speed and uptake of innovation in the field vegetable and potato sectors
- Evaluate the suitability of using crop sensing data to carry out measurements in field experiments
- Define a new approach for delivering research in the field vegetable and potato sectors

# INNO-VEG – Increasing the speed & uptake of innovation in the field vegetable & potato sectors

- Field experiments focus on:
  - Using crop sensing data to carry out measurements in field experiments
  - Upscaling from small plot to field scale farmer led experiments
  - Field vegetable & potato crops

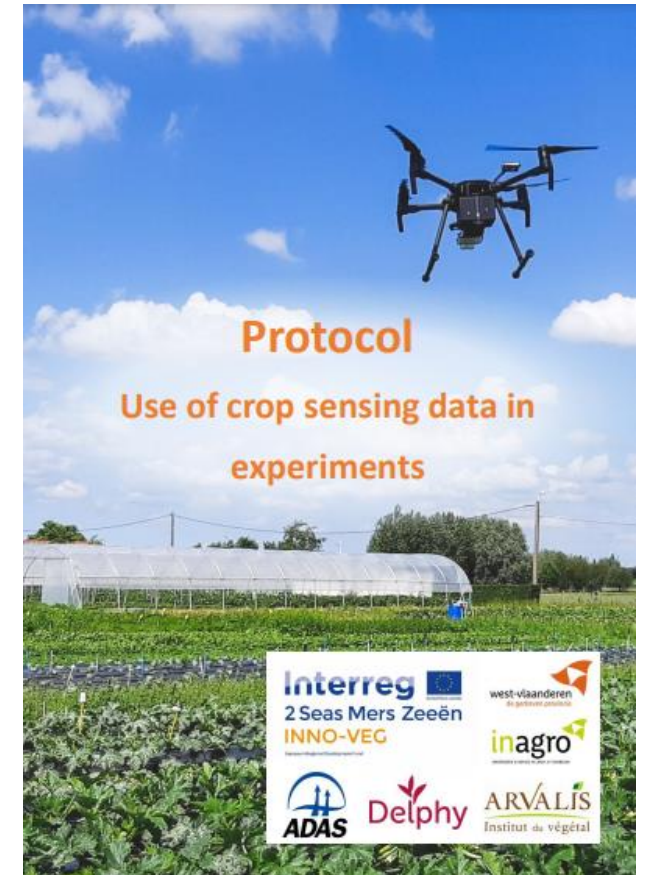
# Crop types

- Alliums (leeks/onions)
- Brassicas (cauliflower/sprouts)
- Leafy salads (lettuce/spinach)
- Vining peas
- Root vegetables (carrots)
- Cucurbits (courgettes)
- Potatoes



# Experimental work

- 2019 - 47 small plot field experiments in UK, FR, BE & NL
  - Range of crops
  - Use crop sensors to measure reflectance
  - Calculate range of vegetation indices & correlate to crop yield

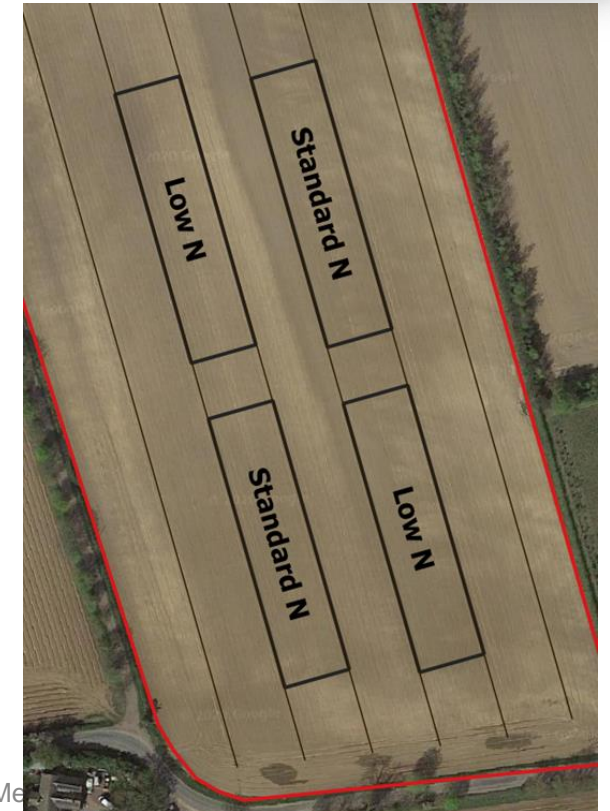
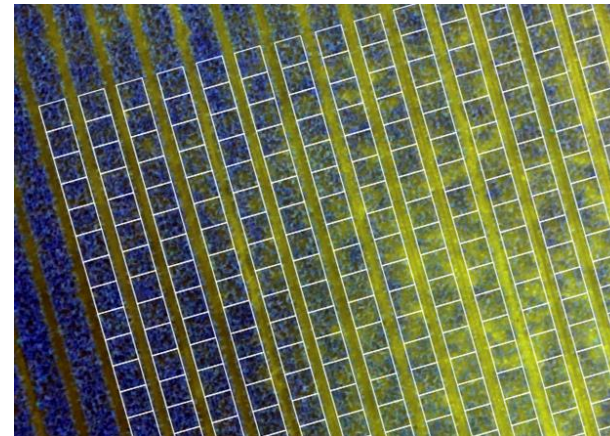


[www.inno-veg.org](http://www.inno-veg.org)



# Field scale field experiments (2020 & 2021)

- Field scale farmer led experiments
- Host farms apply treatments
- Collect crop reflectance data
- Use spatial statistics to analyse data
- ‘Framework for farmer led research’



# INNO-VEG Cross border innovation network

- Knowledge transfer & networking
- Register on our website for project updates
  - [www.inno-veg.org](http://www.inno-veg.org)
- Talk to us on social media ☺



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# Theory and practice: how to make use of crop sensors in field vegetable and potato crops

Lizzie Sagoo, ADAS



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# Outline

- What is crop sensing
- Why use crop sensing
- Vegetation indices
- Types of sensor
- INNO-VEG - lessons learnt



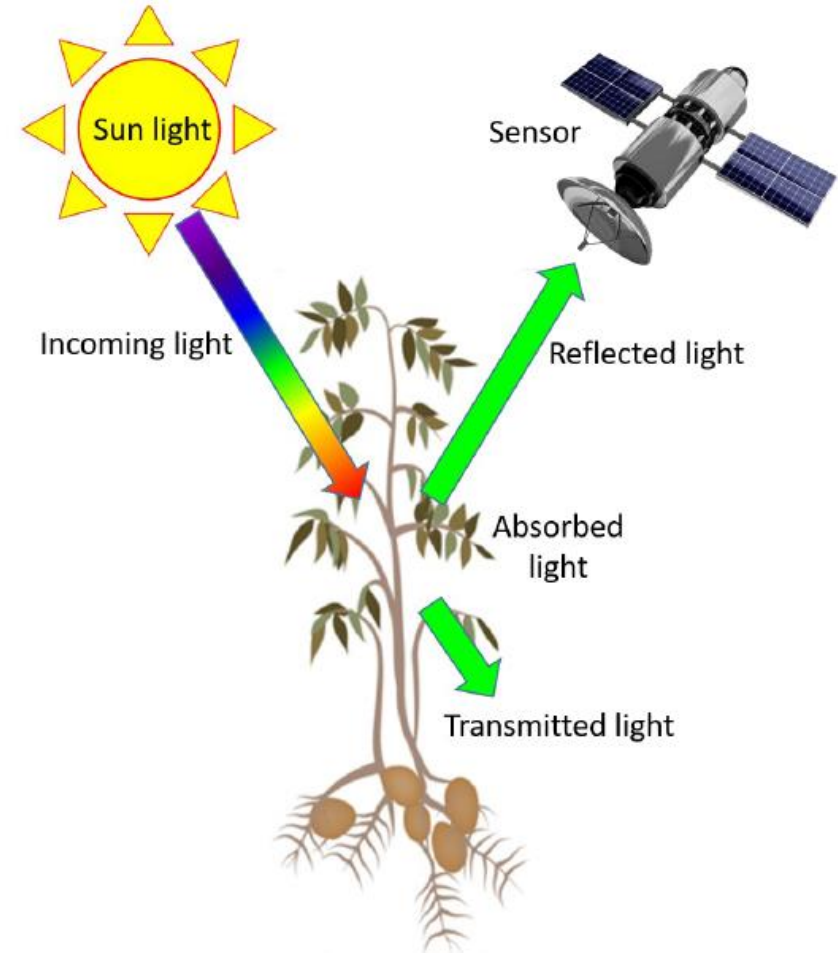
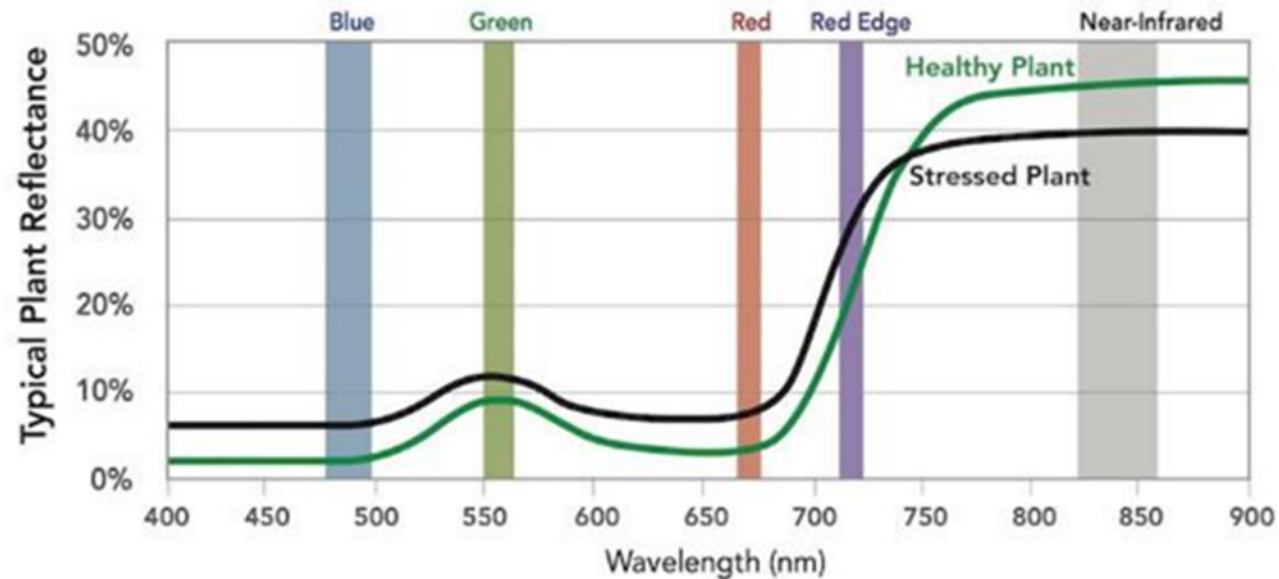
# Why use crop sensing?

- Data can be used to provide an indicator of crop growth/performance
- Non-destructive
- Relatively quick
- Cost effective for measuring from larger areas and for crops where yield mapping is not available



# What is crop sensing?

- Capturing reflected light in different wavelengths
- Using this data to provide information on crop growth and vigour



# Sensor types

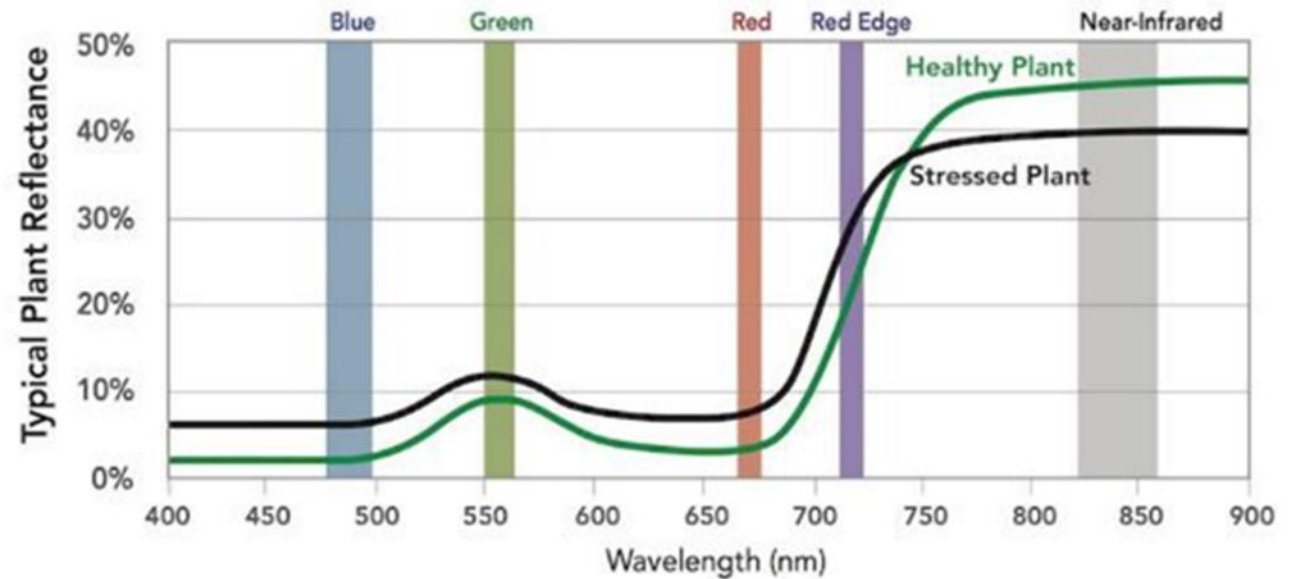
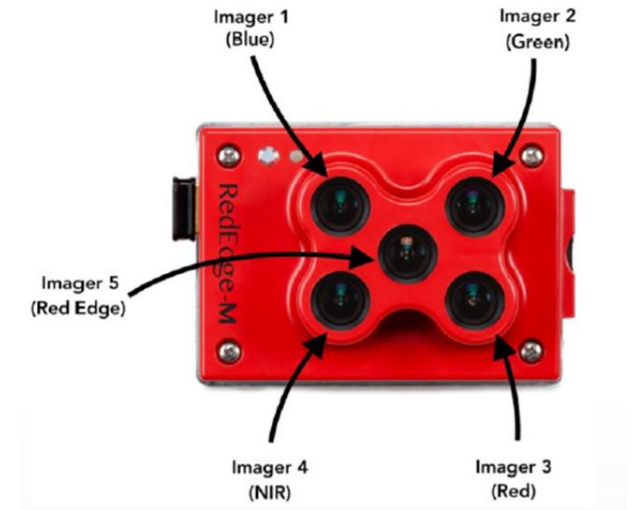
## Spectral resolution

- Multispectral
- Hyperspectral
- RGB

## Light source

- Passive
- Active

## Platform



# Sensor platform

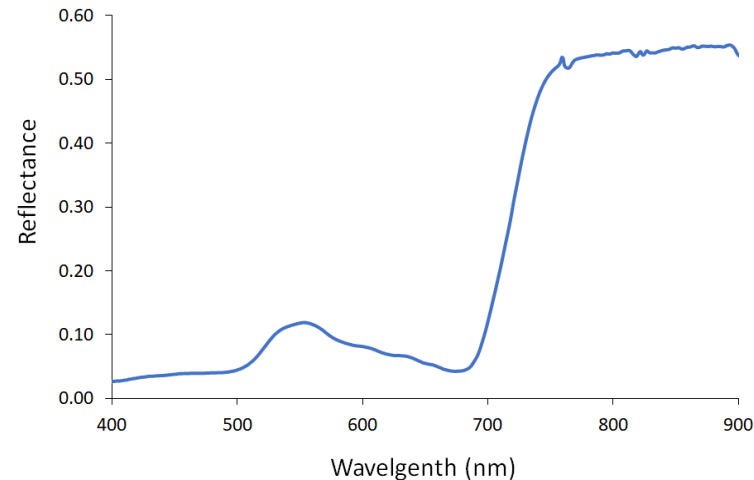
- Handheld sensors
- Tractor mounted sensors
- Drone mounted sensors
- Satellite images





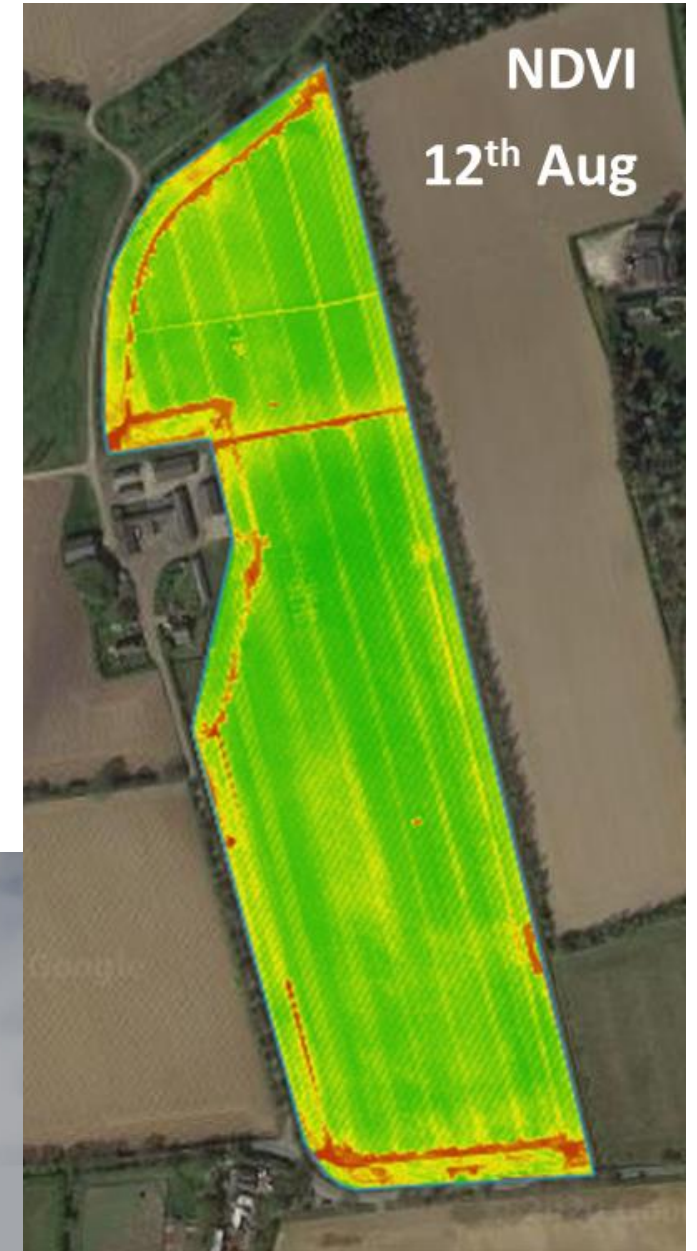
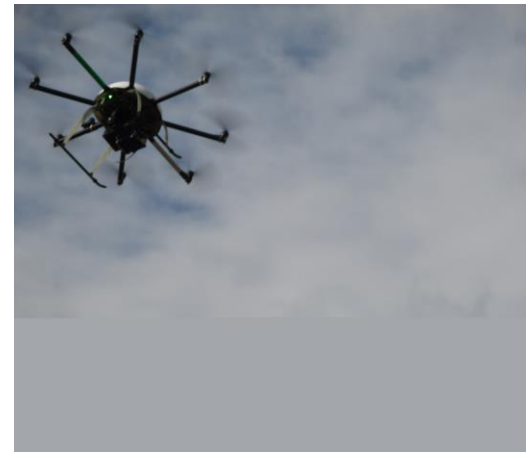
# FieldSpec HandHeld 2

- Hand held sensor
- Used in small plot experiments in 2019
- **Hyperspectral** – wavelength range 325-1075 nm
- Records reflectance values every 1nm
- Passive sensor – calibrate in field using a white reference disc



# MicaSense Red Edge 3

- Drone mounted
- Used in 2020 & 2021 field scale experiments
- **Multispectral** – 5 bands
  - 475, 560, 668, 717, 840nm



# Other sensors used



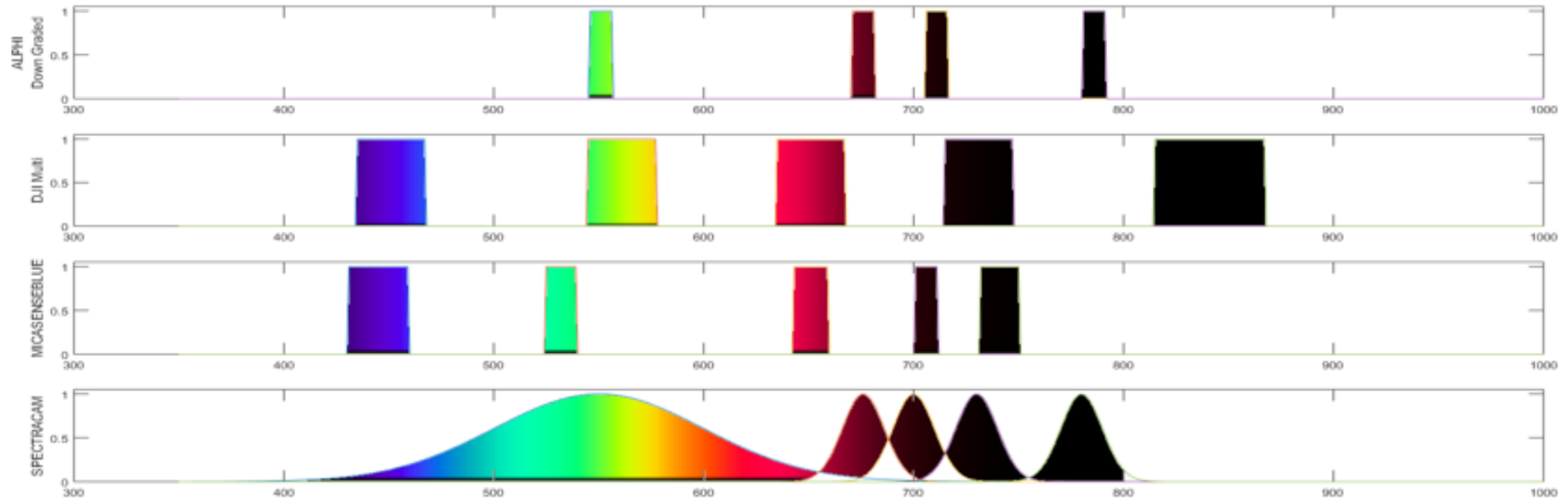
# Vegetation Indices

- A vegetation index (VI) is a single number calculated using the reflectance at two or more bands
- There are lots of VIs!
- VIs used in INNO-VEG
  - NDVI
  - MCARI2
  - CI Green
  - CI Red-Edge
  - NDRE
  - REIP
  - MTCI

$$NDVI = \frac{NIR - Red}{NIR + Red}$$

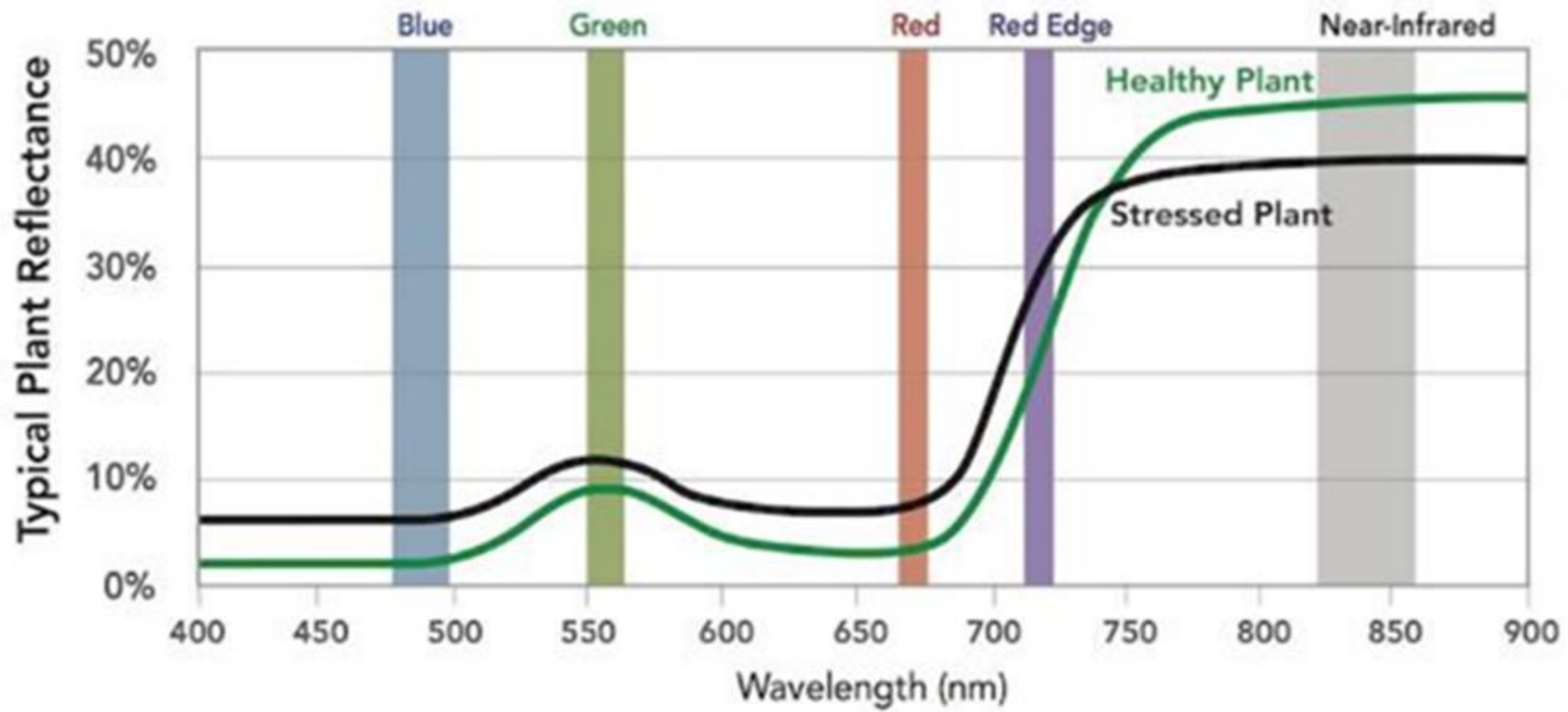
$$NDRE = \frac{790 - 720}{790 + 720}$$

# What impact does sensor type have?



ALPHI and FIELDSCAN  
Full Spectra





# Relationship between Vegetation Indices and yield – what have we learnt?

- Good relationship with marketable yields where there was a significant treatment effect
- Strength of the relationship varied between crops and across experiments
- Beware of other complicating factors – weeds & disease
- Relationship between VIs and yield tended to improve through the season

## INNO-VEG Protocol

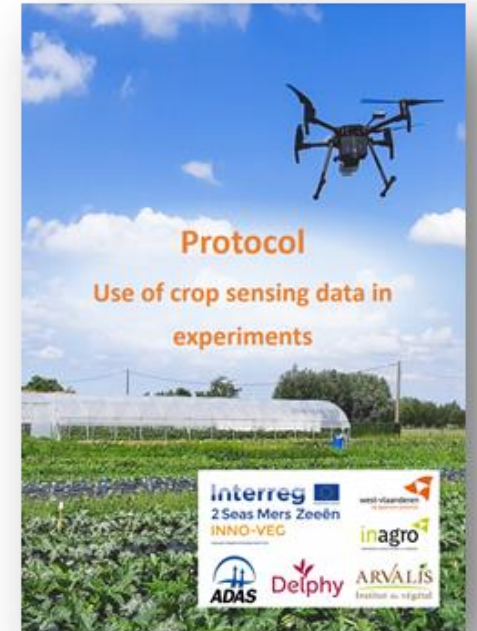
This Protocol provides guidance on using crop sensing data to assess treatment differences in field experiments. The guide focusses on field vegetable and potato crops and has been produced as part of the INNO-VEG project. The Protocol is aimed at researchers, agronomists and farmers who want to use crop sensing technology to assess their crops and aims to support them to make best use of the technology.

The Protocol includes information on the use of crop sensing technology in the field and on the management and interpretation of the data. The information provided is based on the experience of the authors and the results of the INNO-VEG project.



## Downloads

[INNO-VEG Protocol \(EN\)](#)





## Protocol provides advice on

- 'Best practice' when collecting crop sensing data
  - Time of day, geolocation, when to collect the data etc
- Advice on commissioning a drone survey
- Management and interpretation of the data
- Information on each crop type





# Questions

[Lizzie.Sagoo@adas.co.uk](mailto:Lizzie.Sagoo@adas.co.uk)

 @LizzieSagoo



## Analysis of field scale crop reflectance data using agronomics data analysis methods

Susie Roques, ADAS

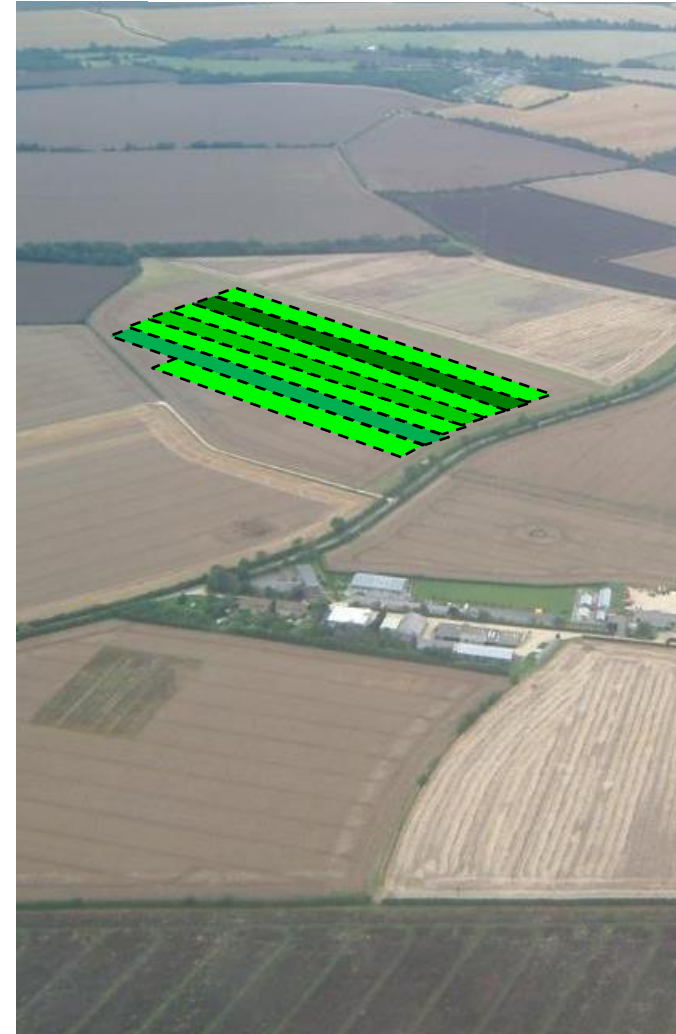


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# Agronomics

## Agronomics spatial data analysis

- Agronomics approach developed 2013-2017 for cereal yield maps
- New statistics to model treatment effects, after accounting for underlying spatial variation
- Statistics and software also work for other spatial data, e.g. drone/satellite crop reflectance



Innovate UK  
Technology Strategy Board

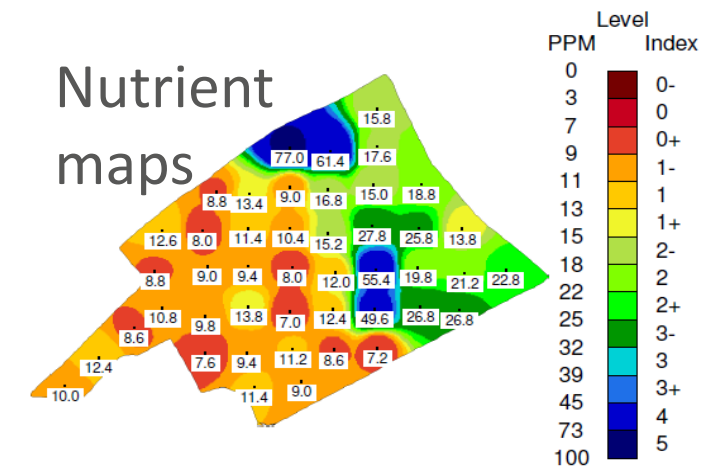
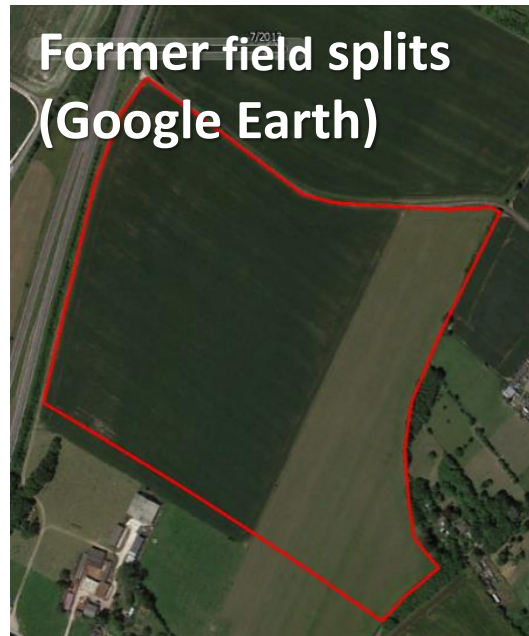
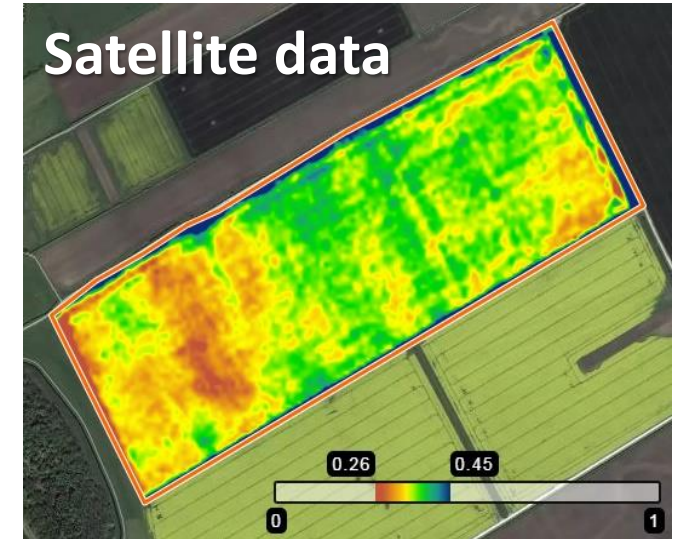


# Why carry out field scale trials?

Advantages	Disadvantages
Test treatments over larger areas	Max 4 treatments (ideally 2-3)
Allows treatments not practical at plot scale (e.g. variable rate, cultivations)	Reliance on host farmers – greater risk of error or trial failure
Directly applicable to farm practice	Higher costs of treatment supply & yield compensation
Farmer engagement / involvement	Less suited to assessments other than yield / crop sensing
Low labour costs	

# Choose a suitable trial field

- 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



Test treatment replicated in most even section of field

# Treatment application

- Accurate application to treatment area
- Need area of overlap if using broadcast spreaders
- Mark treatment locations in field
- Geolocate treatment locations





# Assess the impact of treatment application

## Yield map data

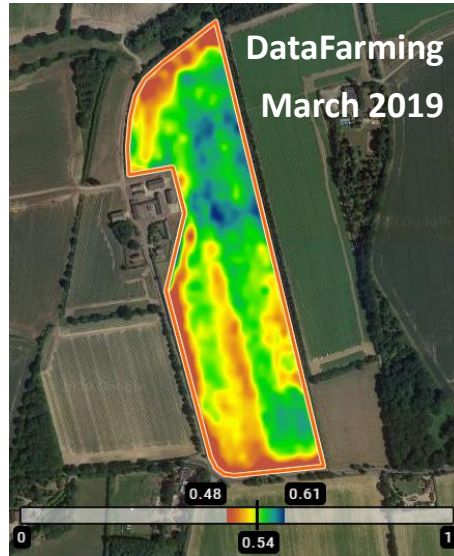
- Advantages
  - Actual measure of crop yield
  - Yield monitoring equipment now fitted as standard to most combines
- Disadvantages
  - Not available for all crops
  - Data 'errors' & noise – need to clean data

## Crop sensing data

- Advantages
  - High resolution data
  - More 'precise' data
  - Can be correlated to yield
- Disadvantages
  - Proxy for yield
  - Cost for acquiring data

# Case study 1: onions

- Two replicated N rate treatments, applied to pairs of 24m tramlines
- Trial focused in south end of field as more even

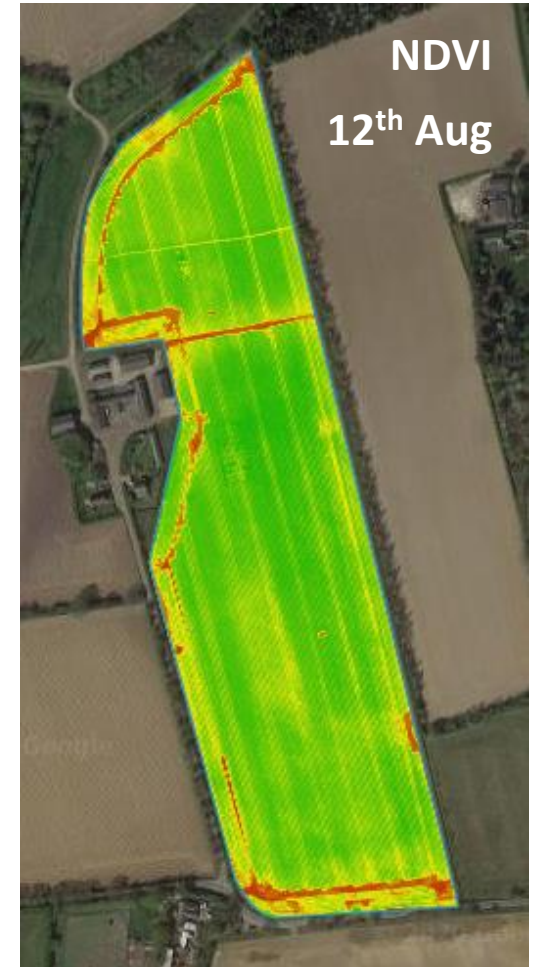
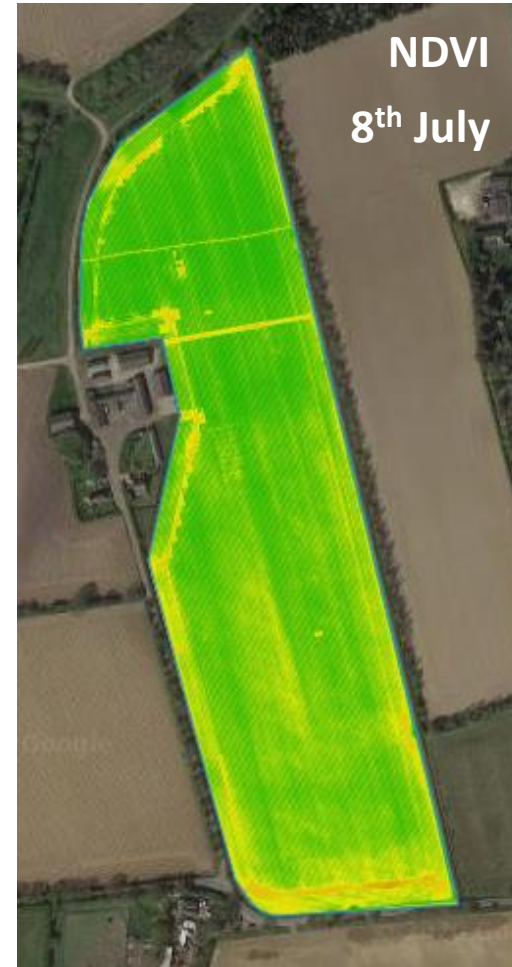


## P.G.RIX (FARMS) LTD



# Onions – new drone imagery

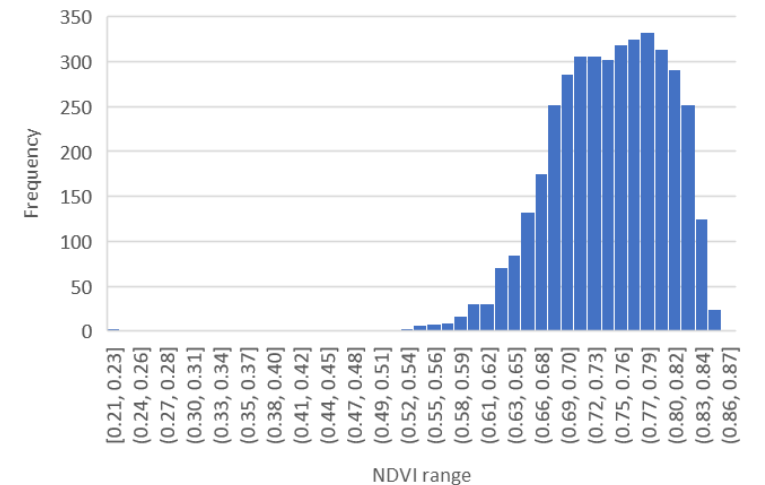
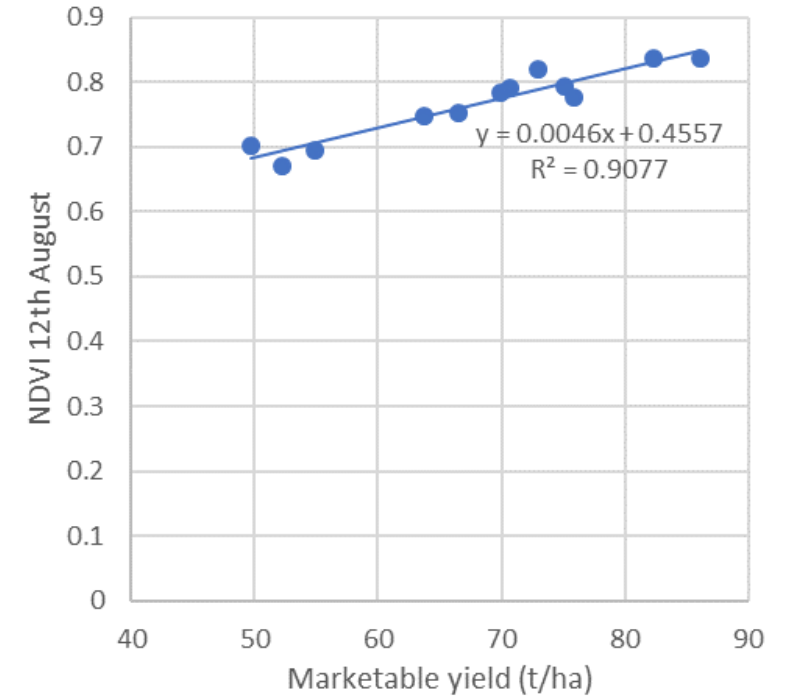
- Multispectral images supplied for 8<sup>th</sup> July and 12<sup>th</sup> August
  - (5 wavelengths from MicaSense Red Edge drone mounted sensor)
- Low N areas visible as lower NDVI



# Onions – ground truthing

- 12 yield validation plots (3 per plot); 1 bed x 8m
- Sampled mean MS bands for each sample plot
- Calculated 7 VIs from averaged MS bands
- Correlated VIs with marketable yield

	1 <sup>st</sup> flight (8 July)	2 <sup>nd</sup> 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

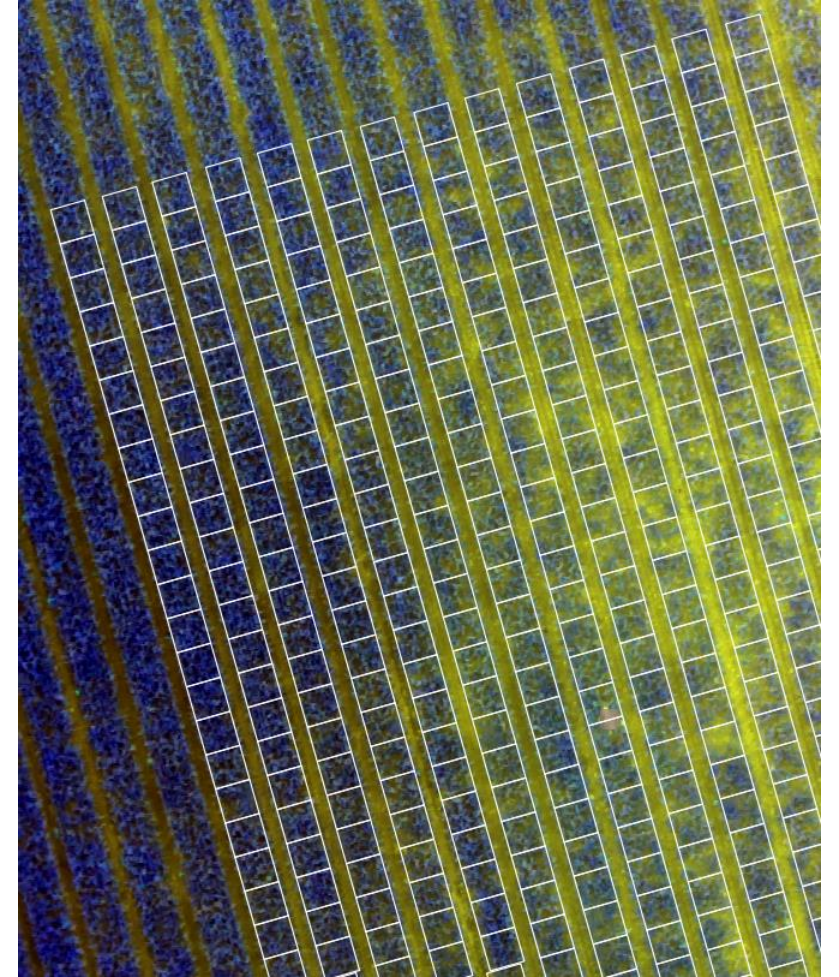


# Onions – data processing

Agronomics analysis requires point data

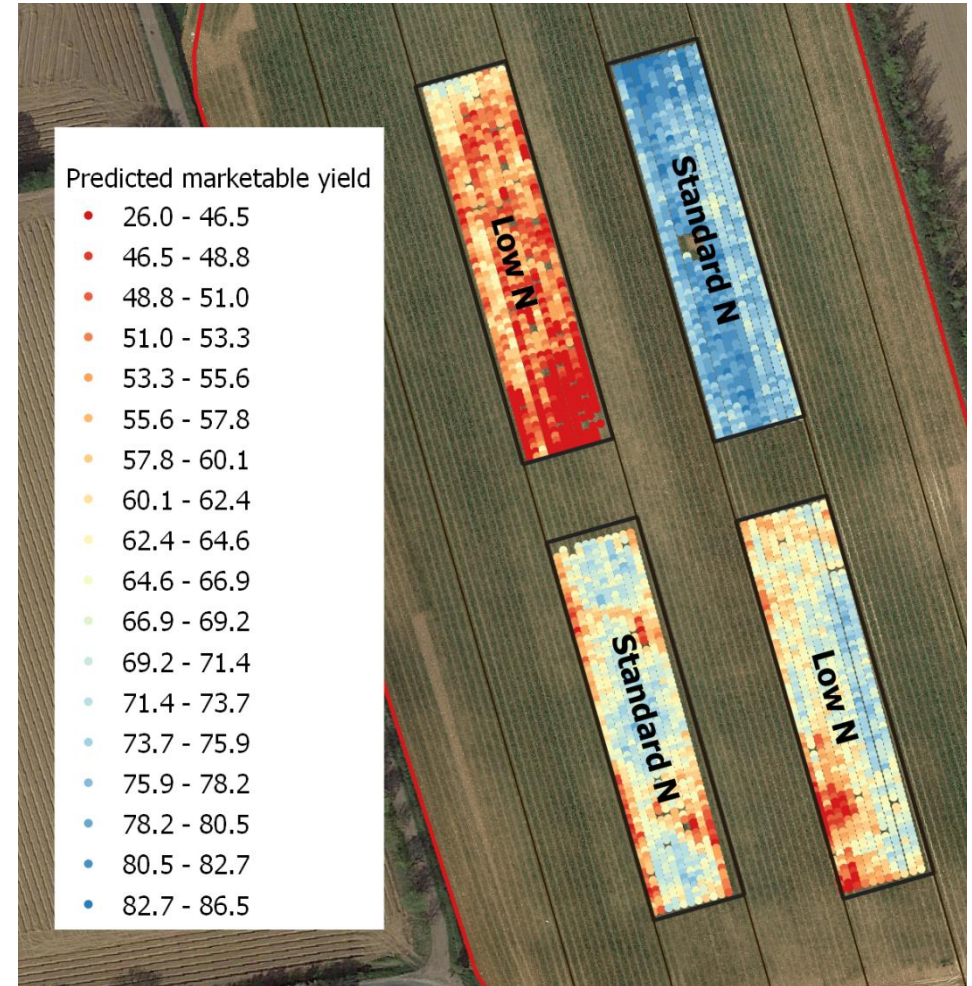
Crop grown in beds 1.5m wide with 0.5m gaps

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  $\pm$  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

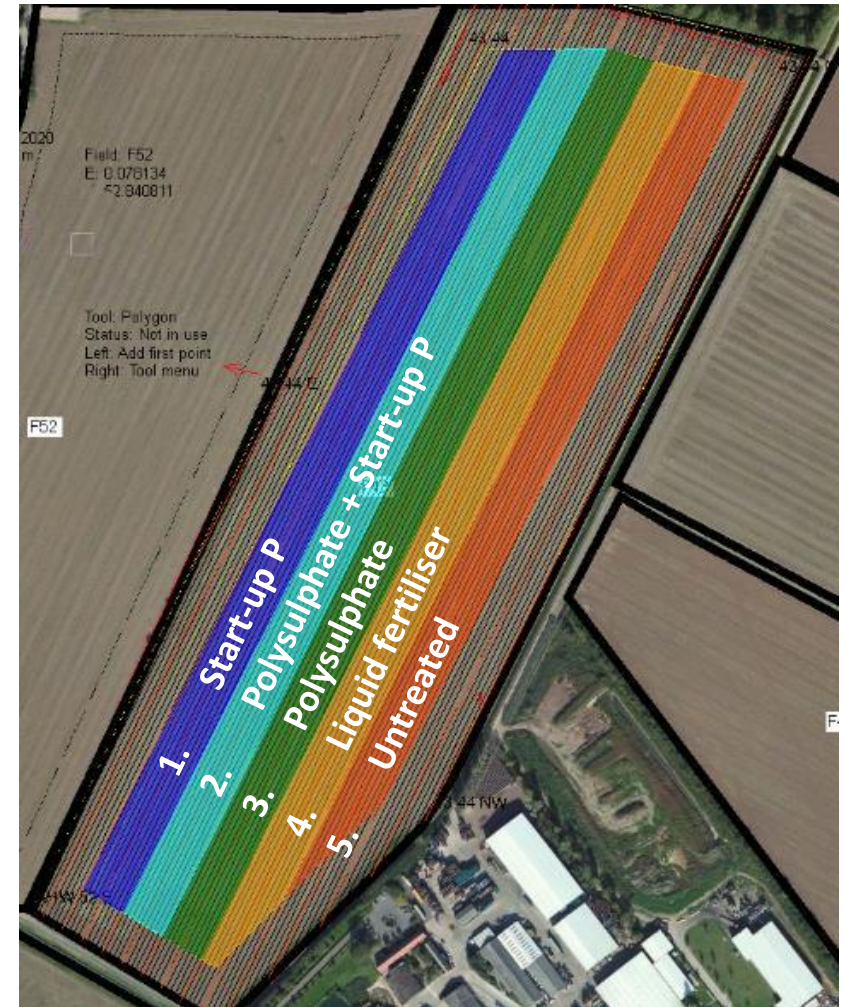


- HMC Peas are a co-operative of 43 vining pea growers in the UK
- Grow green peas for processing
- Growers want to maximise yields through good crop nutrition
- Research question: can the growers increase yields with starter fertiliser
- Set up field scale trials to test products in 2020 & 2021



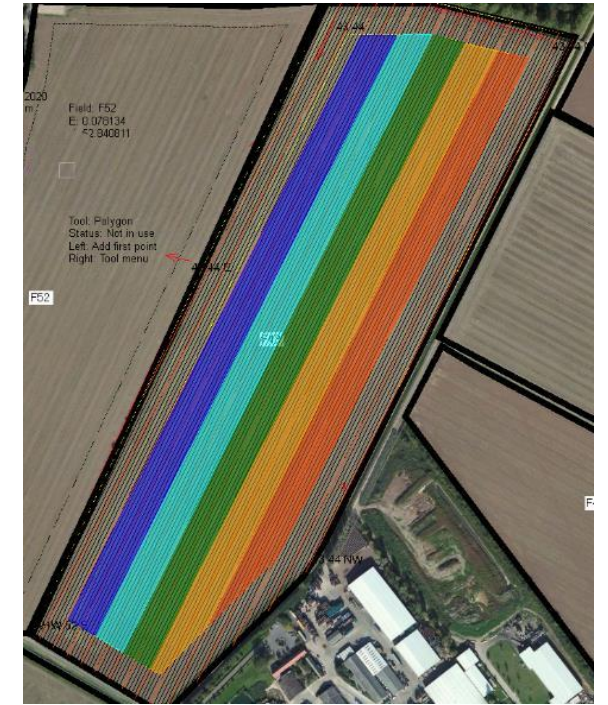
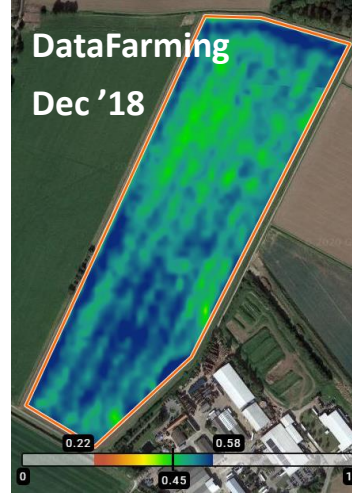
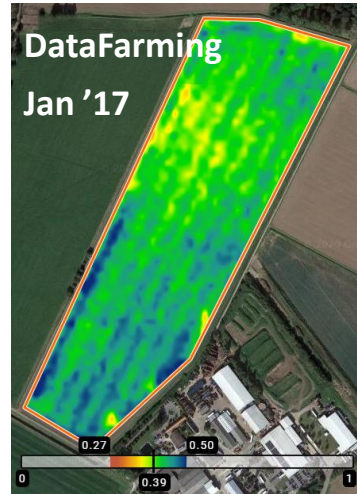
# Vining peas 2020 trial

- HMC trial site - five unreplicated treatments
- Plots one tramline (36m) wide
- Two drone flights with multispectral camera
- Seven vegetation indices
  - NDVI, MCARI2, MTCI, CI Green, CI Red Edge, NDRE & REIP
- 20 yield validation plots
- Plus yield map data from farm

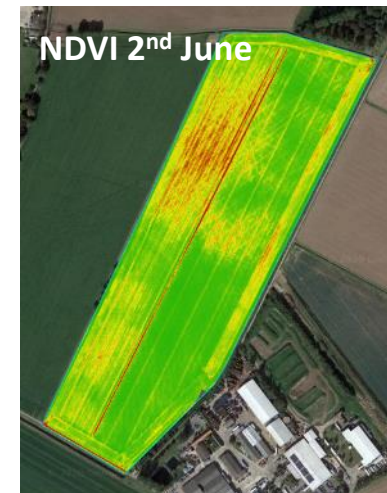
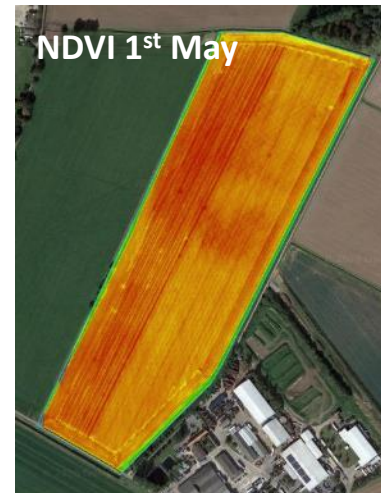




# Vining peas 2020: underlying variation

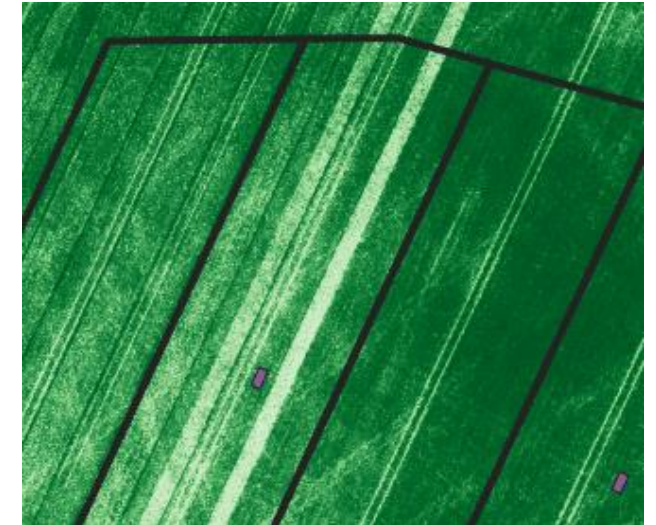


- Previous crops show poor patch in NW corner
- Treatments 1 and 2 stood out as worse in 2020

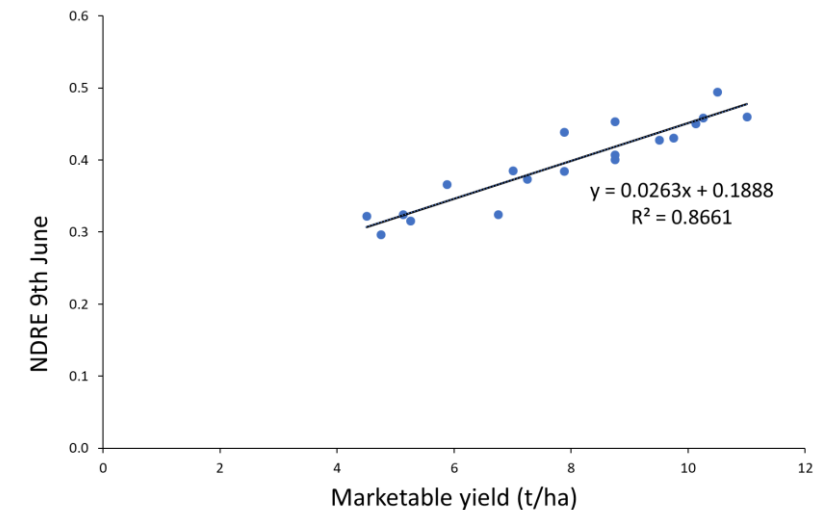


# Vining peas 2020 – ground truthing

- 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



	1 <sup>st</sup> flight (9 June)	2 <sup>nd</sup> 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

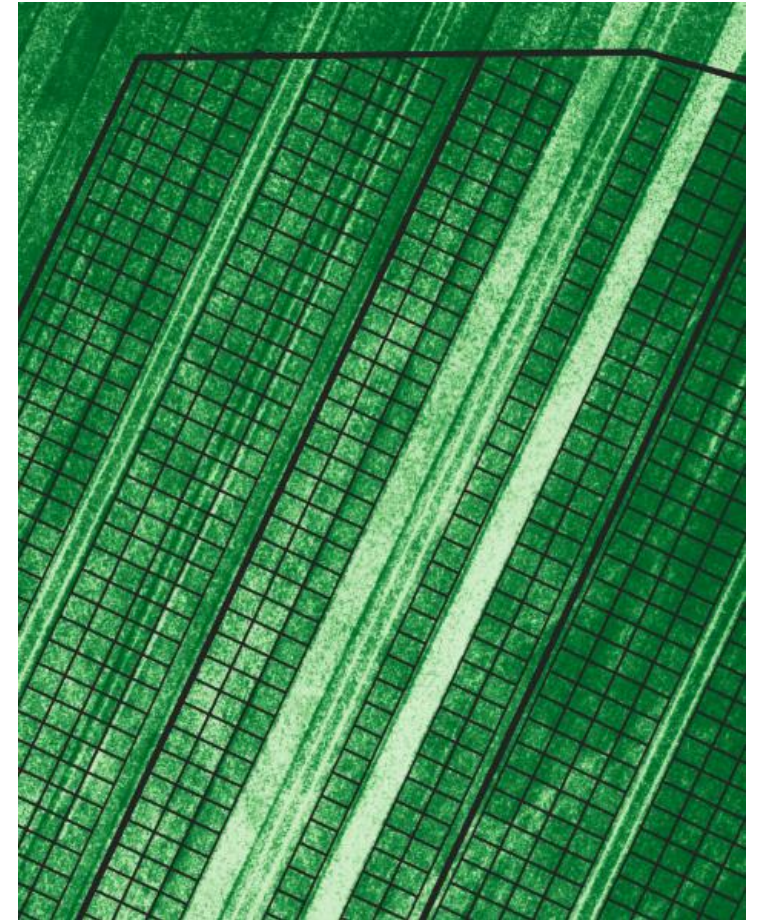


## Vining peas 2020 – data processing

Drone image converted to point data as for onions

Grid cells 3.5m wide x 3m long

Four rows of cell in each half tramline, avoiding wheelings, drill misses and treatment boundaries



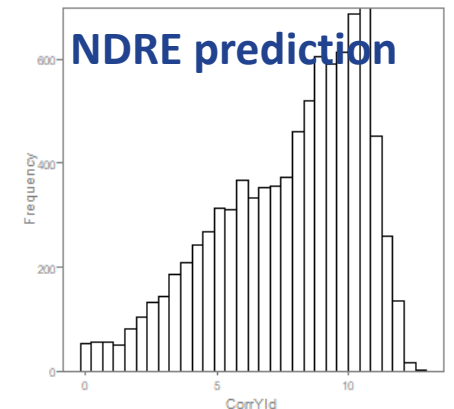
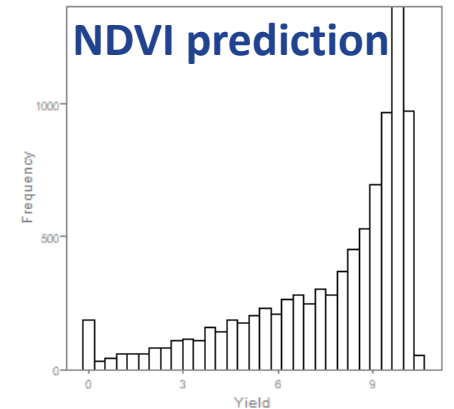
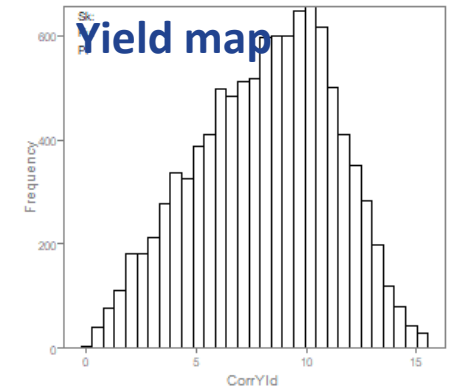
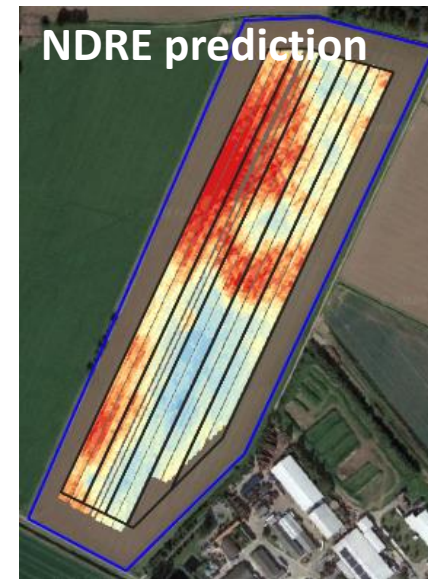
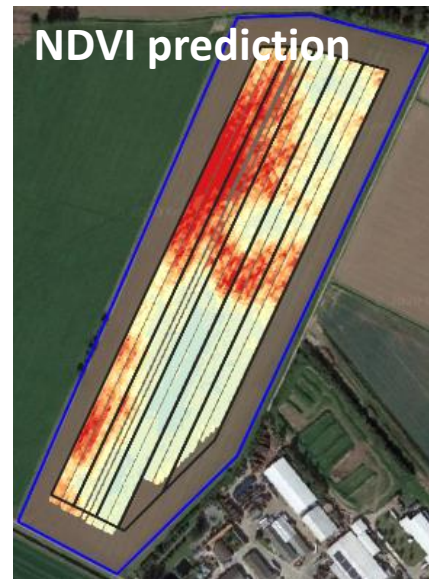
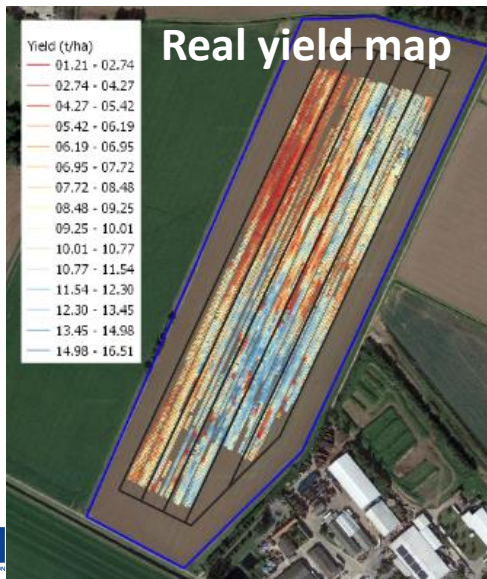
## Vining peas – trial results

- Predicted yield maps created from NDRE and NDVI (first drone flight), according to correlations with sample plot yields.
- Results very similar to actual yield map, but far more precise

Treatment	Yield from yield map	
	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

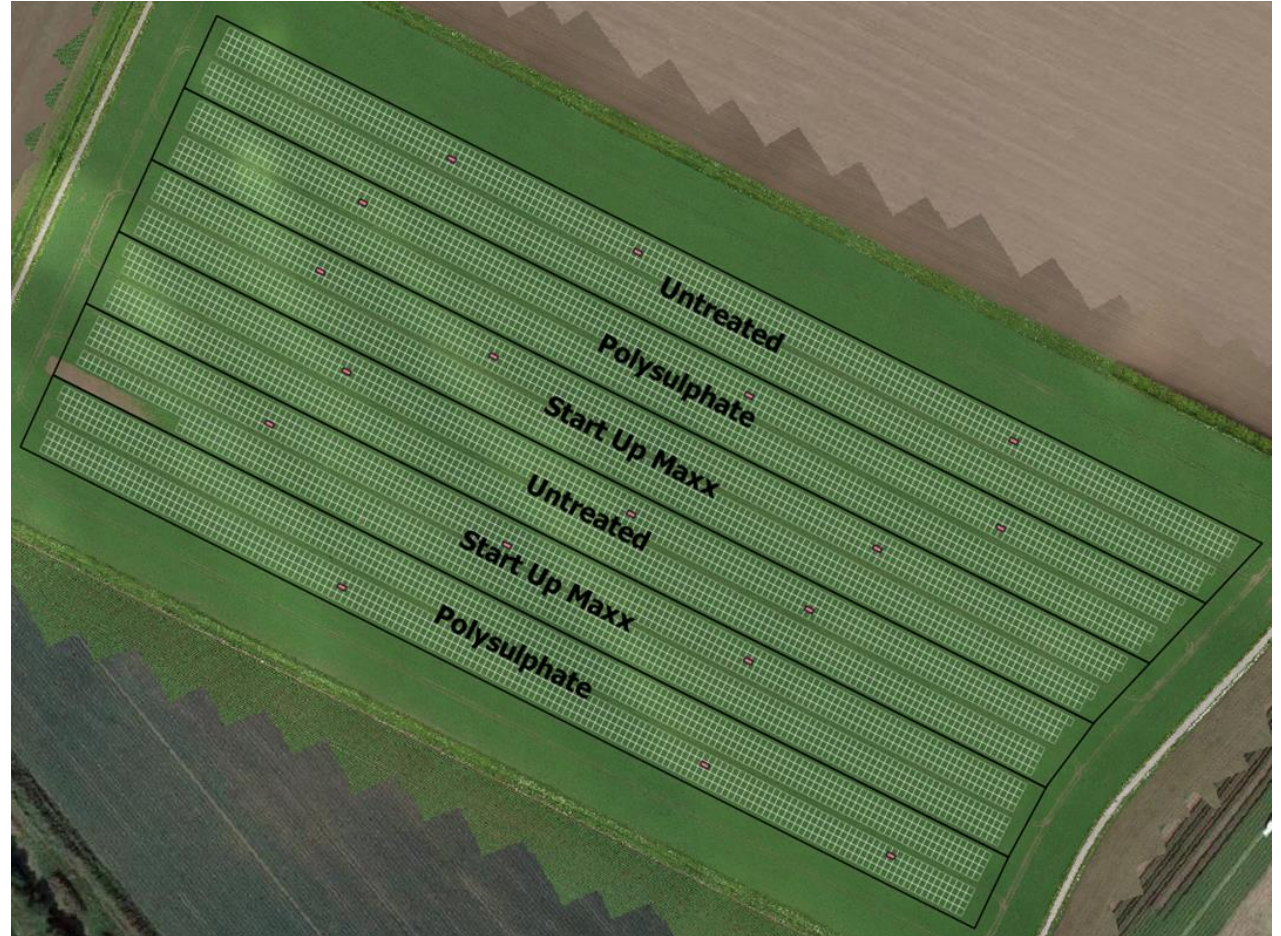
# Vining peas – real vs predicted yield maps

- Real yield map noisy and 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.



# Vining peas 2021 trial

- HMC trial site – 3 treatments x 2 replicates
- Plots one tramline (36m) wide
- Ideal trial design
- Two drone flights
- 18 yield validation plots
- Plus yield map data from farm

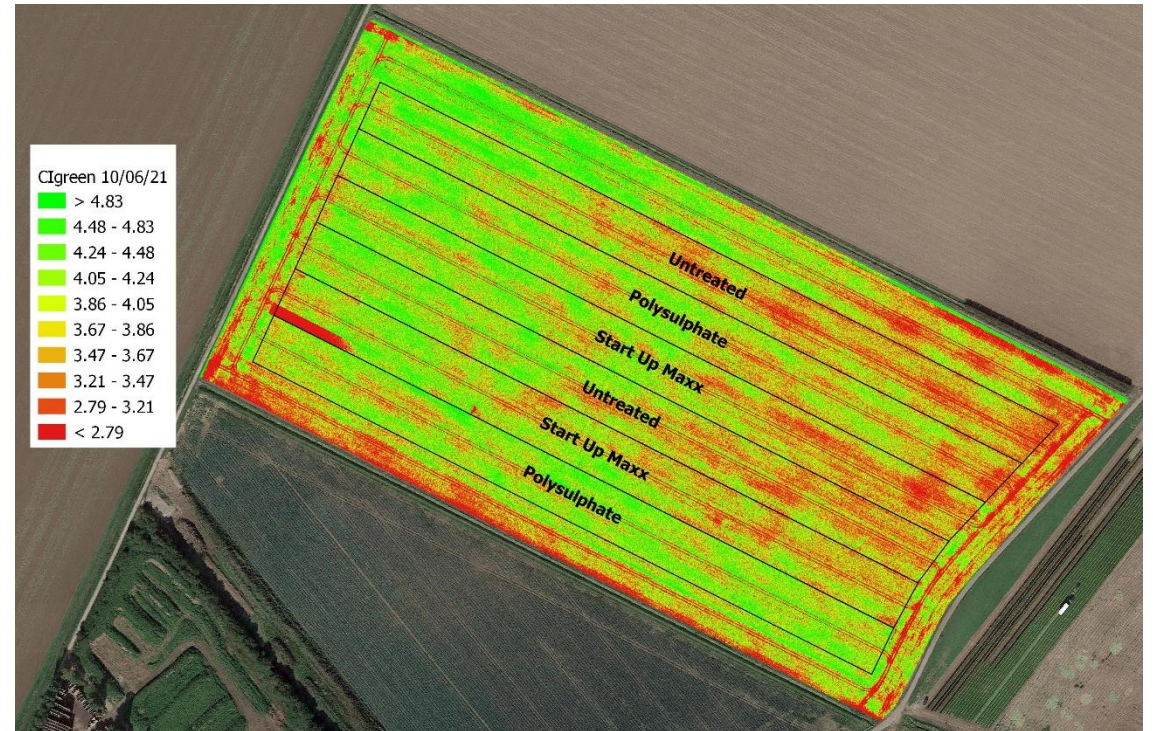


2 February  
2023

# Agronomics analysis – NDVI data

- Weaker correlations between yield and vegetation indices than in 2020
- Polysulphate significantly increased most vegetation indices

	Total fresh weight biomass (t/ha)		Marketable pea yield (t/ha)	
	Scan 1	Scan 2	Scan 1	Scan 2
	10/06/21	19/06/21	10/06/21	19/06/21
NDVI	0.55	0.63	0.17	0.25
MCARI2	0.30	0.25	0.18	0.11
MTCI	0.35	0.35	0.06	0.24
CI Green	0.44	0.62	0.09	0.27
CI RedEdge	0.40	0.41	0.08	0.25
NDRE	0.43	0.42	0.09	0.26
REIP	0.41	0.38	0.08	0.25



# Agronomics analysis – yield map data

- HMC supplied yield map with 62,000 points (high due to small harvest width)
- Cleaned data by removing headlands, harvest runs on wheelings etc
- Predicted yield lower, because validation plot yields were low

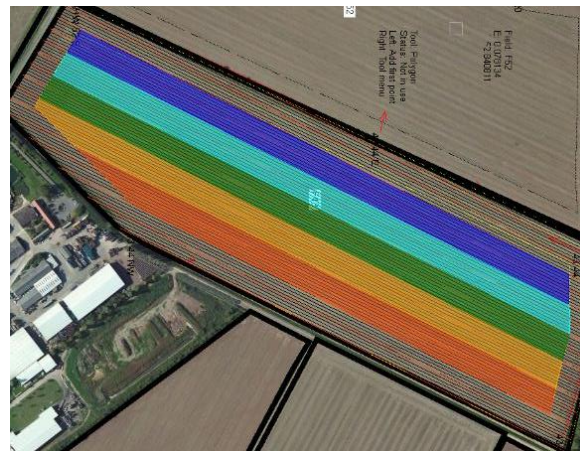


Treatment	Yield from yield map		Predicted from 19/06 NDVI	
	Mean	Modelled difference from trt 1, with 95% confidence interval	Mean	Modelled difference from trt 1, with 95% confidence interval
1 Untreated	10.19		6.00	
2 Start-up Maxx		-0.09 ± 0.61		0.01 ± 0.16
3 Polysulphate		0.49 ± 0.64		0.17 ± 0.16



# Vining peas 2020 vs 2021

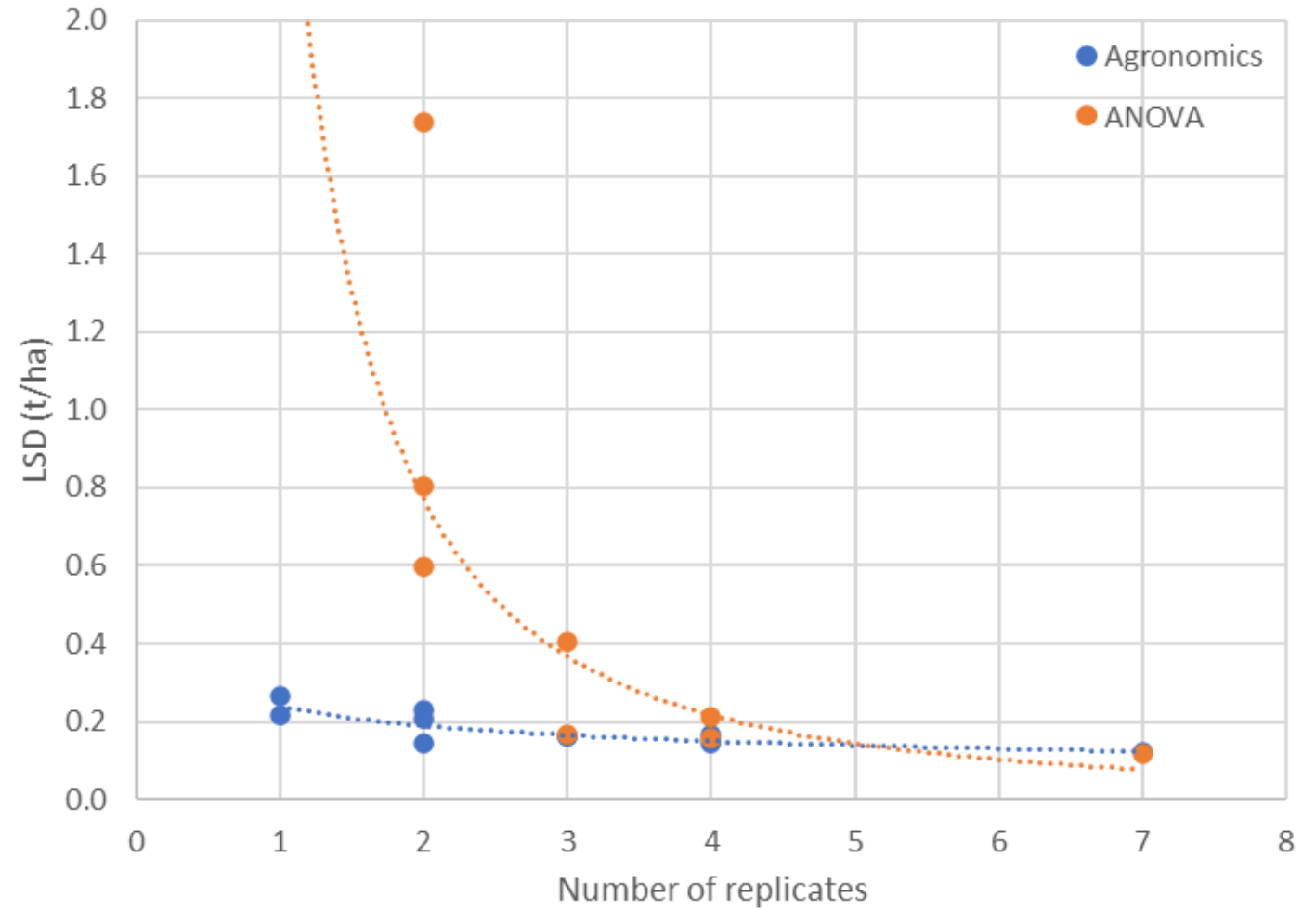
	2020	2021
Trial design	5 treatments x 1 rep	3 treatments x 2 reps
LSD: yield map	1.4 t/ha	0.6 t/ha
LSD: predicted yield map	0.31 t/ha	0.16 t/ha
LSD: NDVI	0.013	0.009



# Agronomics vs conventional statistics



2 Seas Mers Zeeën  
INNO-VEG  
European Regional Development Fund



## 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
- Guidance published in '*Framework for farmer led research*'





# Questions

[Susie.Roques@adas.co.uk](mailto:Susie.Roques@adas.co.uk)

# HMC

## YIELD MAPPING AND CROP SENSING



# CONTENTS

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- Jack Harris – Introduction to HMC
- Yield Mapping and Autosteer
- Crop Sensing technology
- On Farm Trials
- Yield Predictions

# Introduction to HMC



# Introduction to HMC



HMC



# Introduction to HMC



# Yield Mapping & Autosteer

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- Yield Mapping involves weigh cells taking a reading every few seconds with a GPS position being logged against it
- It allows us to see how many peas we are getting in a specific area
- Data is given back by each viner and is cleaned and merged to make maps which show good and poor areas of the field
- Autosteer uses the same GPS technology and will steer the viner in a dead straight line with 1cm accuracy
- Each viner shares data with the others
- HMC were the first pea group to adopt Autosteer and Yield Mapping in the UK

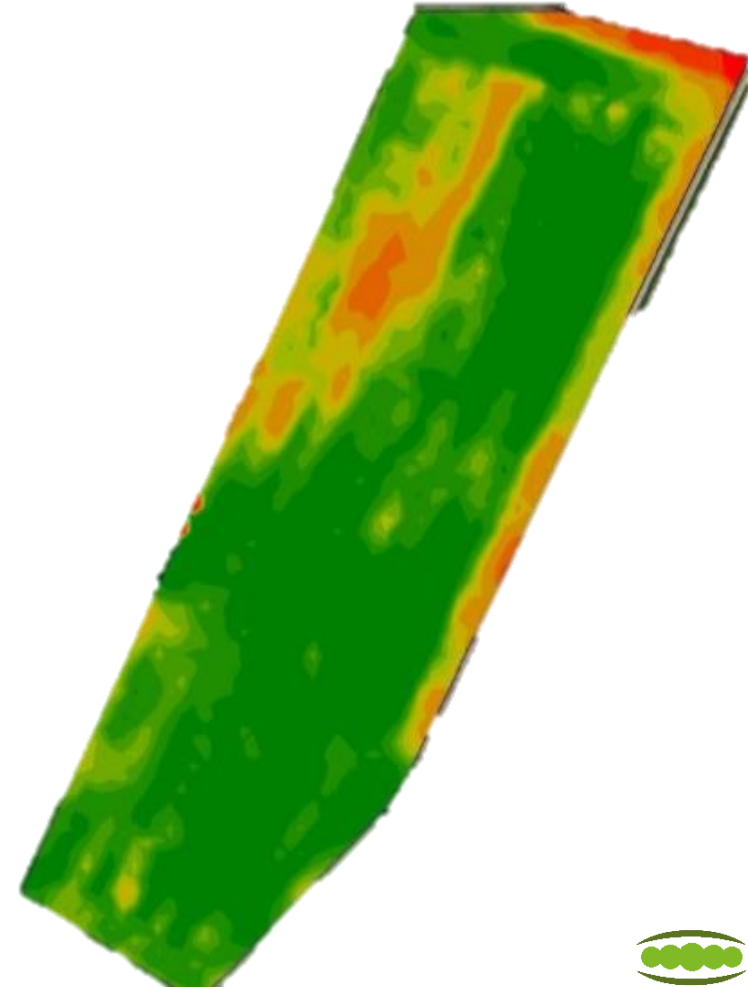
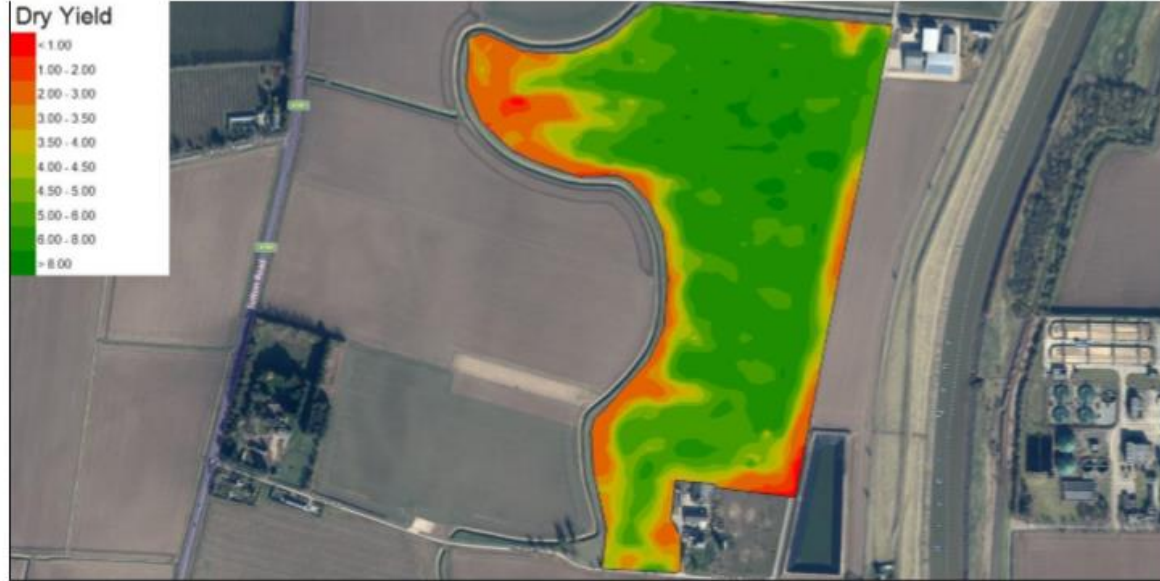
# Yield Mapping & Autosteer



# Yield Mapping & Autosteer

2021 007 HTK      Variety: Peas Vining      Crop: Peas Vining      Working ha: 20.68

Product	Units	Date	Area (ha)	Rate	Quantity	Moisture%
Dry Yield	t	Actual: 30/06/2021	19.95	5.063	101.000	



# Crop Sensing Technology

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- Yield is the base of the data as we can use it to corroborate other data we have
- We started 6 years ago with drone technology using RGB cameras to fly fields and compare against yield data
- After a year of doing this, we moved to a tractor mounted sensor called the Fritzmeir Isaria which utilises 4 different wavelengths and is an active sensor (not passive like RGB). This means the data isn't affected by changes in light or conditions of the crop.
- Using the Isaria we were able to start making predictions for yield. At that time satellite data was hit and miss and the data wasn't readily available to use and process.
- About 2 years ago we made the switch to satellite data to allow us to collect more field data and for a reduced cost. We use NDRE index in satellite data as the work ADAS have done with us suggests a good correlation to yield using that index.

# Crop Sensing Technology



# 2020 Trials

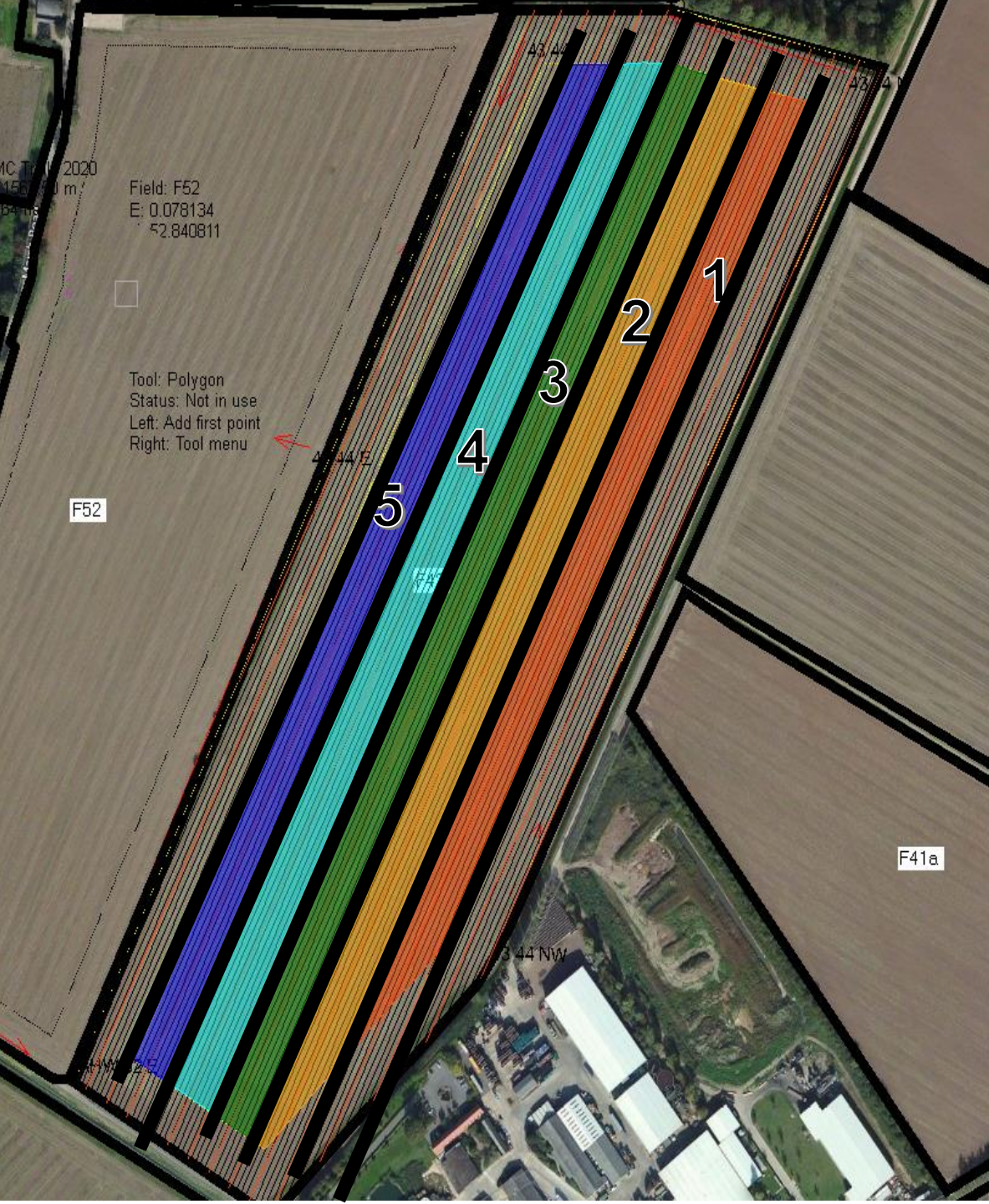
- Amalfi
- Drilled 30<sup>th</sup> March
- Harvested 28<sup>th</sup> June
- Rainfall during grow period 70mm





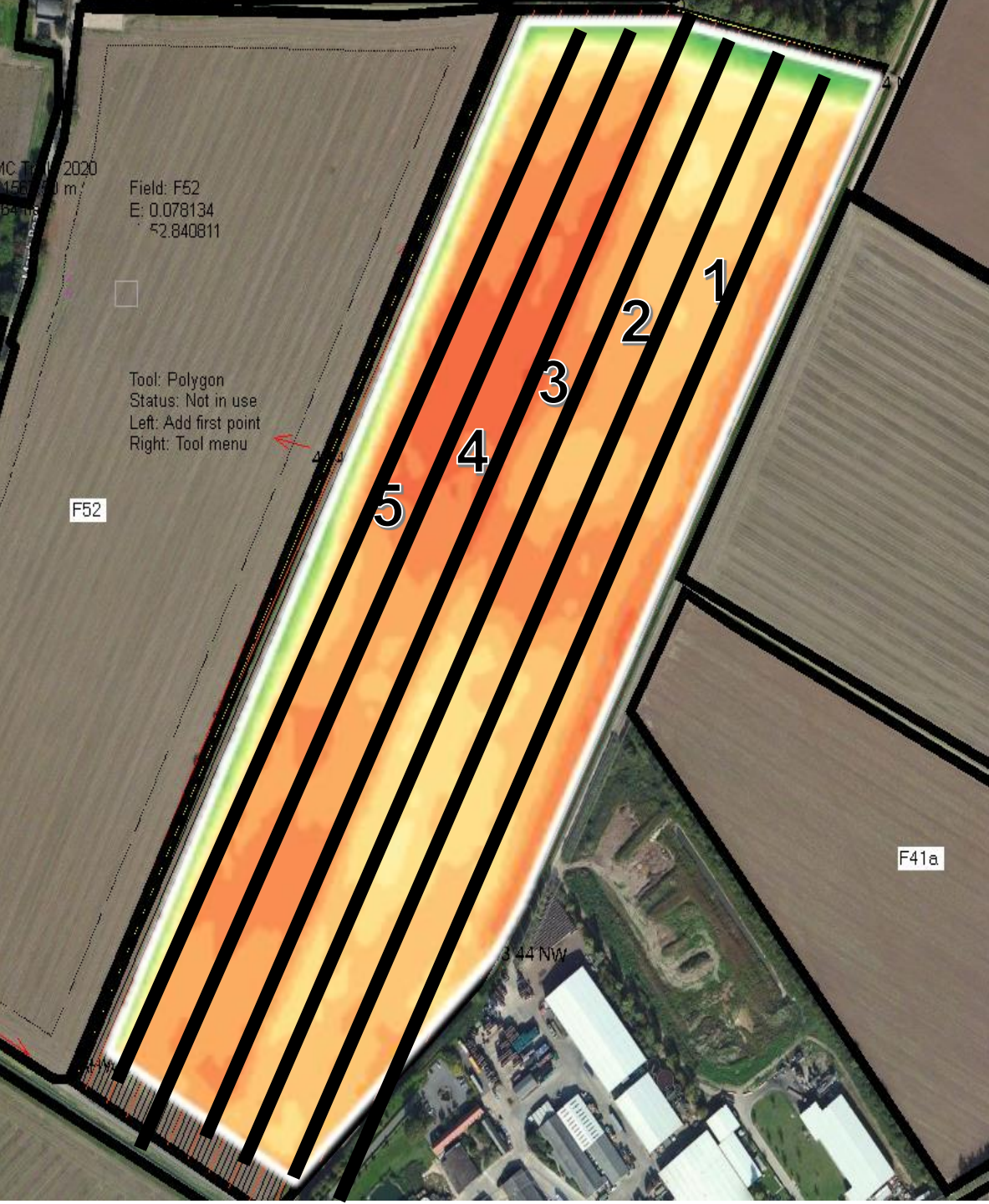


# 2020 Trials



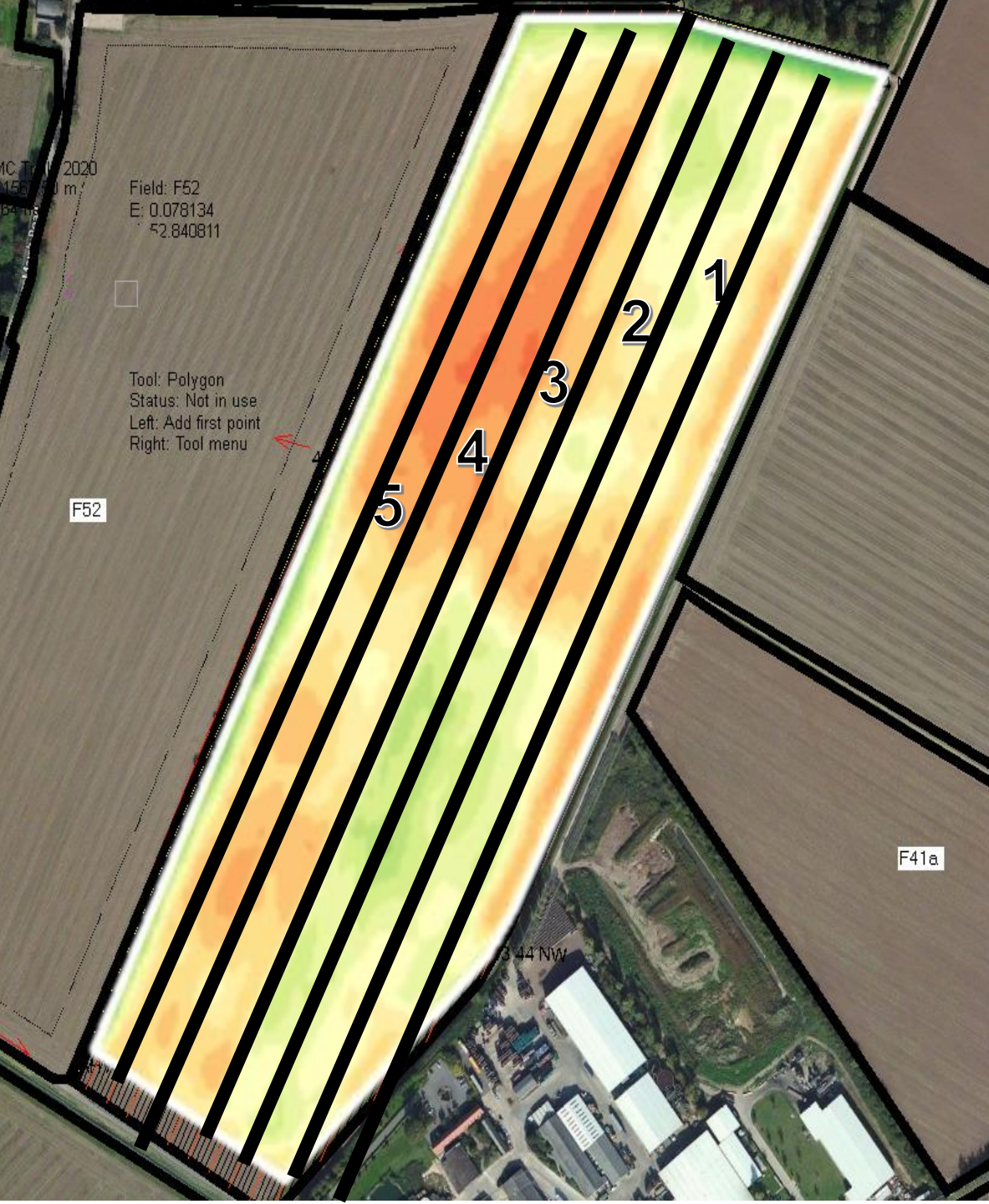
1. Untreated
2. Liquid Fert
3. Poly Sulphate
4. Poly Sulphate and Start Up
5. Start Up

# 11<sup>th</sup> May



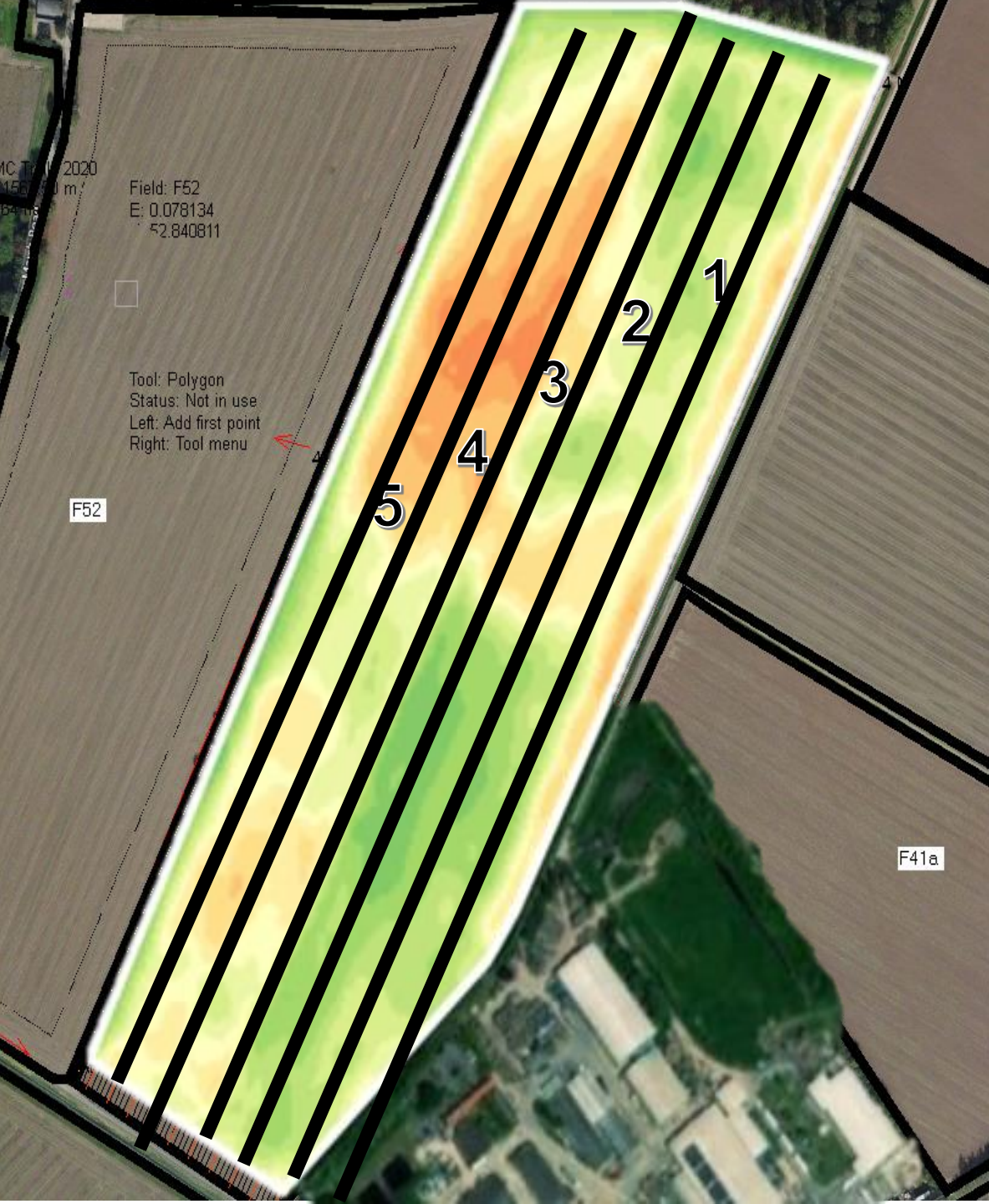
1. Untreated
2. Liquid Fert
3. Poly Sulphate
4. Poly Sulphate and Start Up
5. Start Up

# 21<sup>st</sup> May



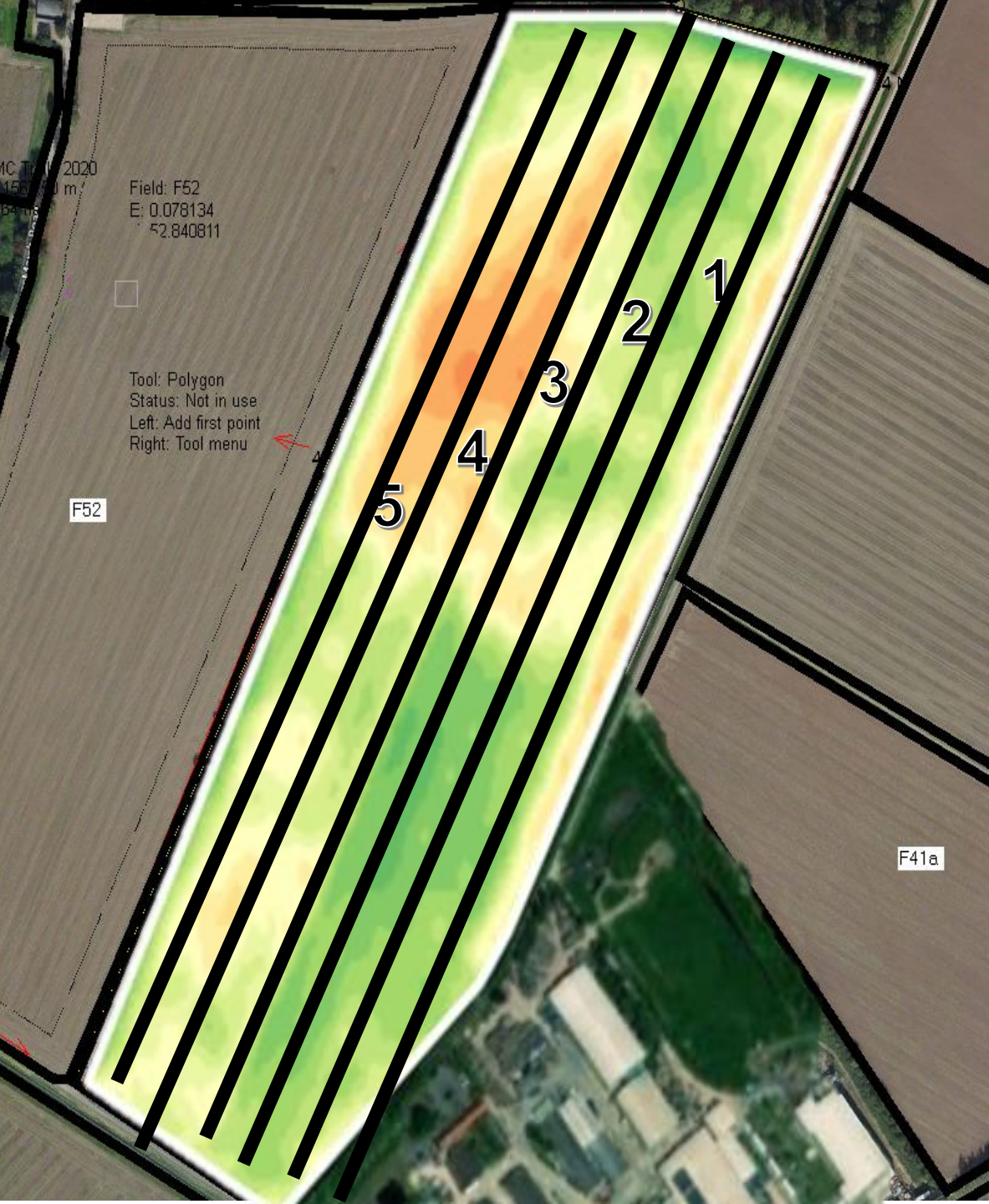
1. Untreated
2. Liquid Fert
3. Poly Sulphate
4. Poly Sulphate and Start Up
5. Start Up

# 28<sup>th</sup> May



1. Untreated
2. Liquid Fert
3. Poly Sulphate
4. Poly Sulphate and Start Up
5. Start Up

# 31<sup>st</sup> May



1. Untreated
2. Liquid Fert
3. Poly Sulphate
4. Poly Sulphate and Start Up
5. Start Up

# 21<sup>st</sup> June



1. Untreated
2. Liquid Fert
3. Poly Sulphate
4. Poly Sulphate and Start Up
5. Start Up

# 20<sup>th</sup> June



1. Untreated
2. Liquid Fert
3. Poly Sulphate
4. Poly Sulphate and Start Up
5. Start Up

# 25<sup>th</sup> June



1. Untreated
2. Liquid Fert
3. Poly Sulphate
4. Poly Sulphate and Start Up
5. Start Up



# Yield



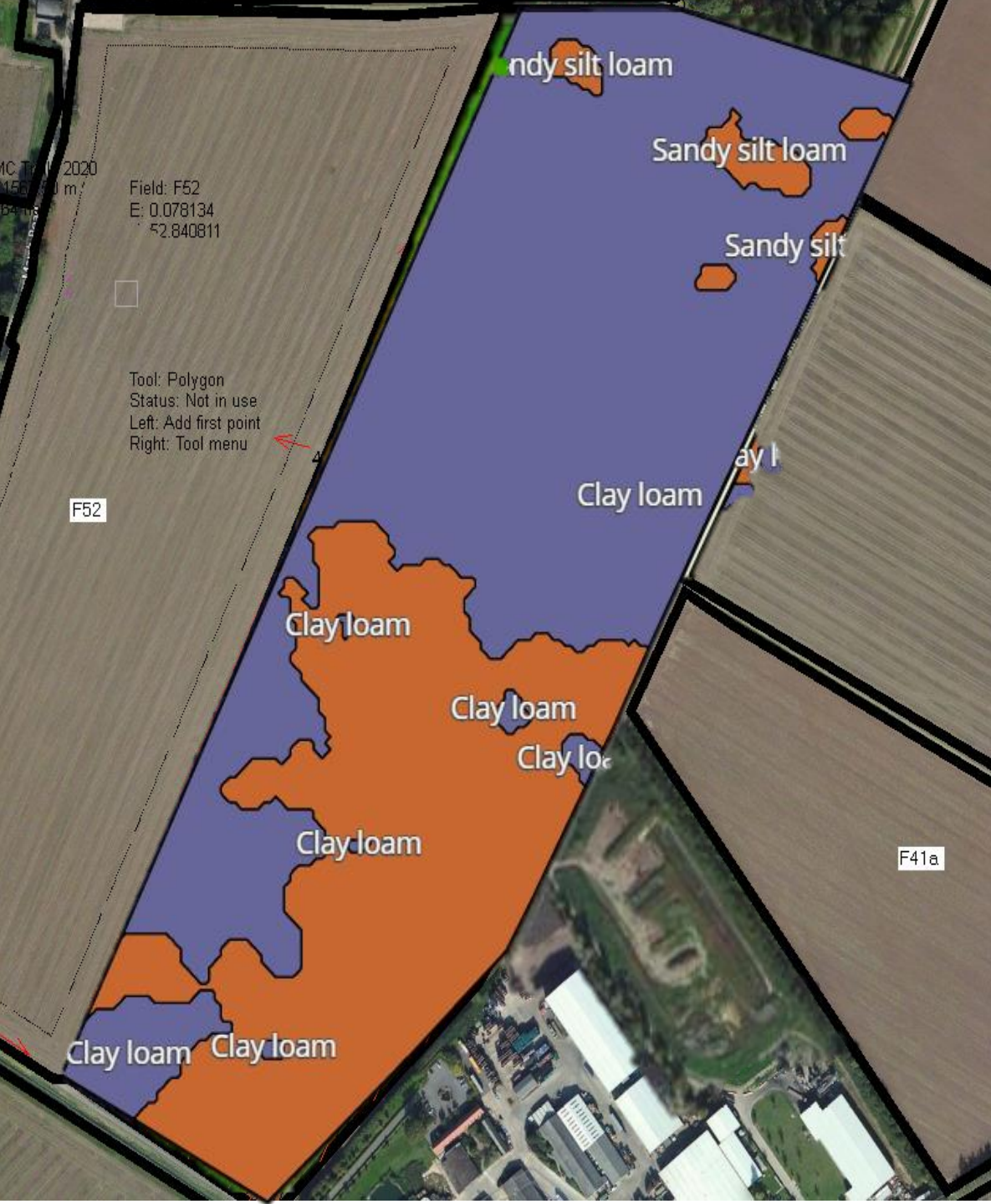
1. Untreated	9.56T/ha
2. Liquid Fert	10.12T/ha
3. Poly Sulphate	9.56T/ha
4. Poly Sulphate and Start Up	8.75T/ha
5. Start Up	6.45T/ha

# Lessons Learnt

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- Field Choice needs to be better
- Scan and look at Satellite History
- Repeat Plots if possible
- We are on right track to yield prediction and data collected by Innoveg helping
- Scanned with Soil Optix after harvest to show field zones and correlation to yield

# Soil Scans



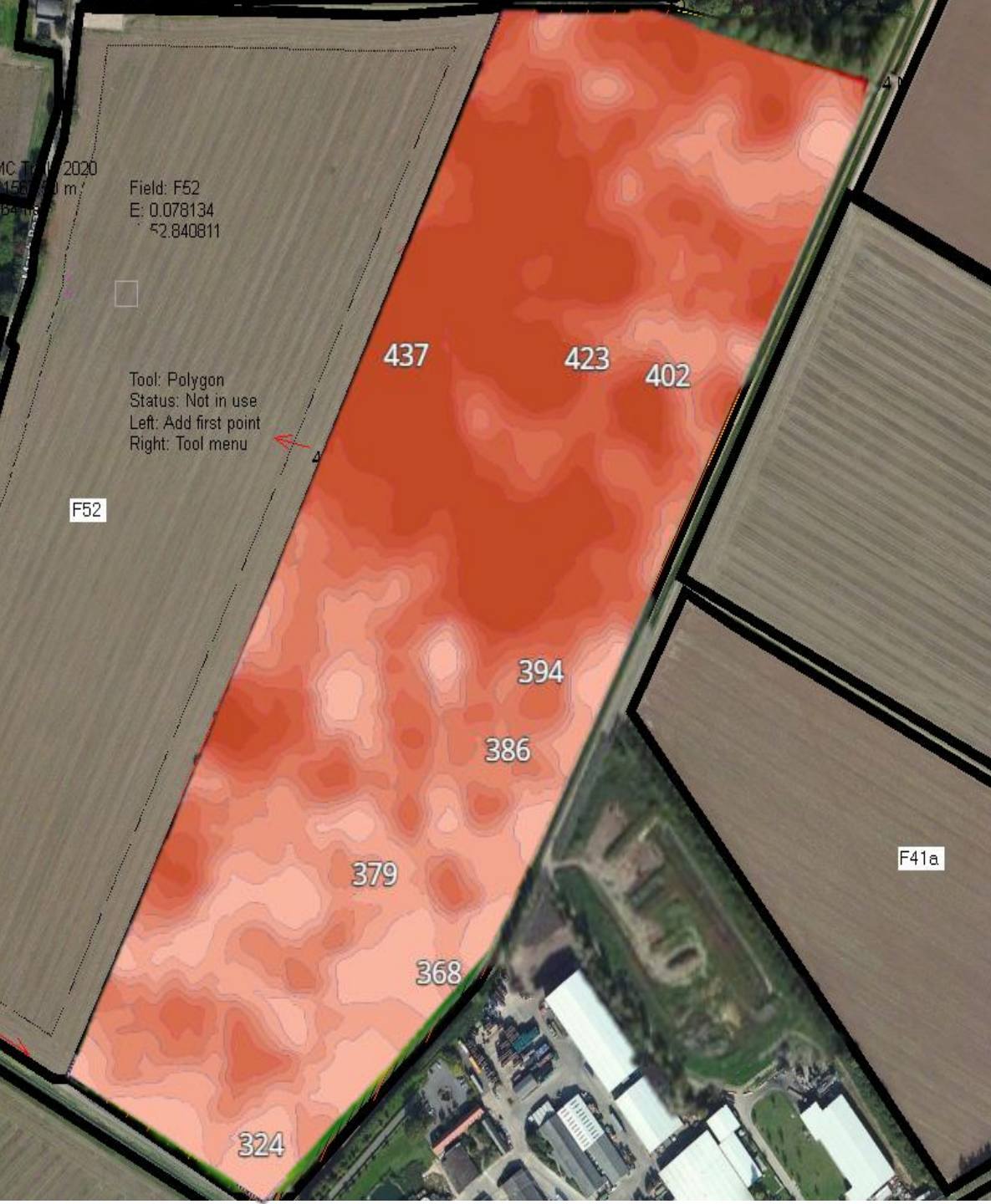
## Soil Texture

# Soil Scans



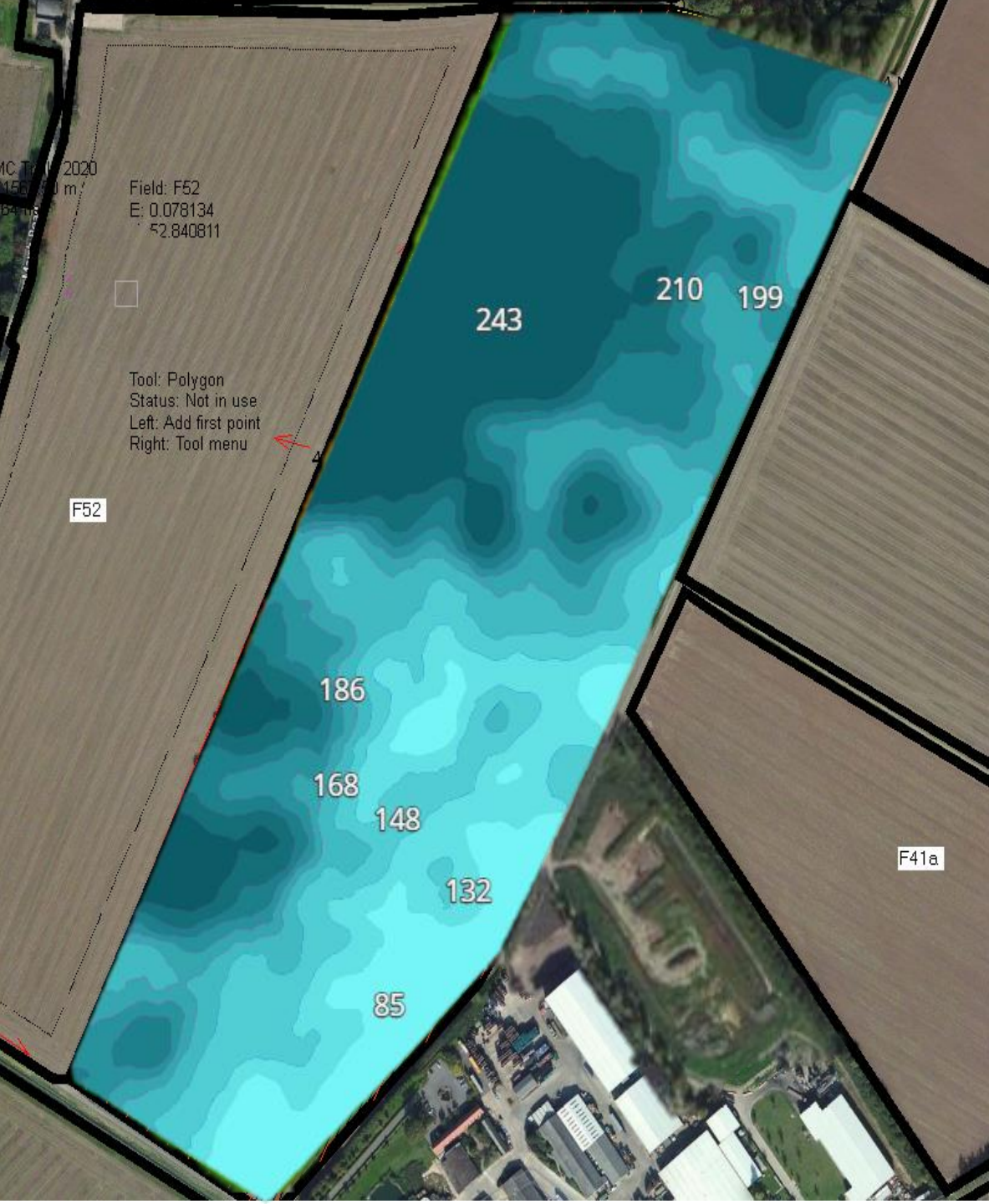
P Index 2-3

# Soil Scans



K Index 3-4

# Soil Scans



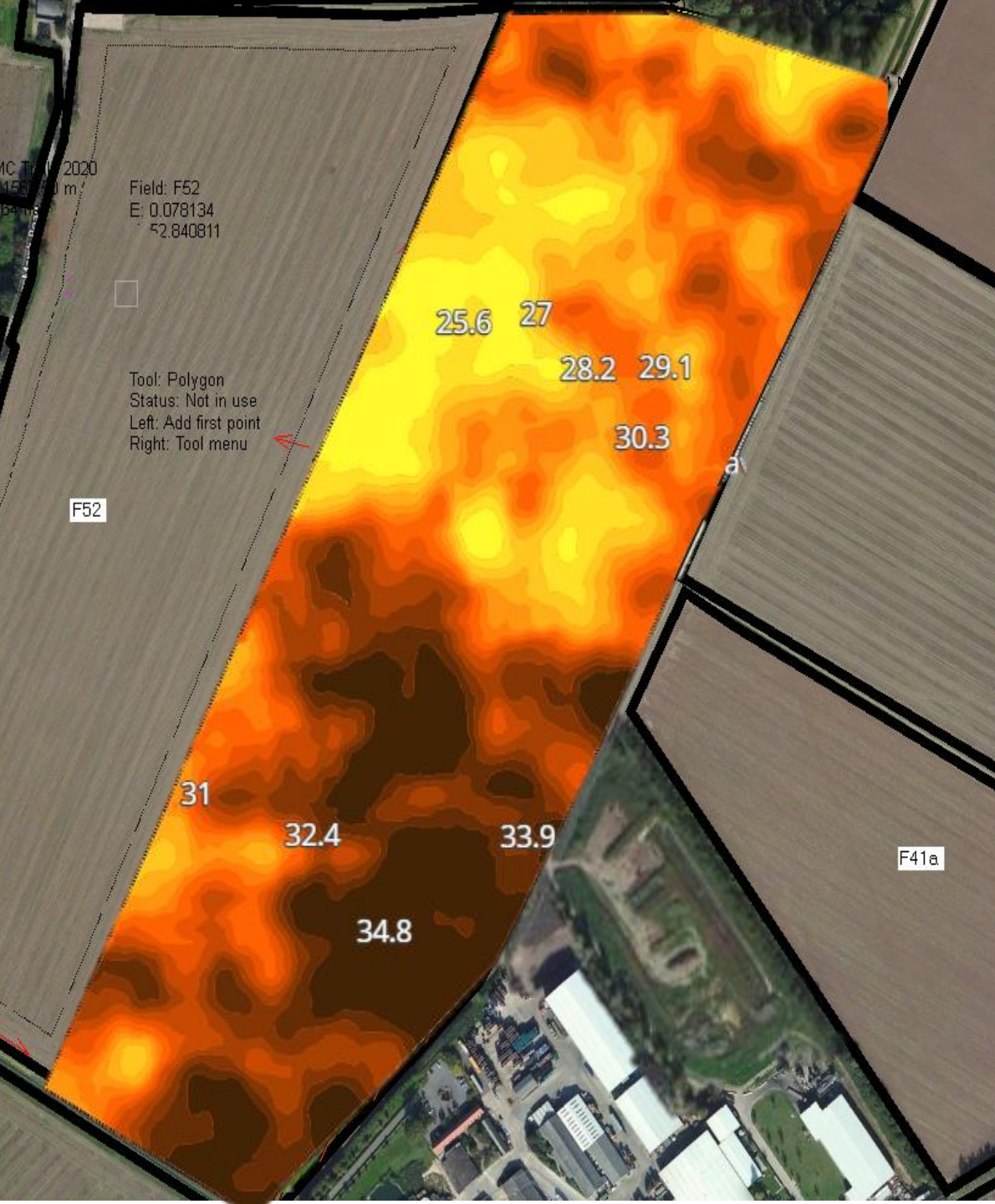
Mg Index 2-4

# Soil Scans



p.H

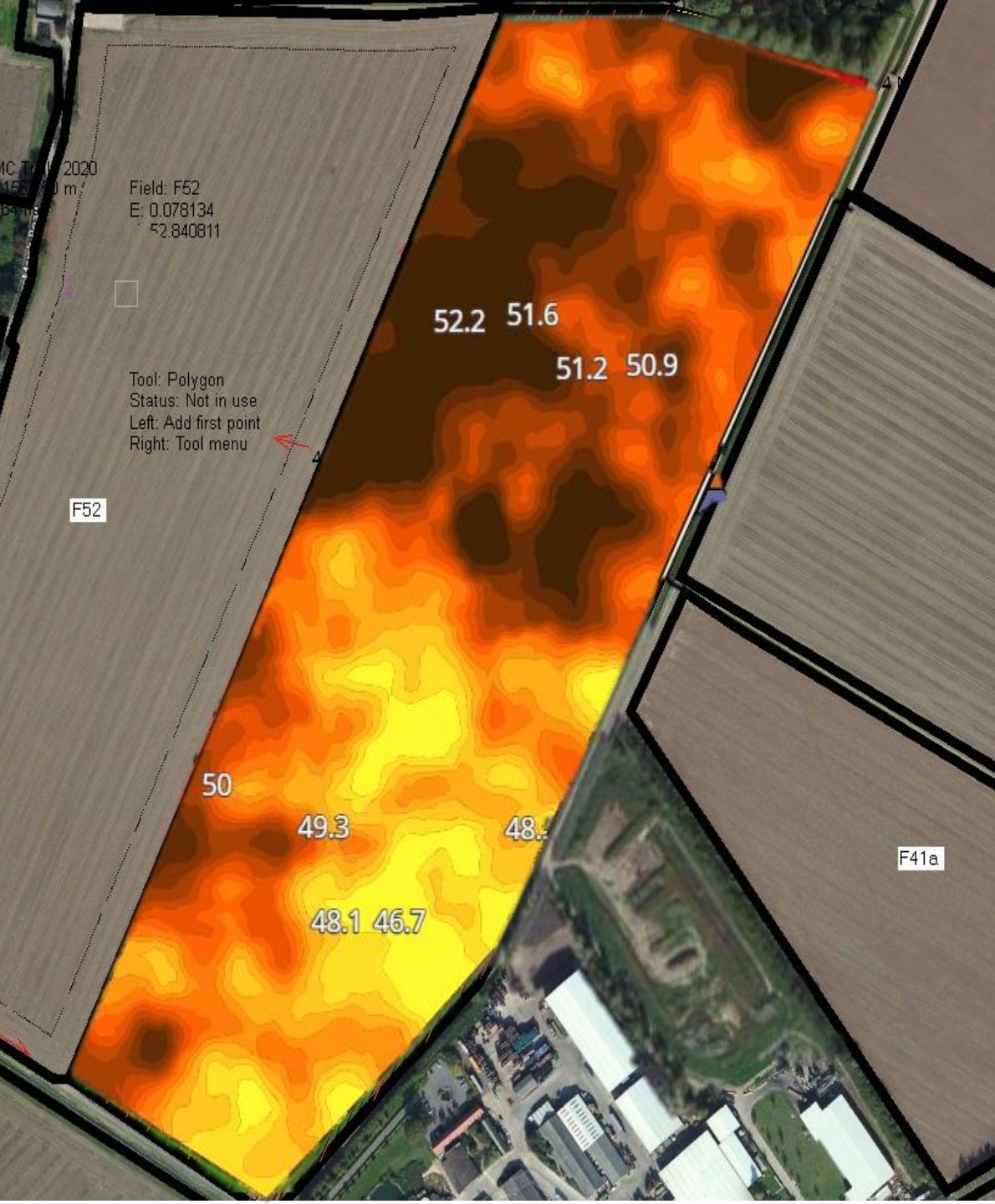
# Soil Scans



**SAND %**

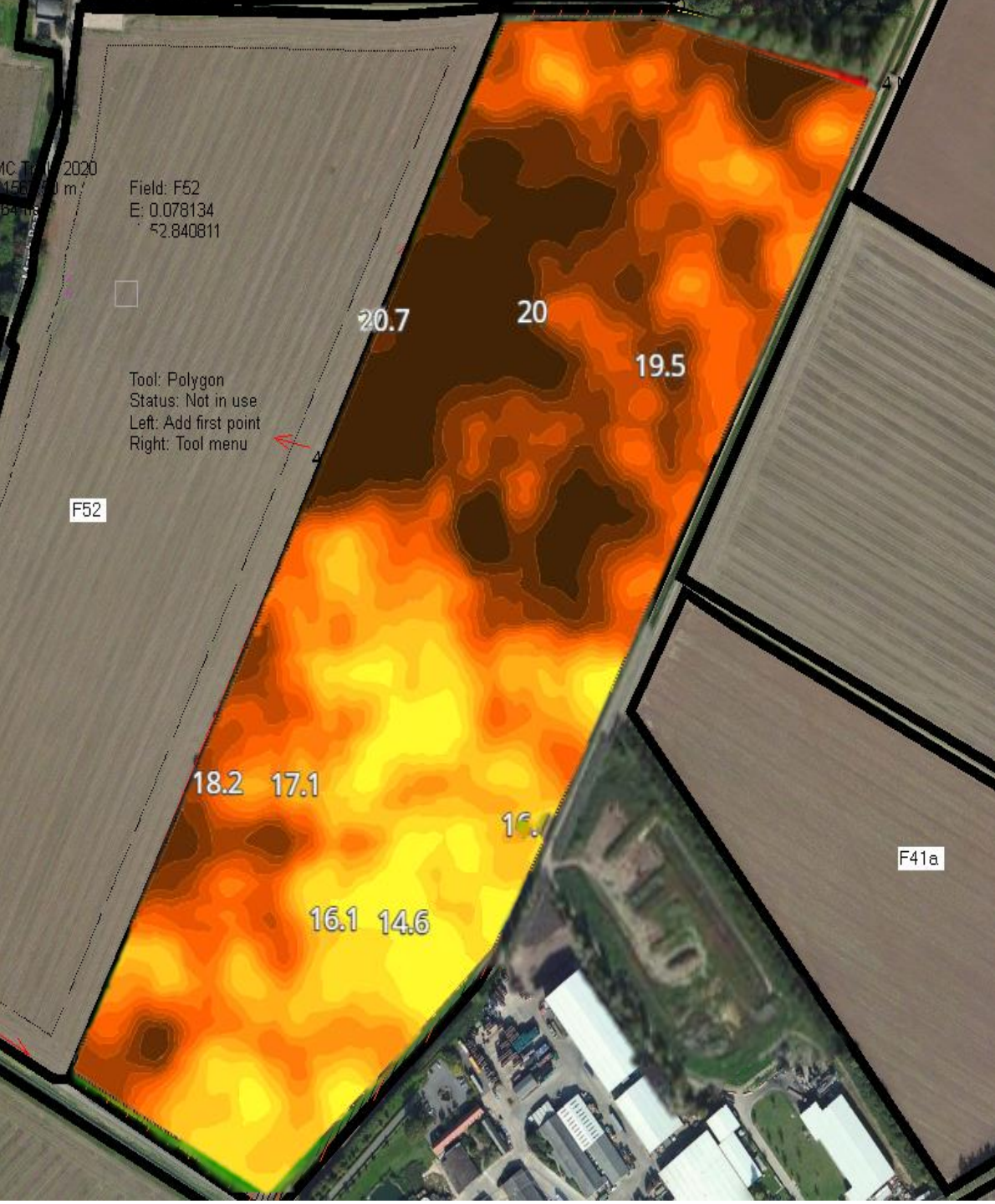


# Soil Scans



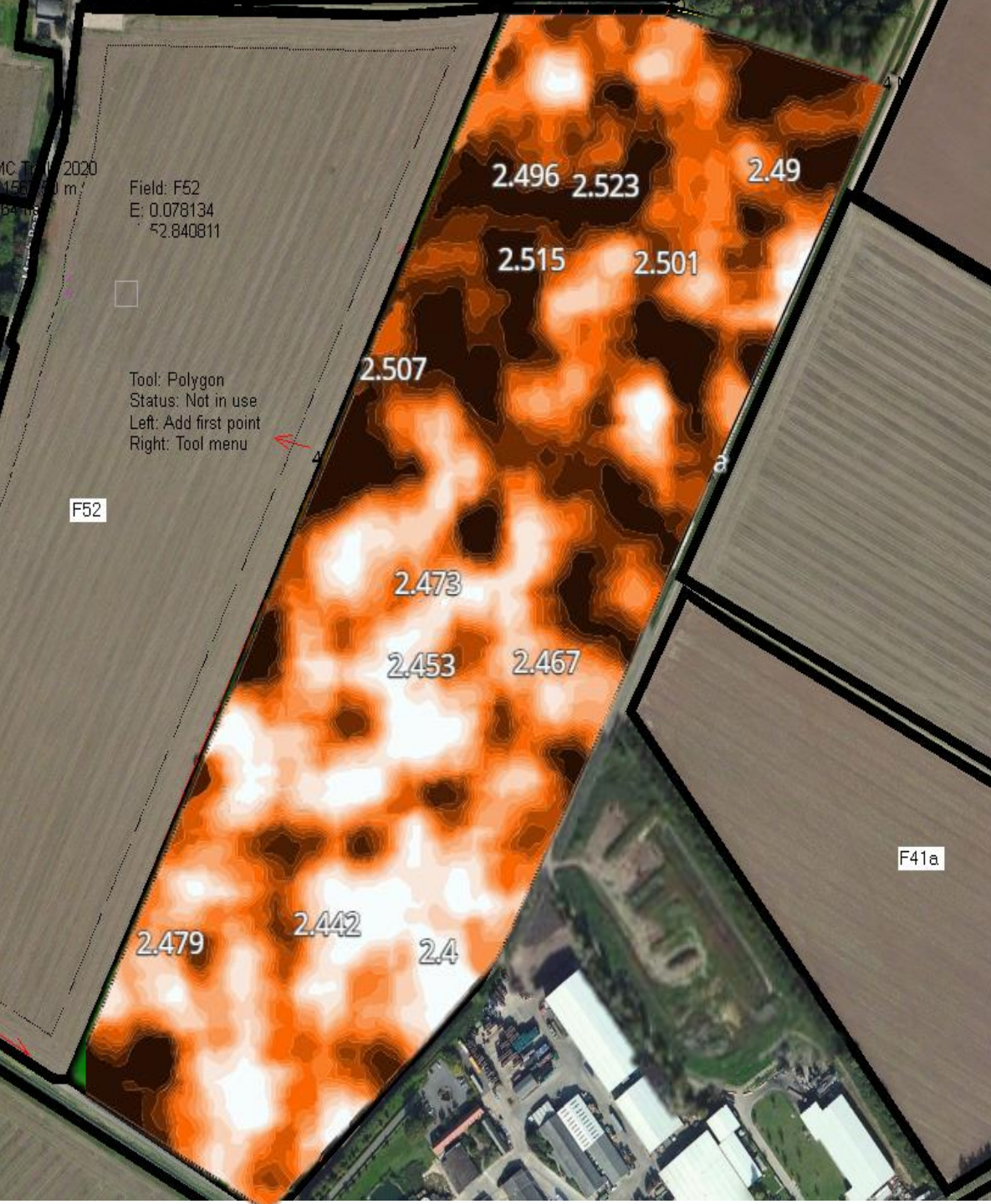
SILT %

# Soil Scans



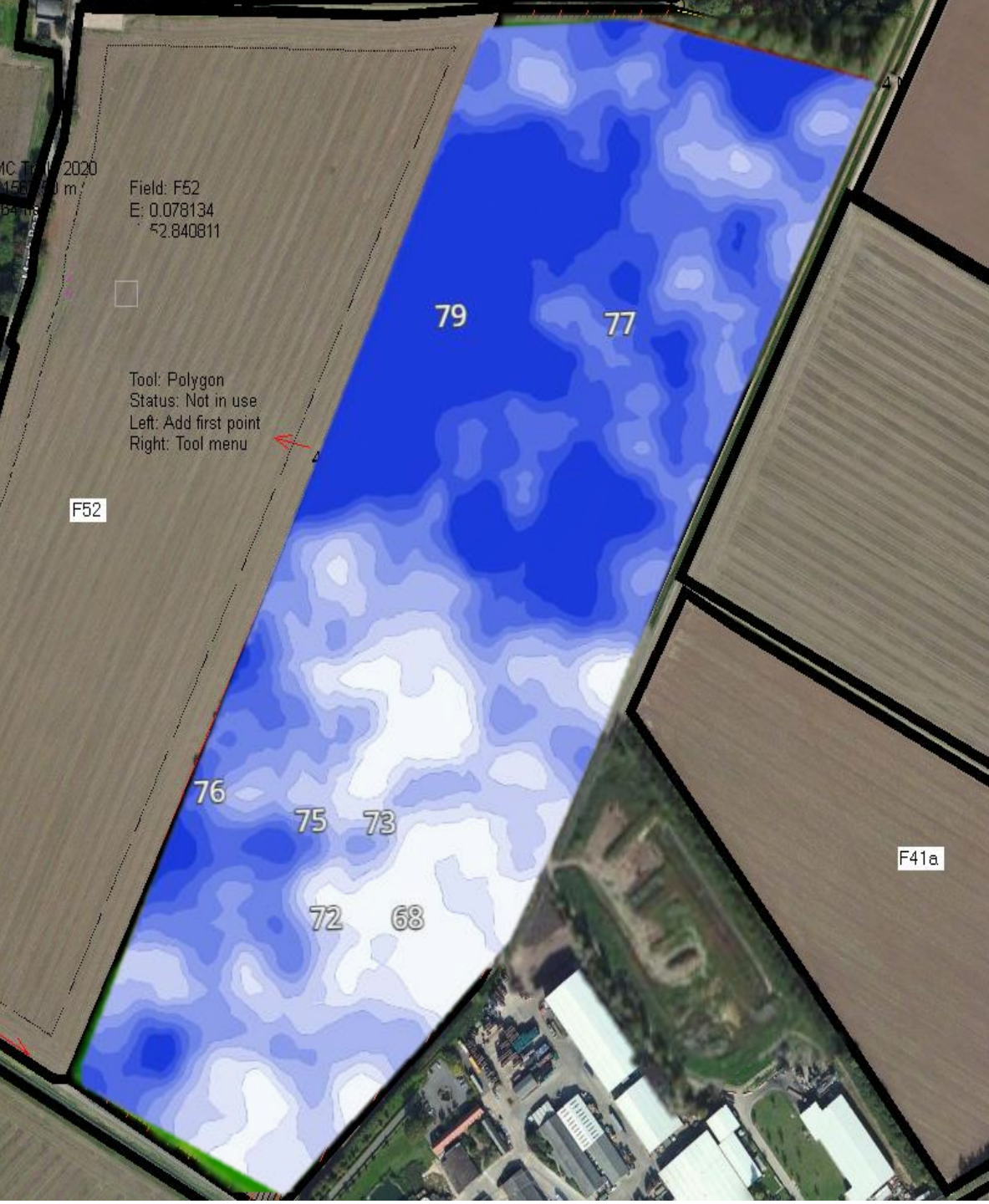
CLAY %

# Soil Scans



OM %

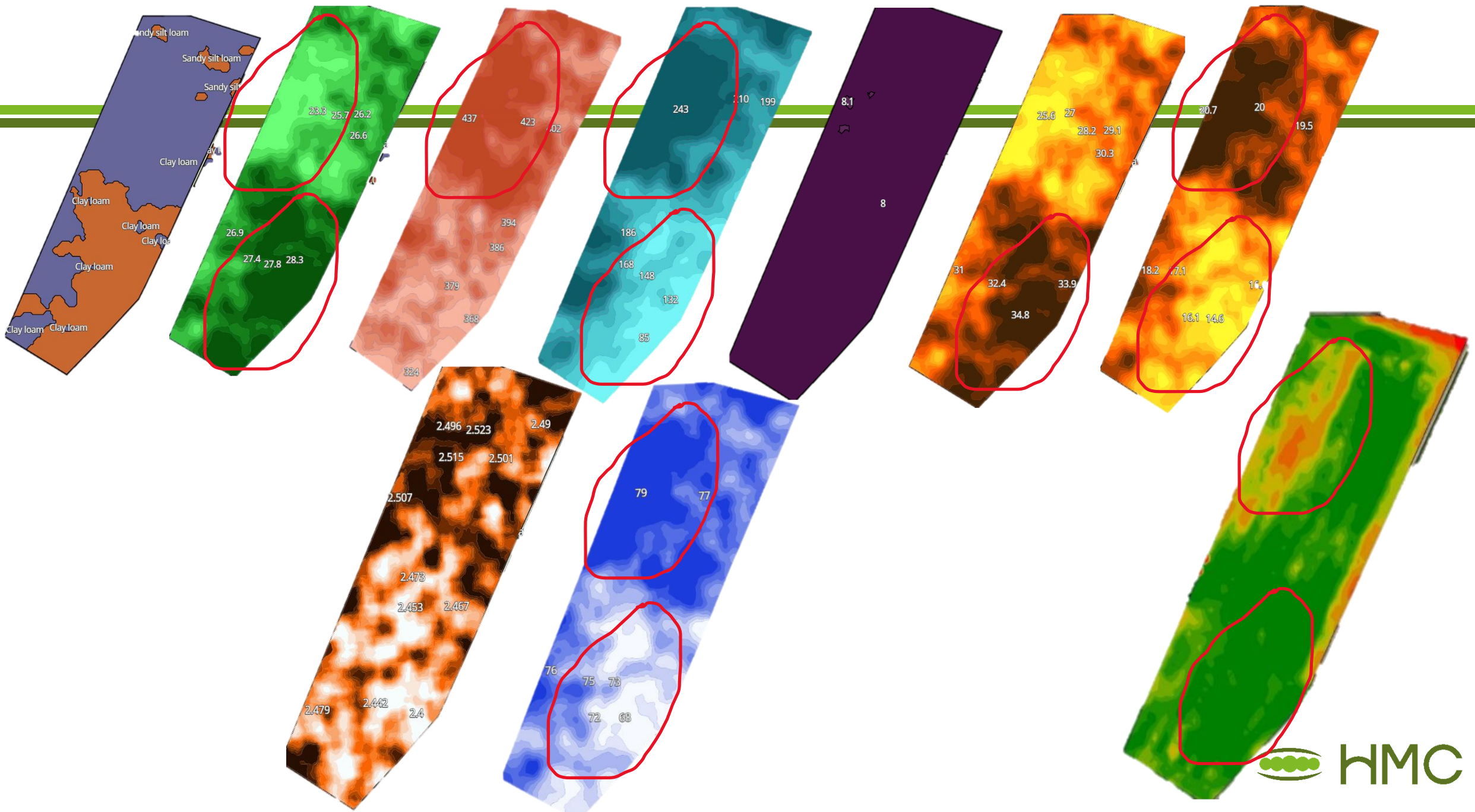
# Soil Scans



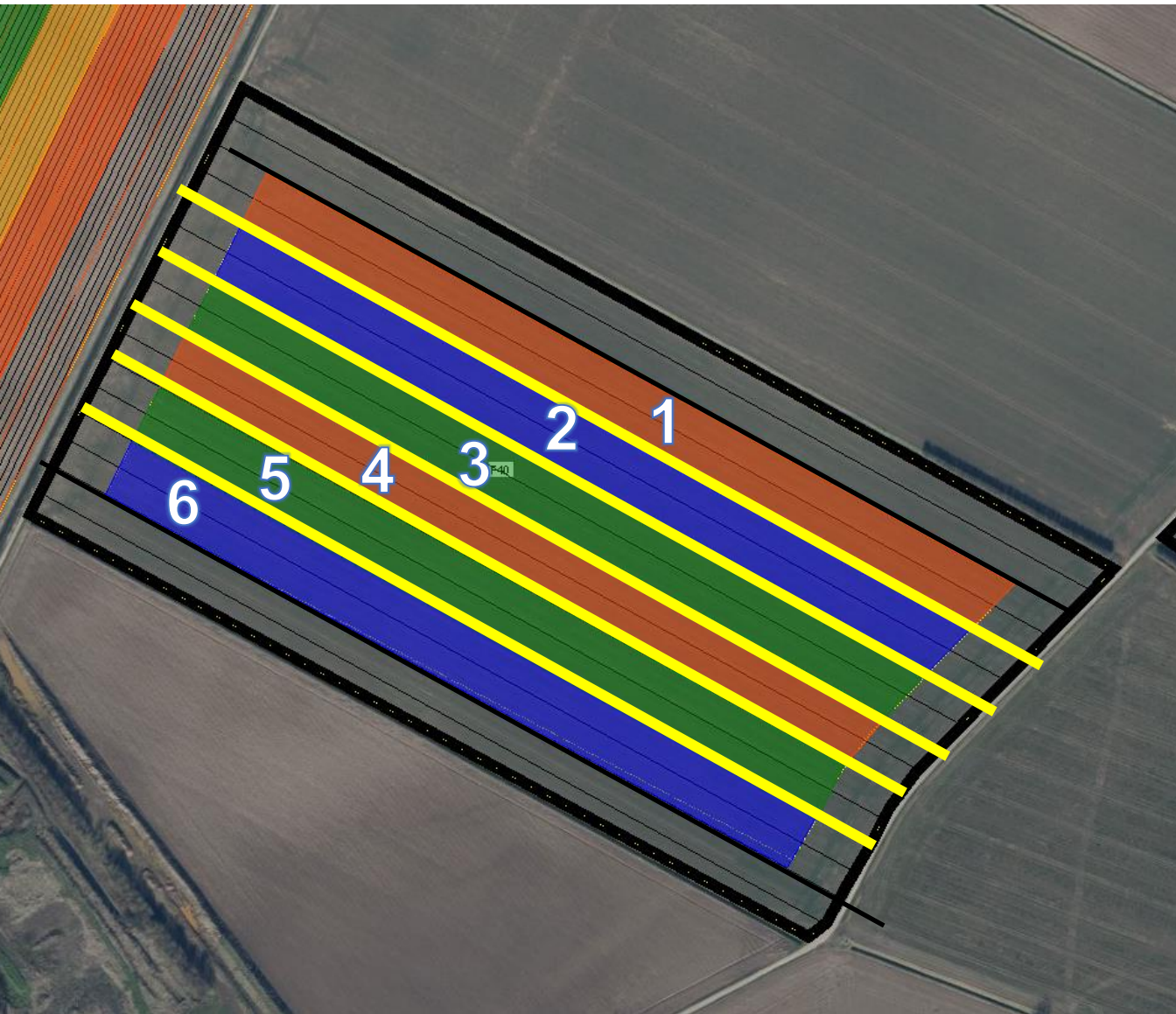
## WATER AVILABLE INDEX

1-100

Combination of Sand, Silt and Clay to give water holding value.  
Higher the number the higher the ability to hold water.

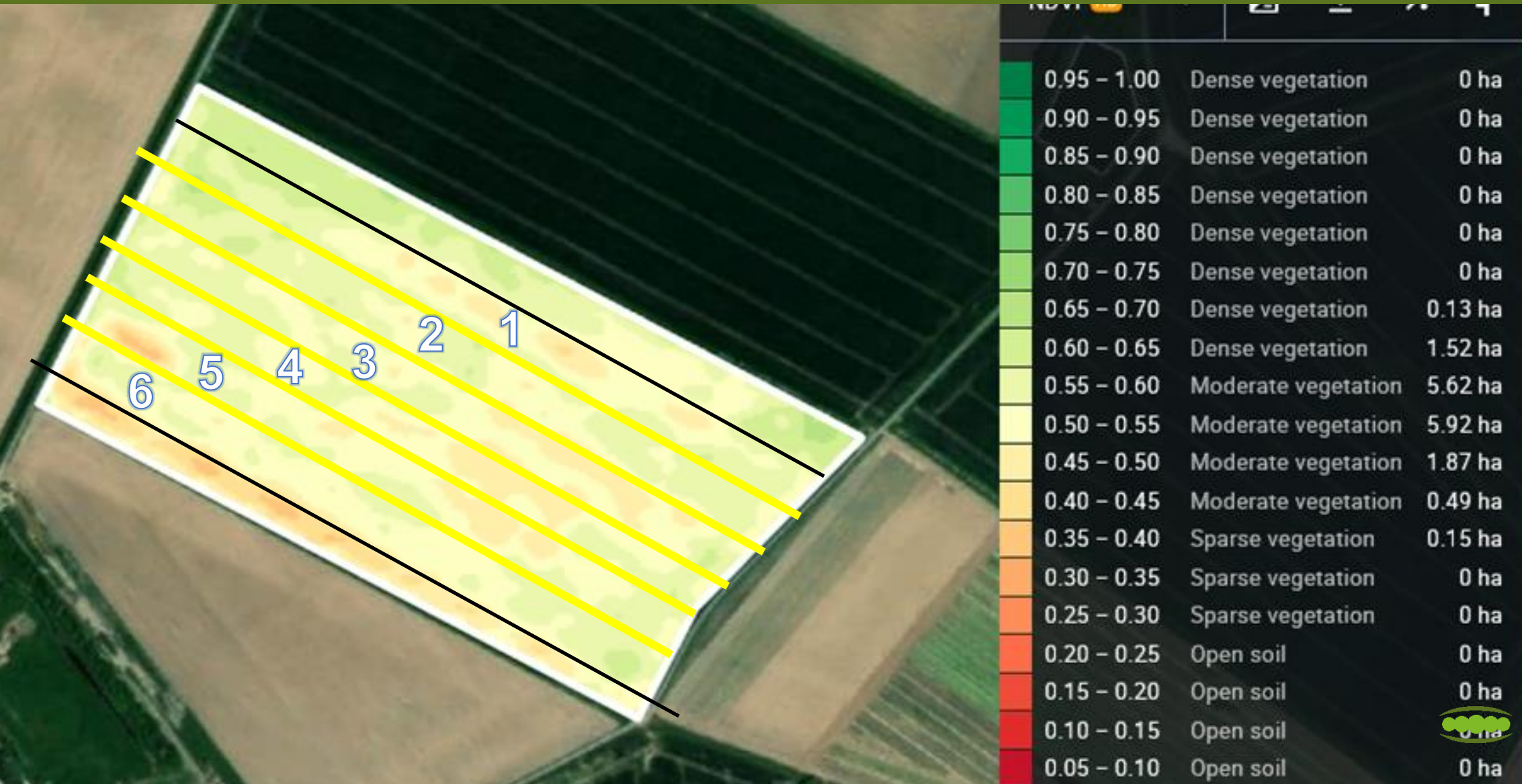


# 2021 Trials



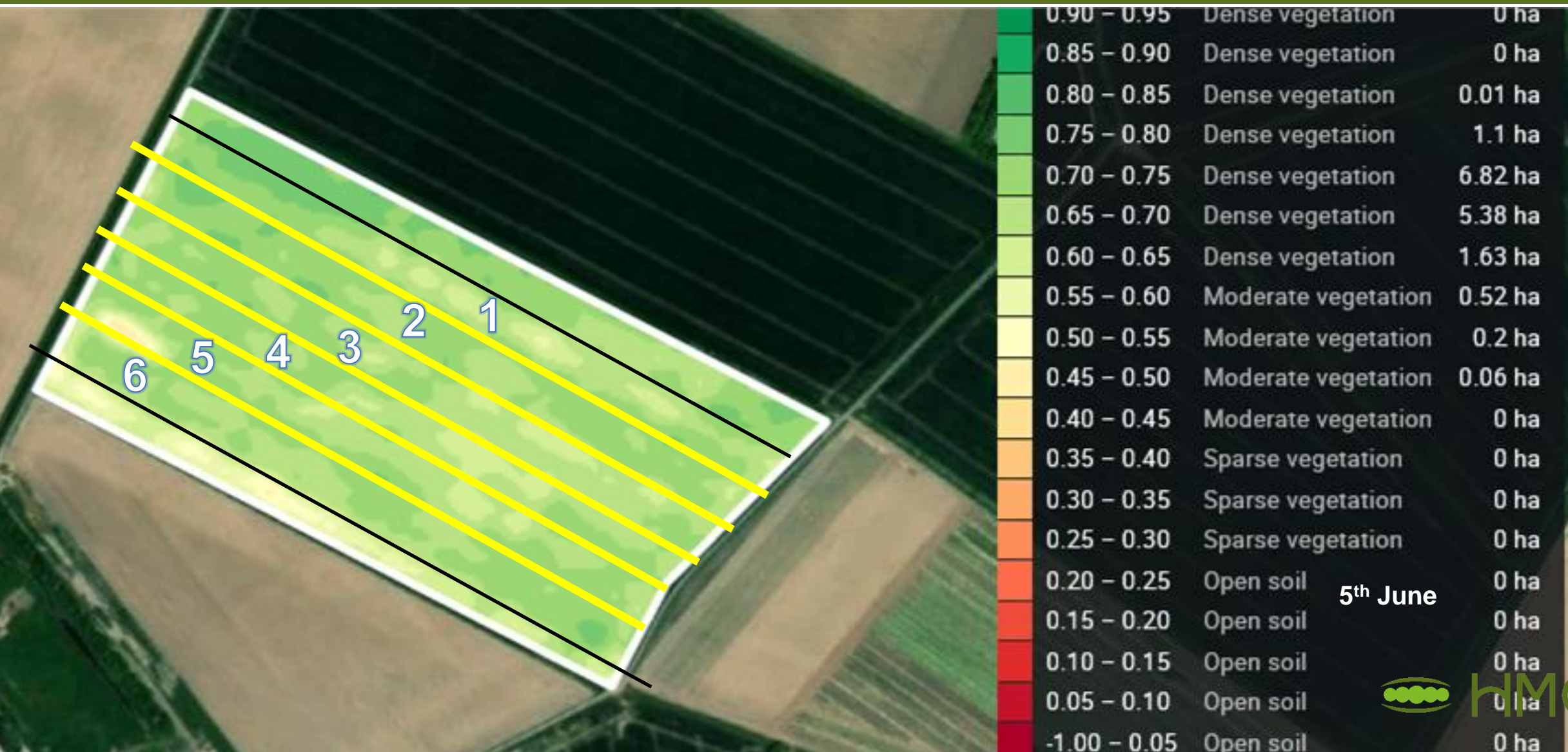
1. Untreated
2. StartUp Maxx
3. Poly Sulphate
4. Untreated
5. Poly Sulphate
6. StarUp Maxx

# 2021 Trials



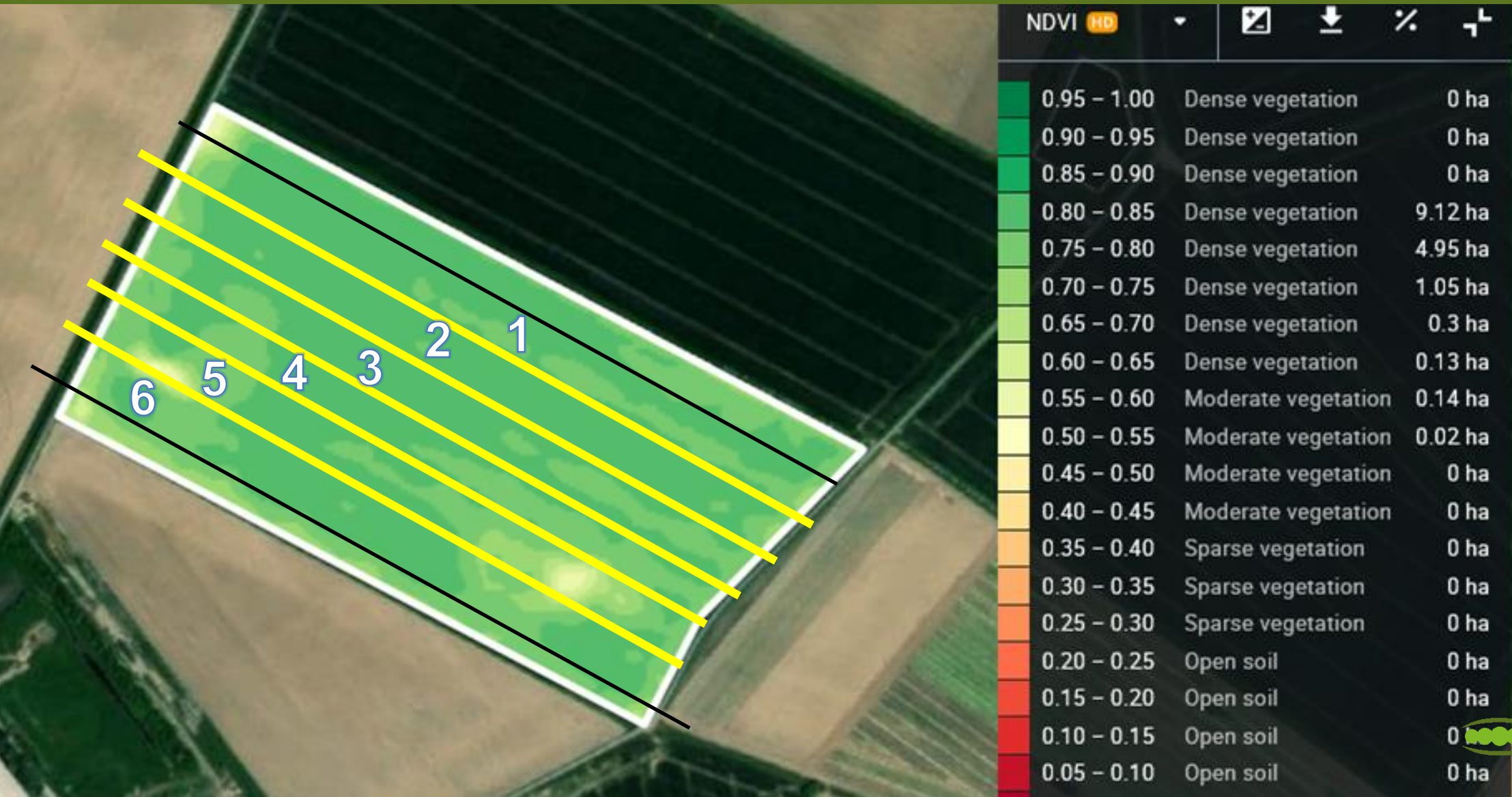
2<sup>nd</sup> June

# 2021 Trials



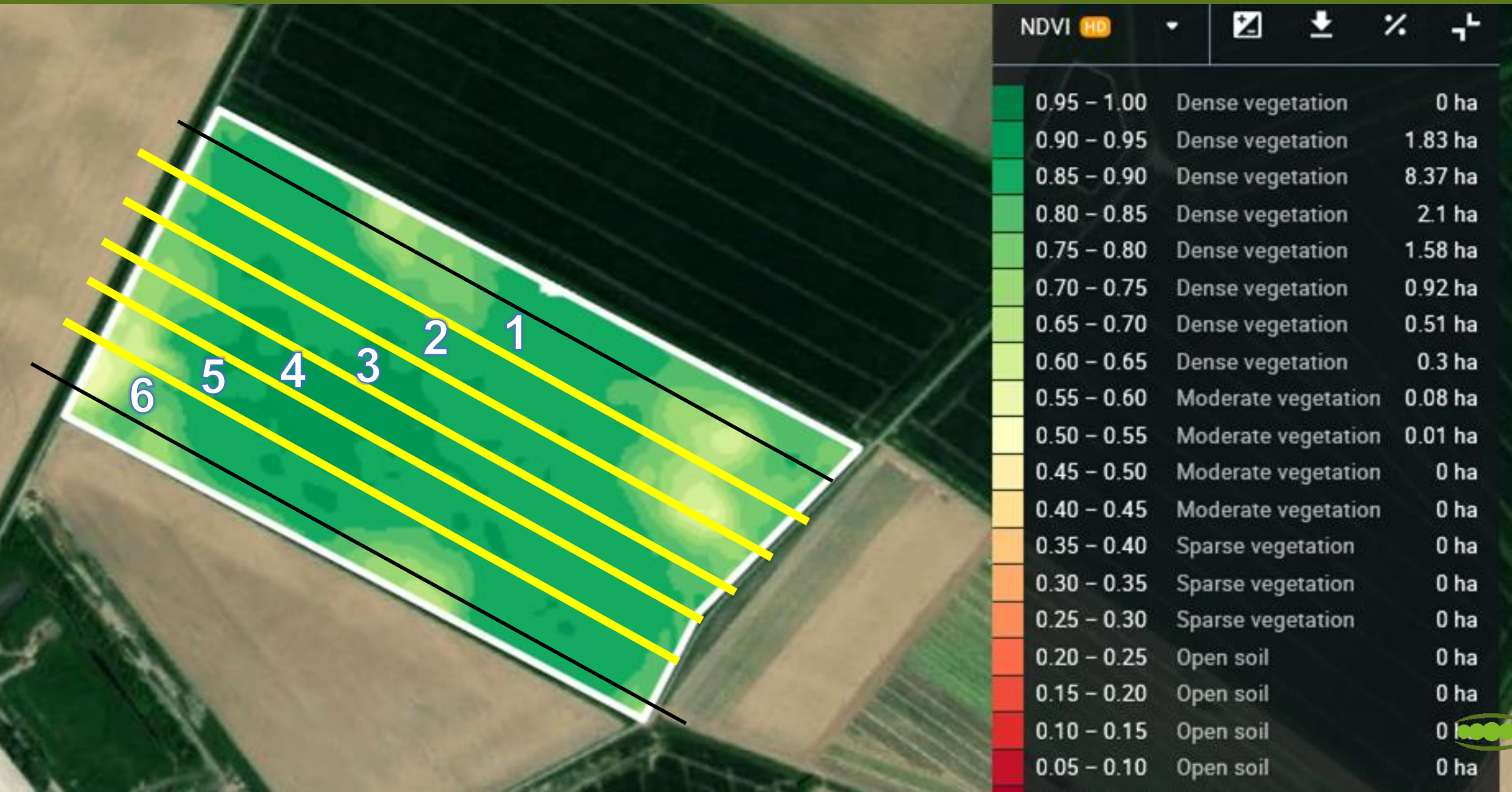


# 2021 Trials



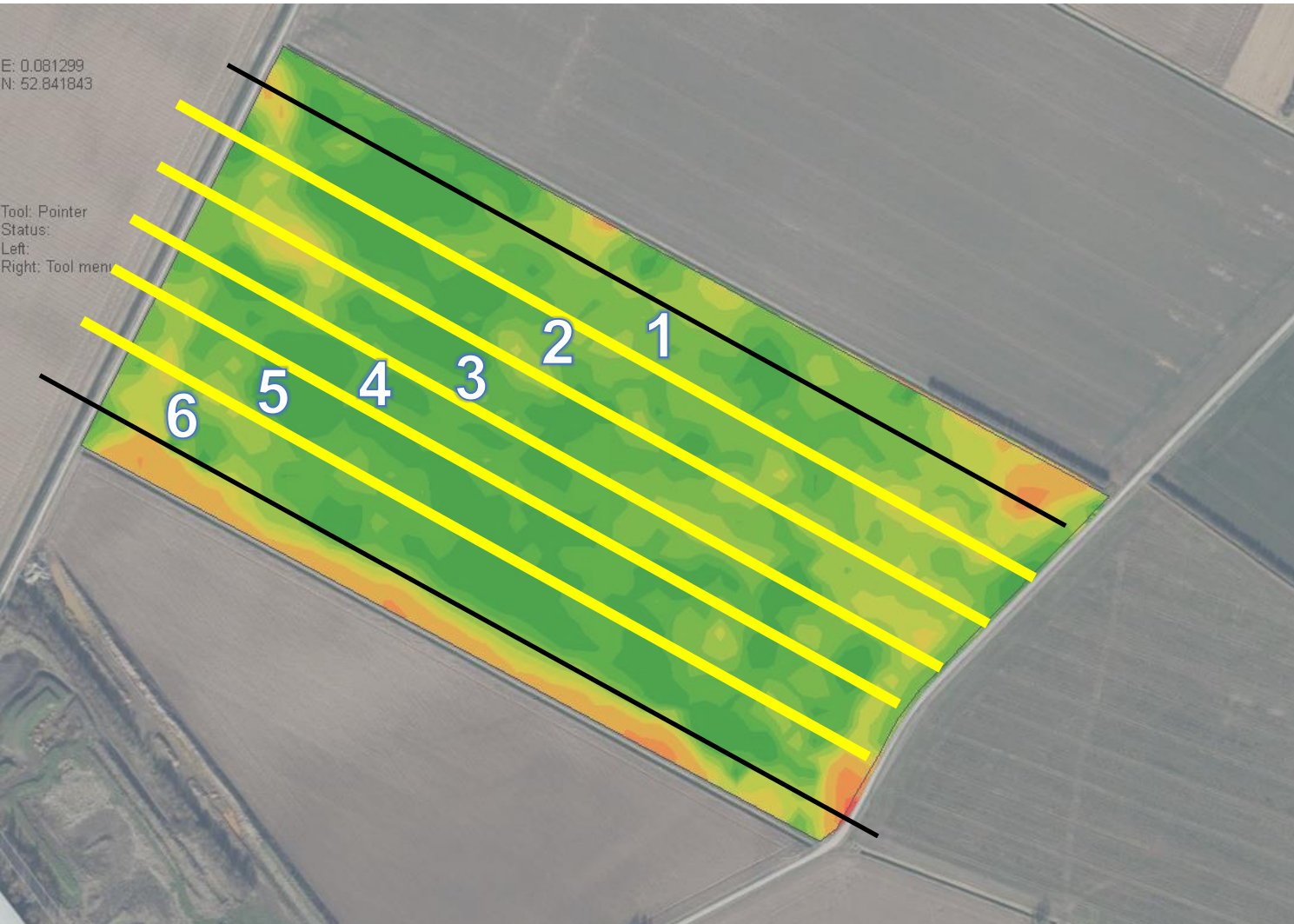
12<sup>th</sup> June

# 2021 Trials



5<sup>th</sup> July

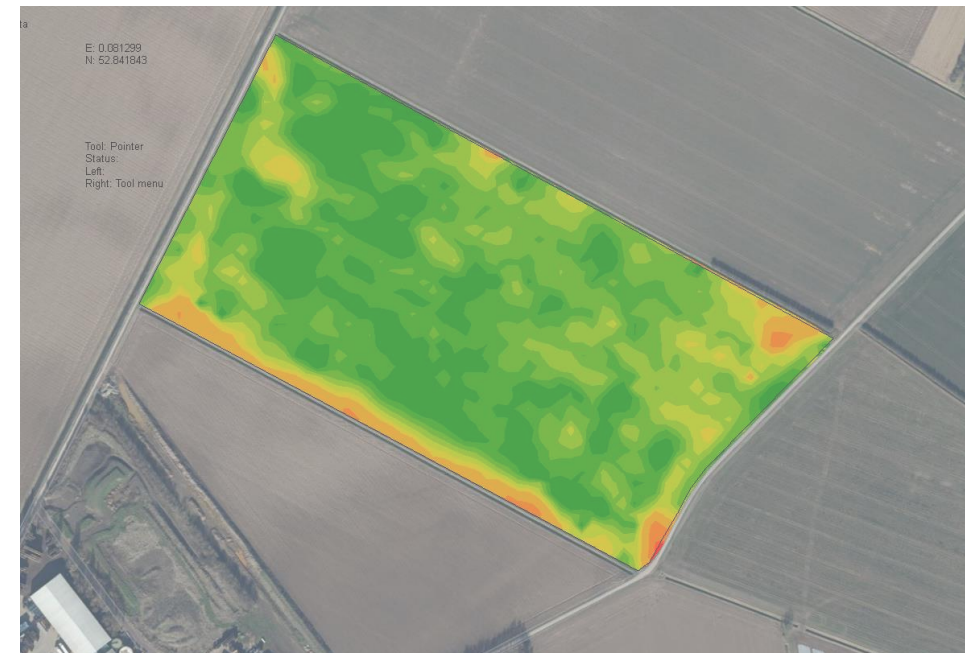
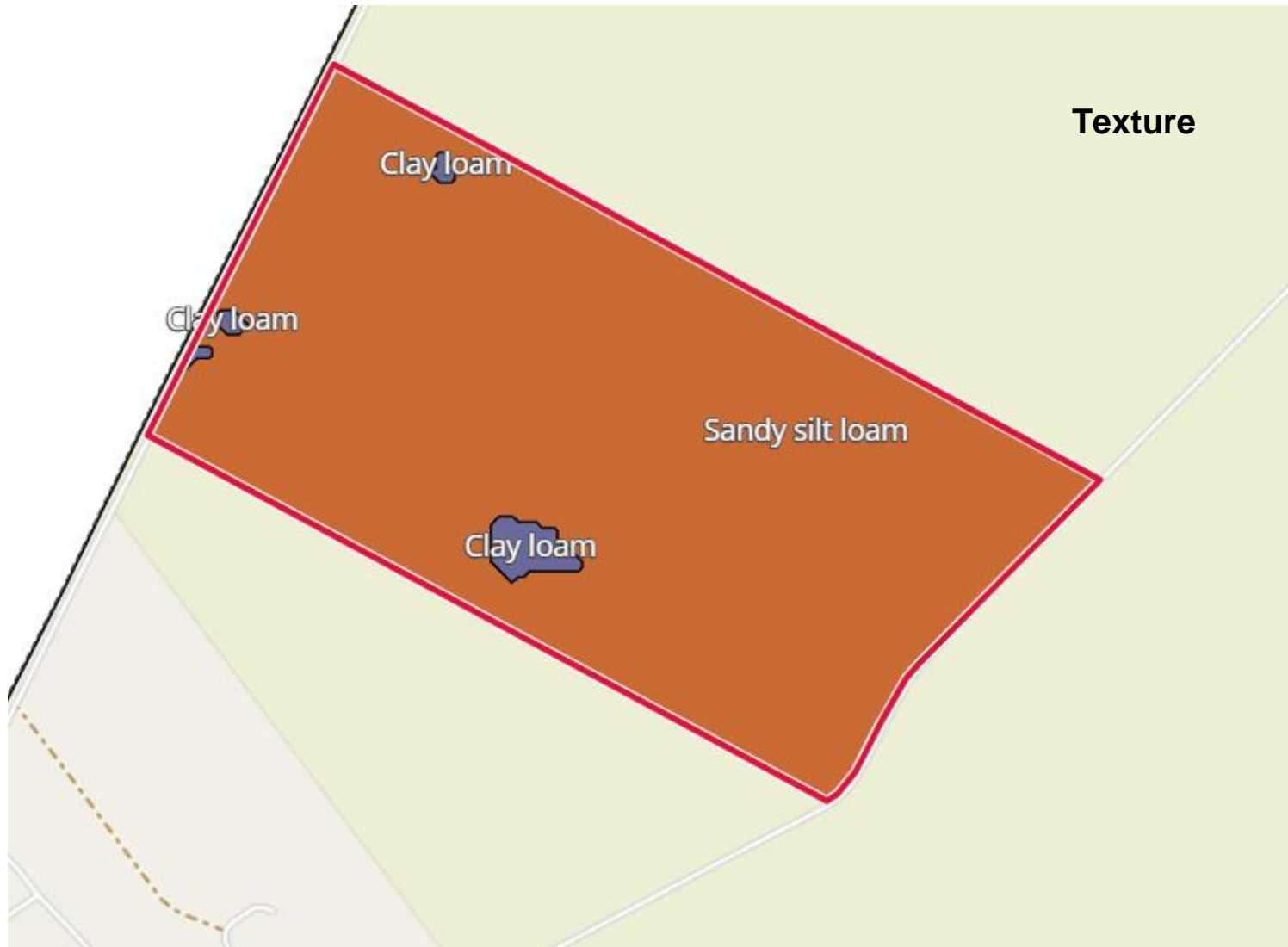
# 2021 Trials



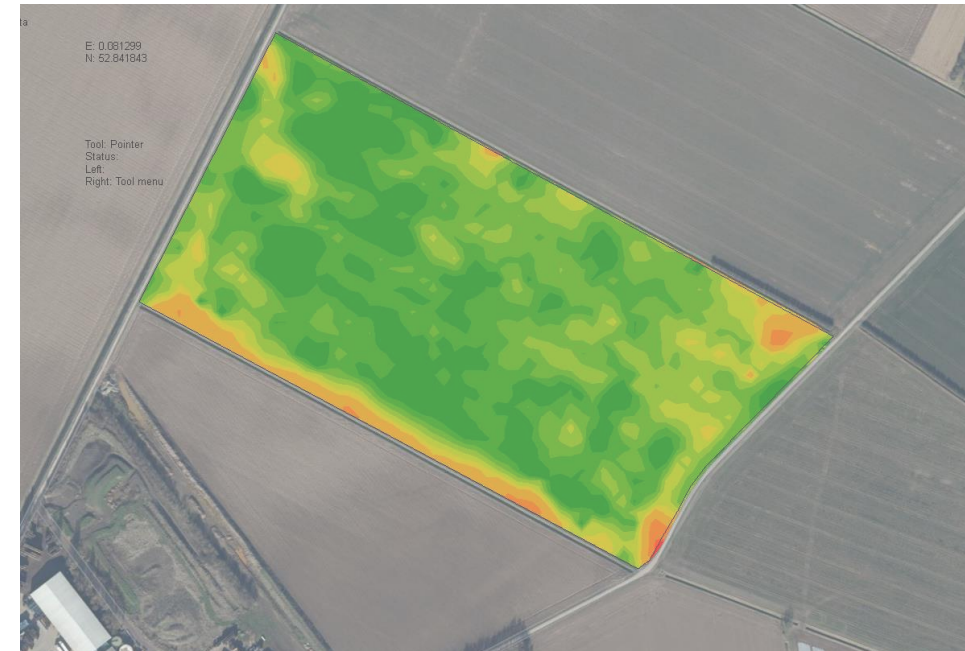
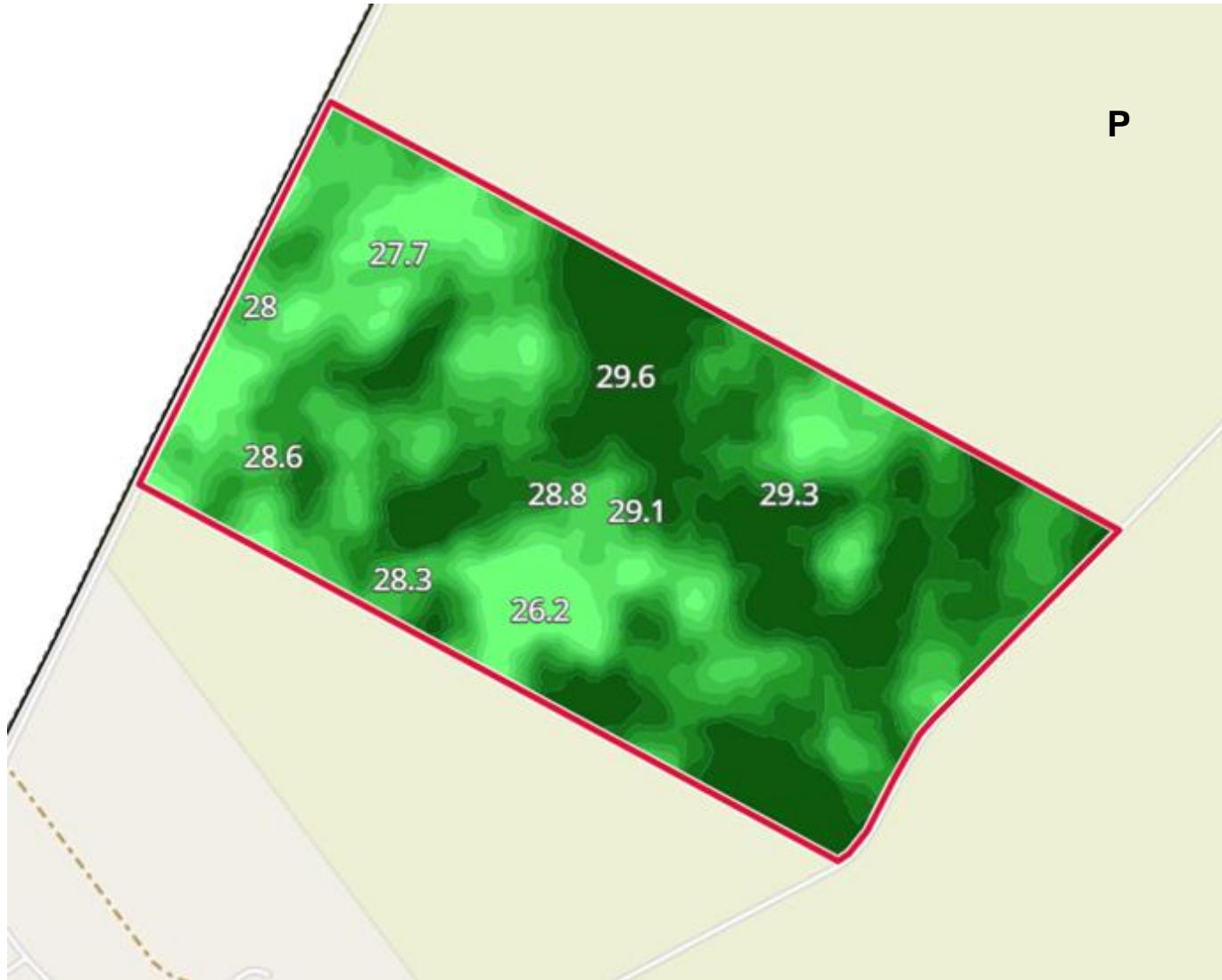
## Yield Fresh

1. **Untreated** = 10.1 T/ha
2. **StartUp Maxx** = 9.5 T/ha
3. **Poly Sulphate** = 8.8 T/ha
4. **Untreated** = 8.9 T/ha
5. **Poly Sulphate** = 9.2 T/ha
6. **StarUp Maxx** = 9.5T/ha

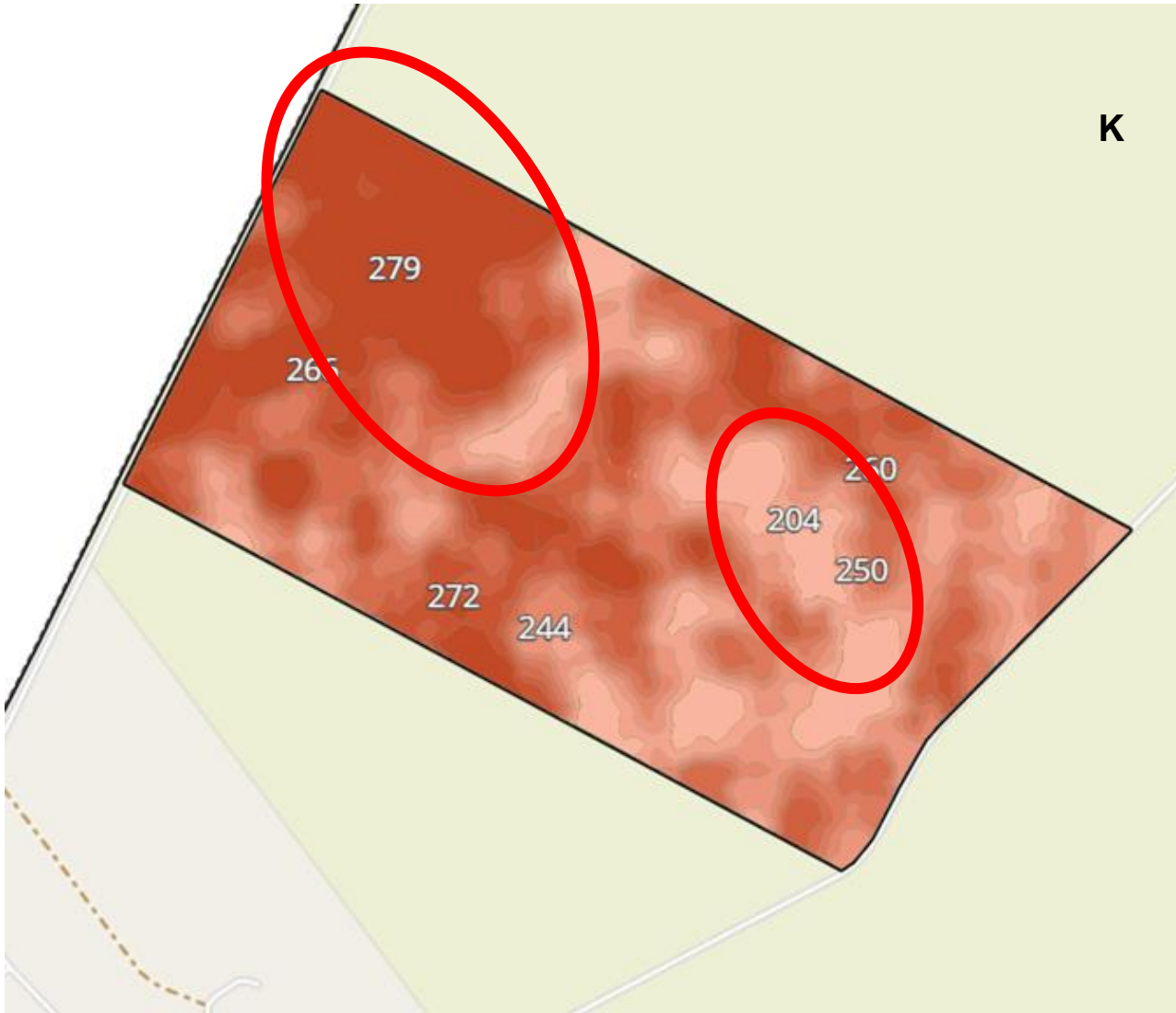
# 2021 Trials Soil Optix Scan



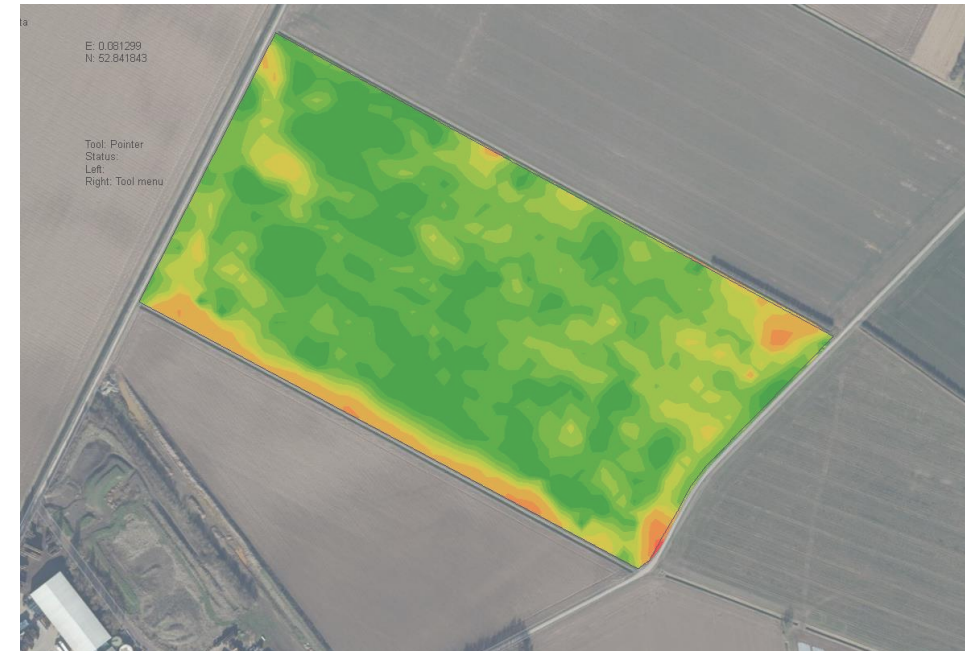
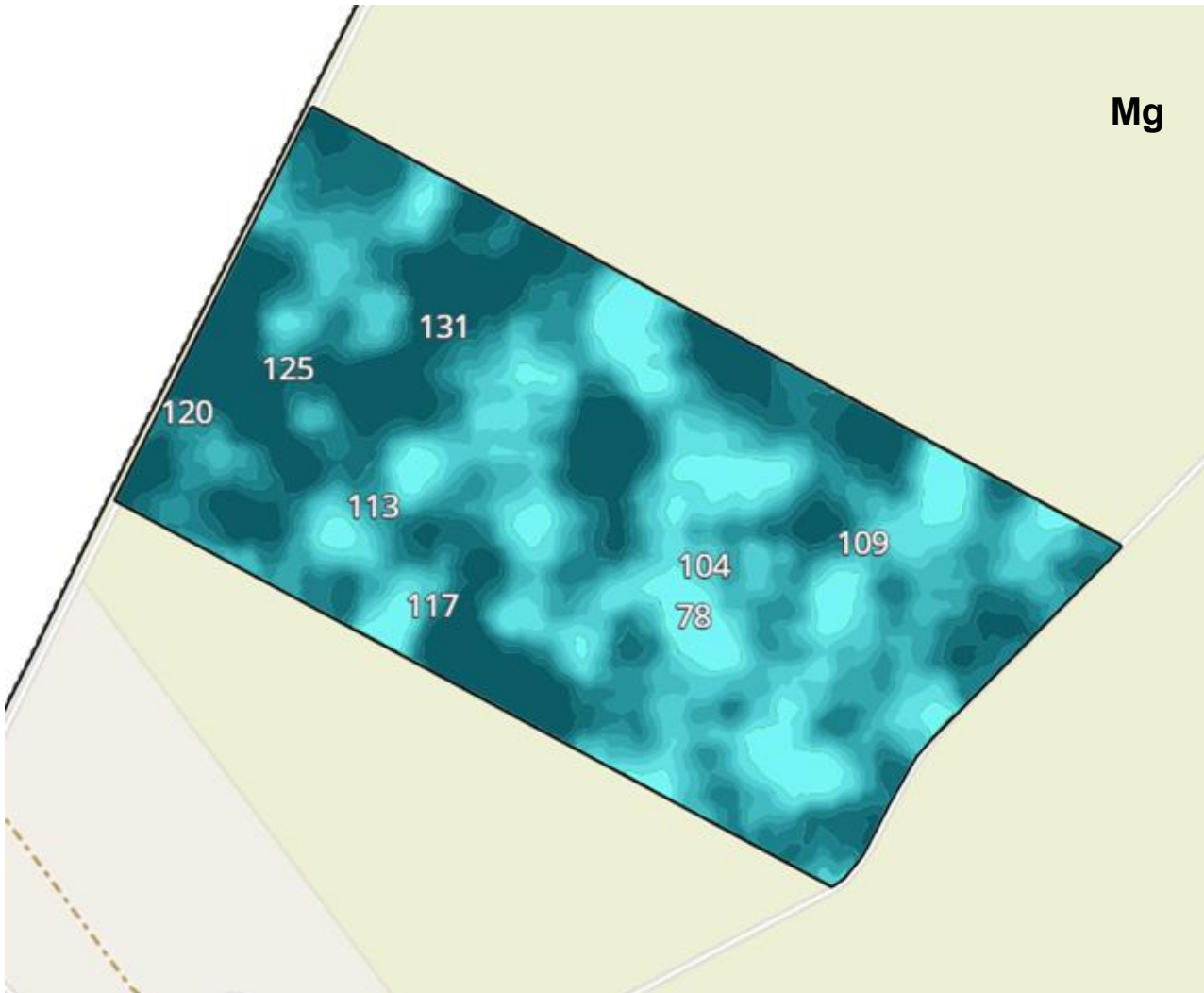
# 2021 Trials Soil Optix Scan



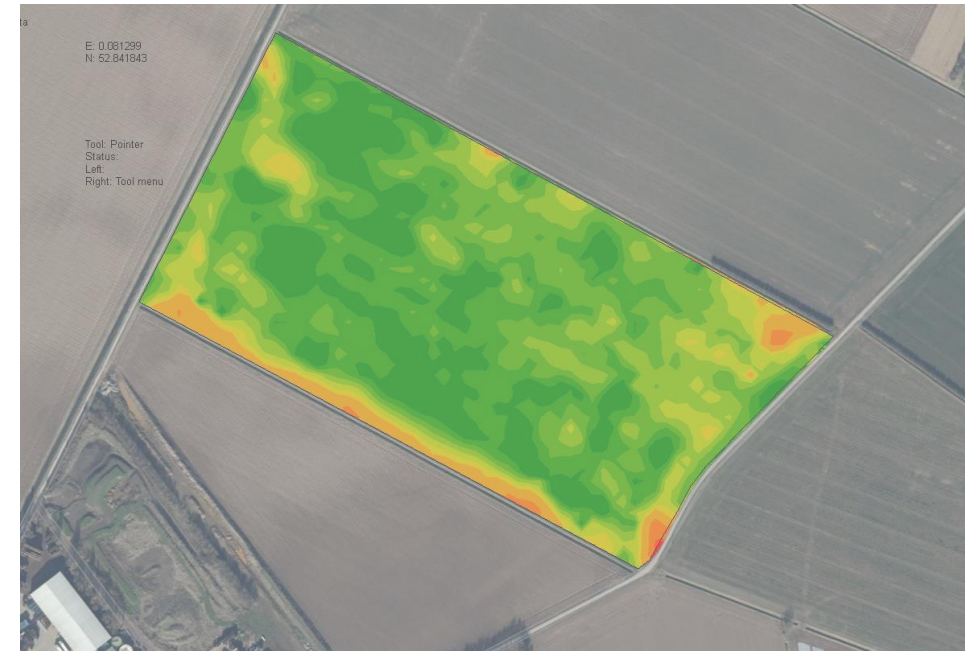
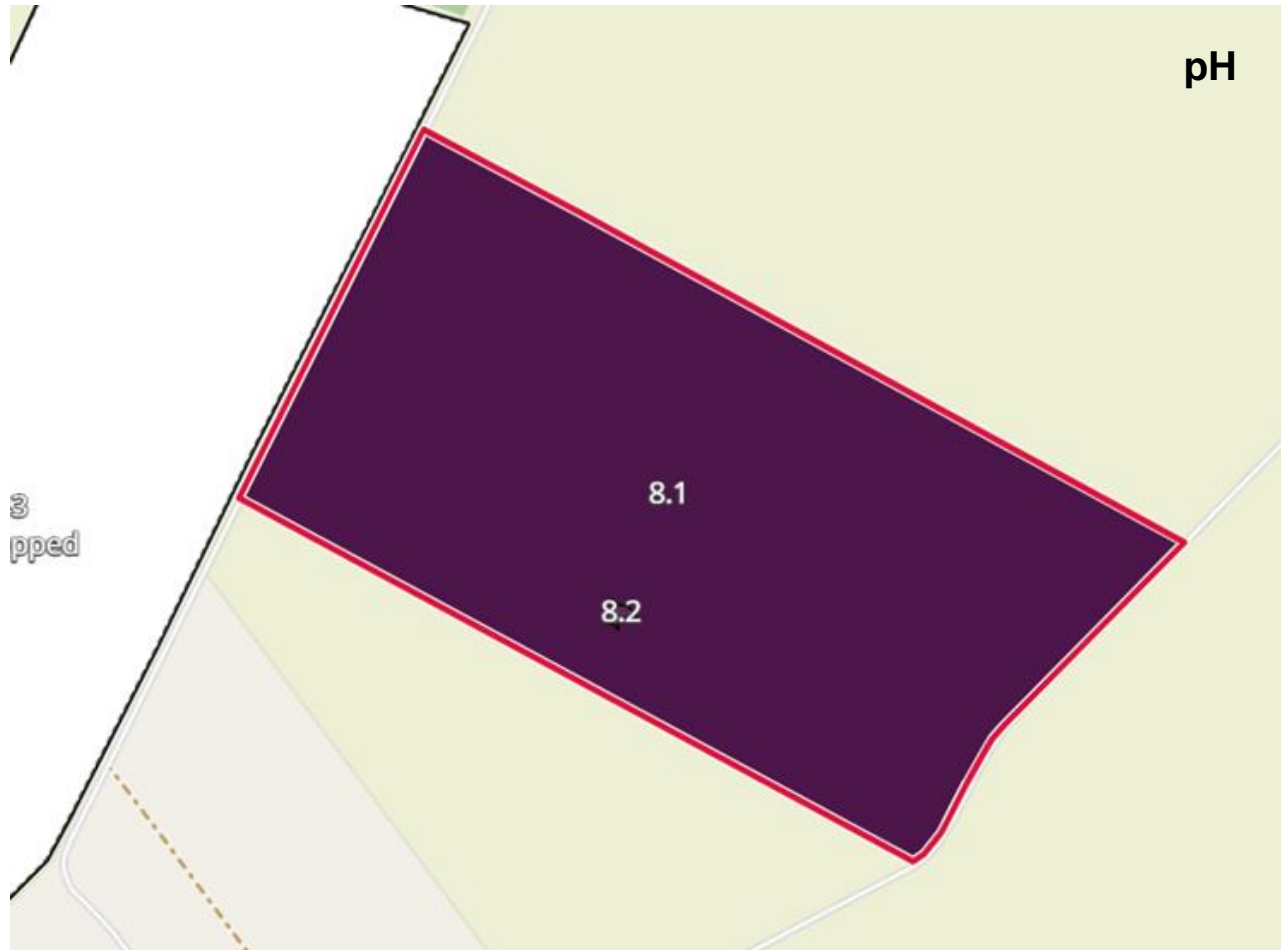
# 2021 Trials Soil Optix Scan



# 2021 Trials Soil Optix Scan

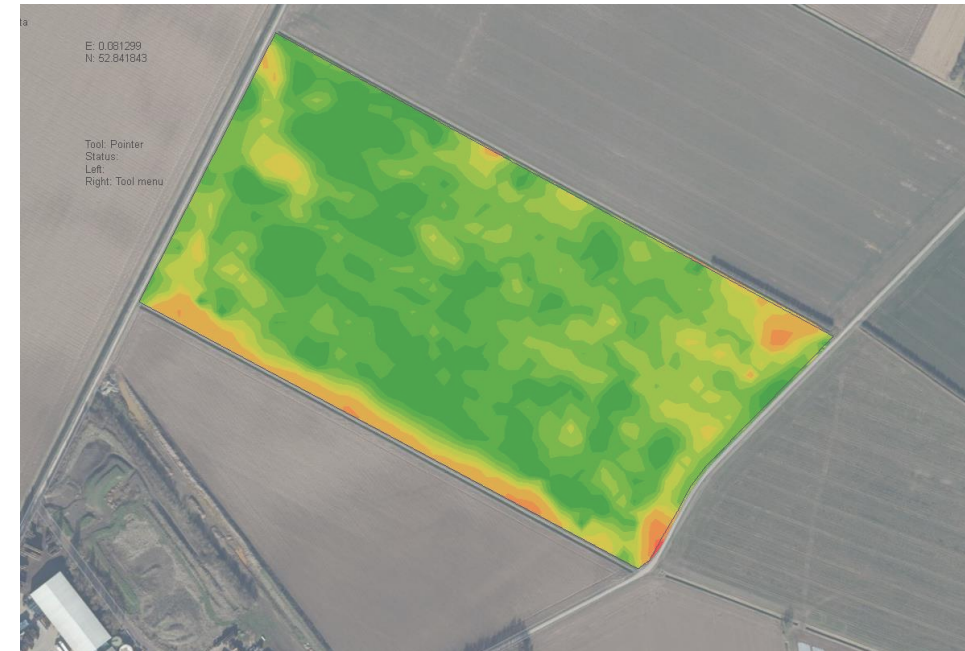
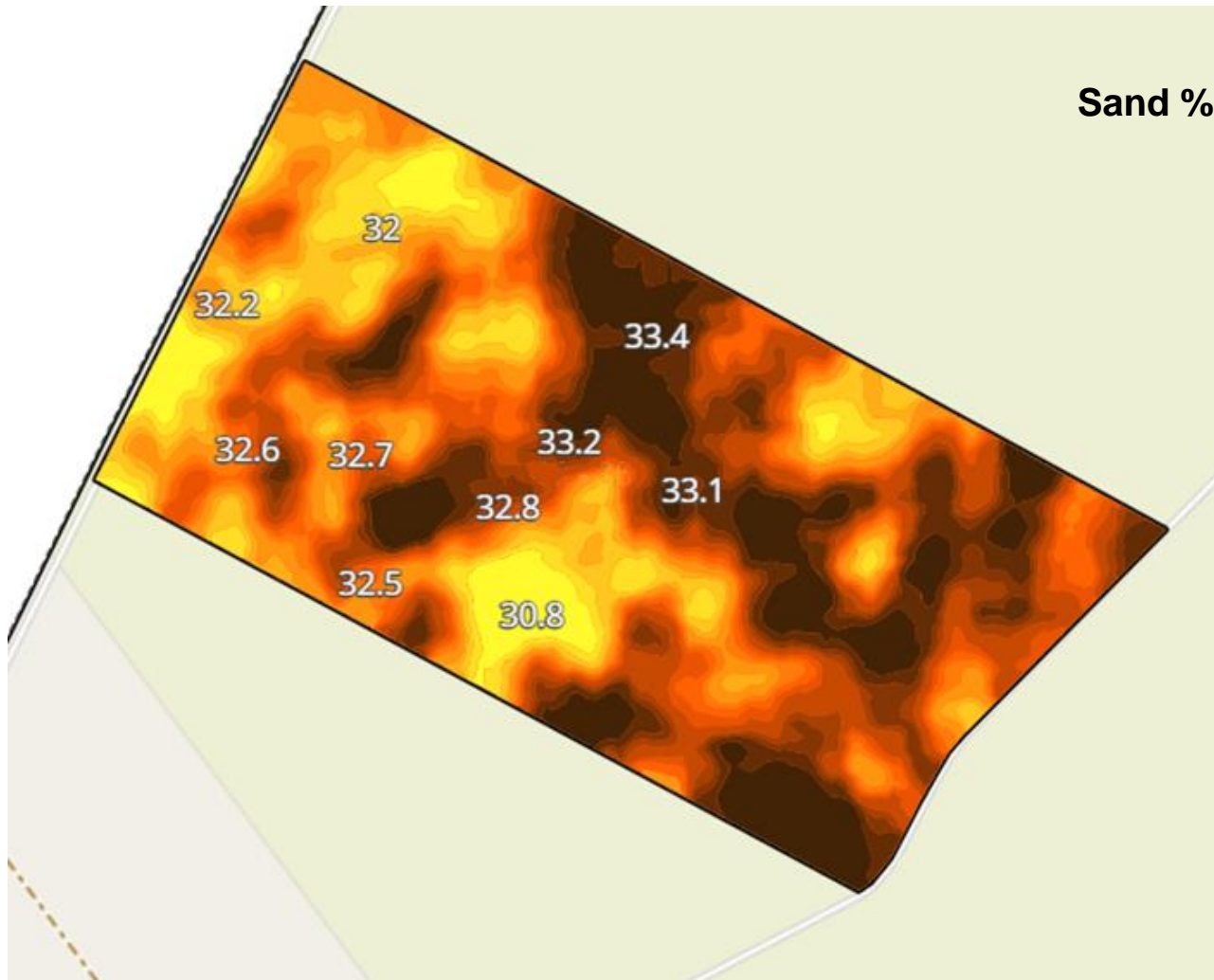


# 2021 Trials Soil Optix Scan

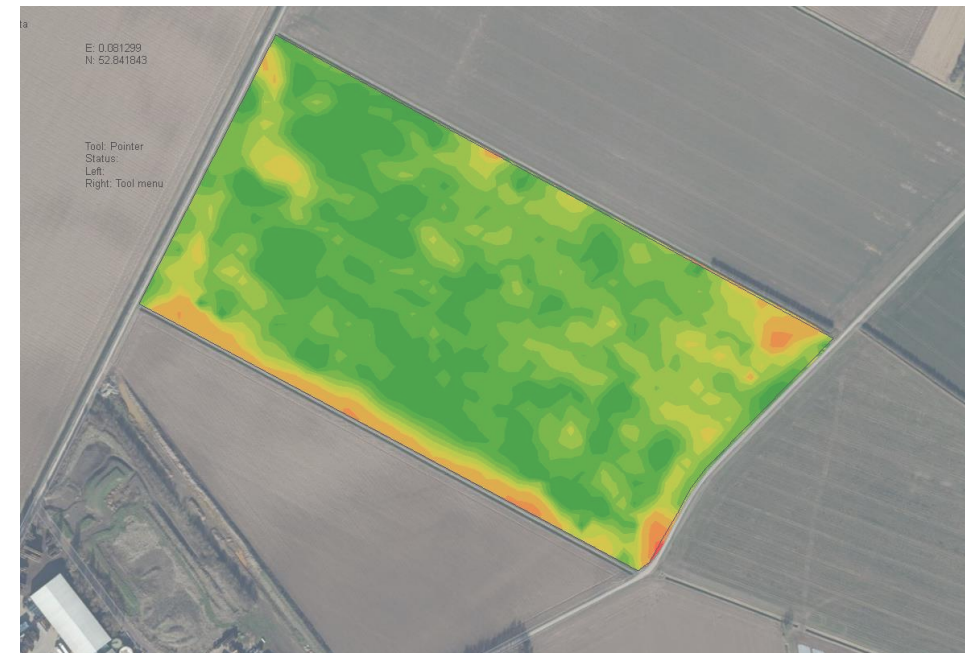
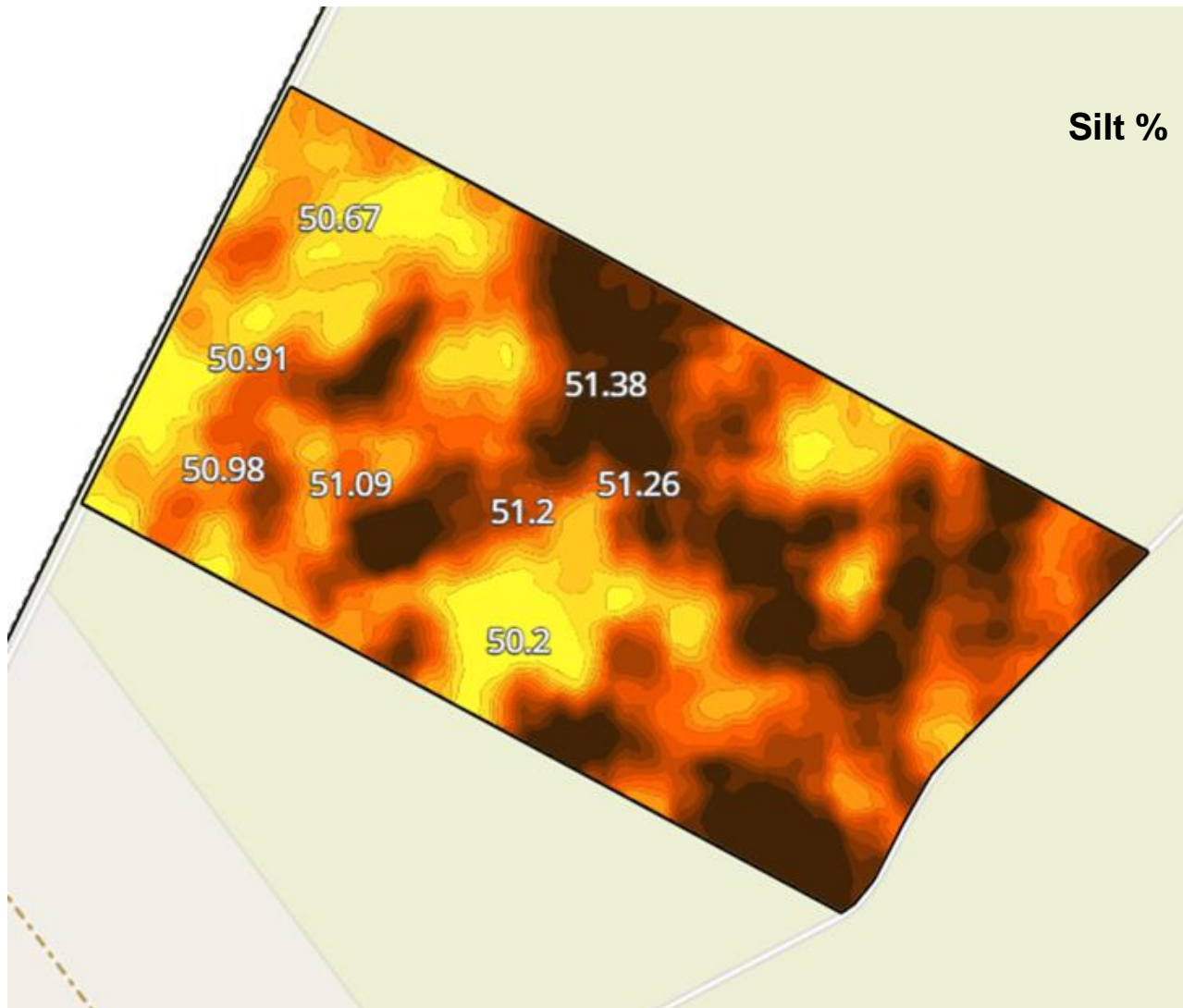




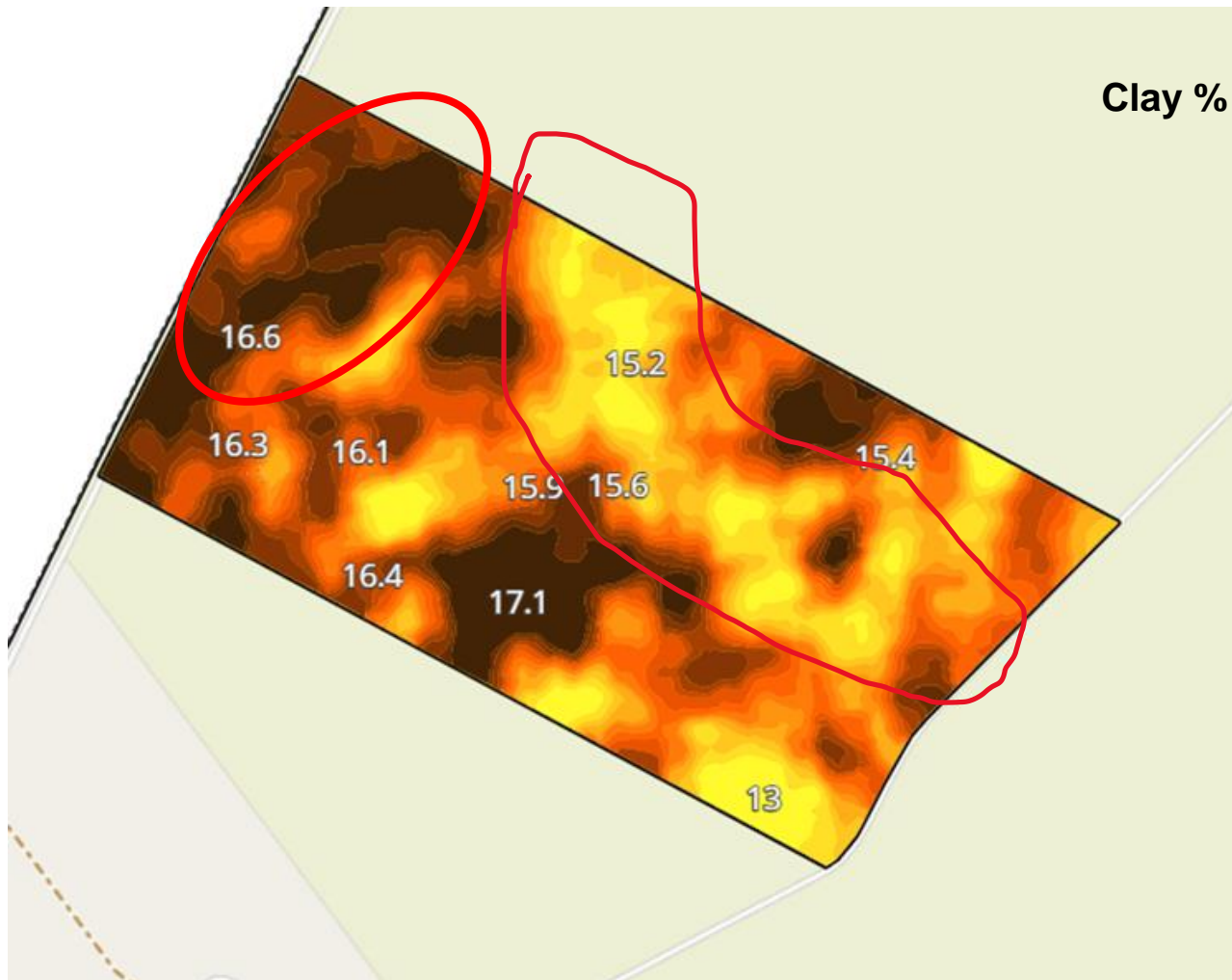
# 2021 Trials Soil Optix Scan



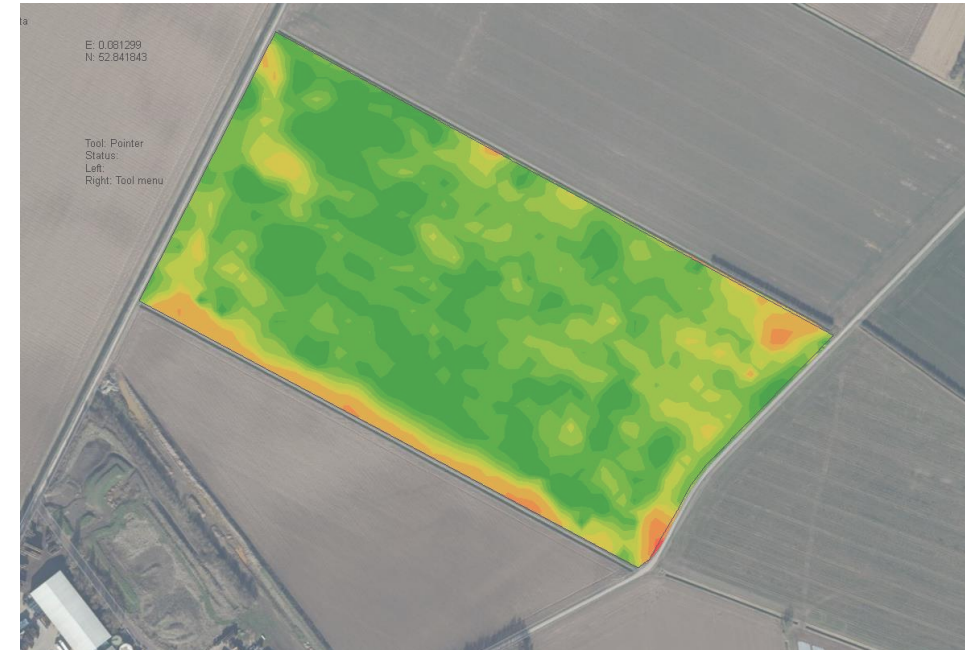
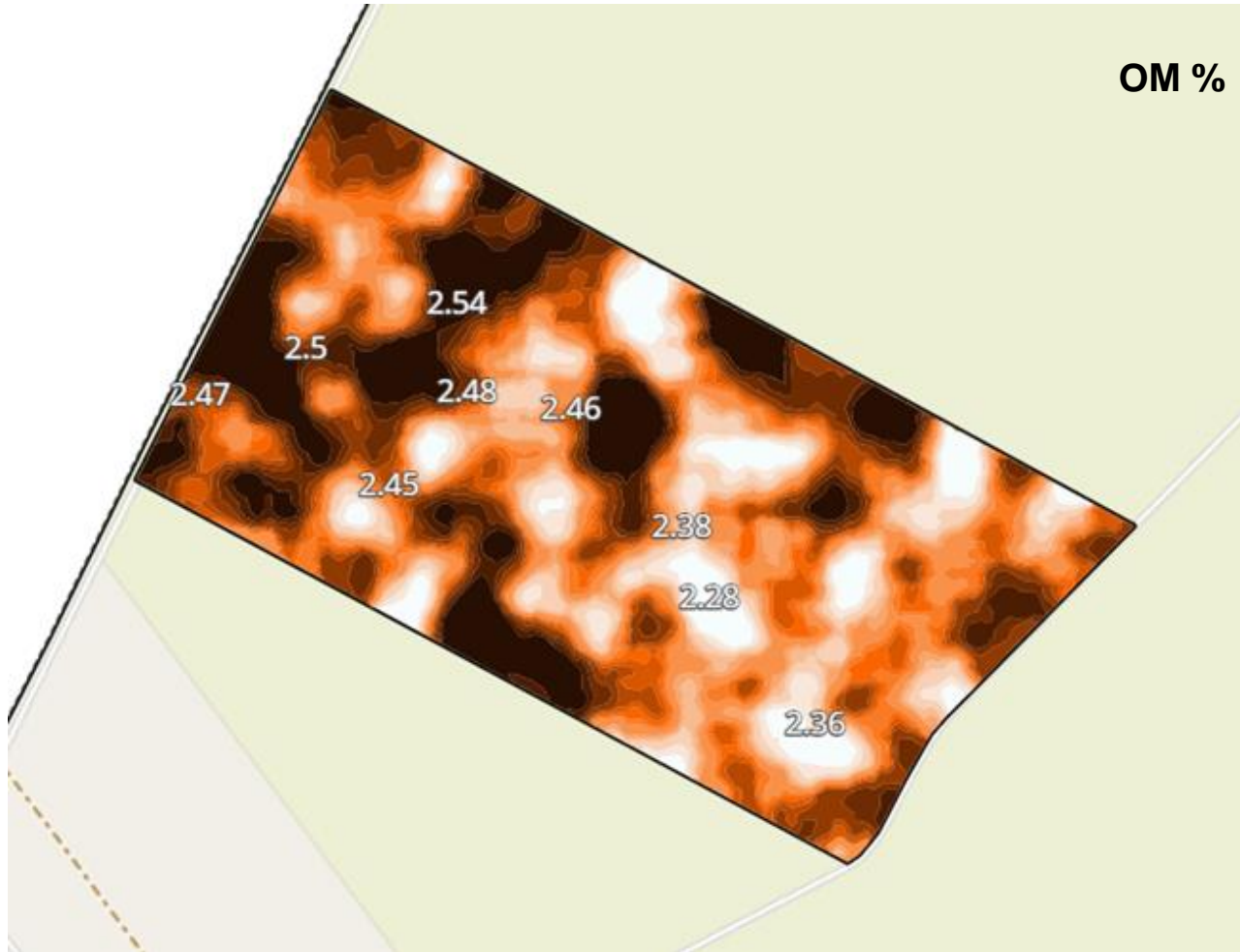
# 2021 Trials Soil Optix Scan



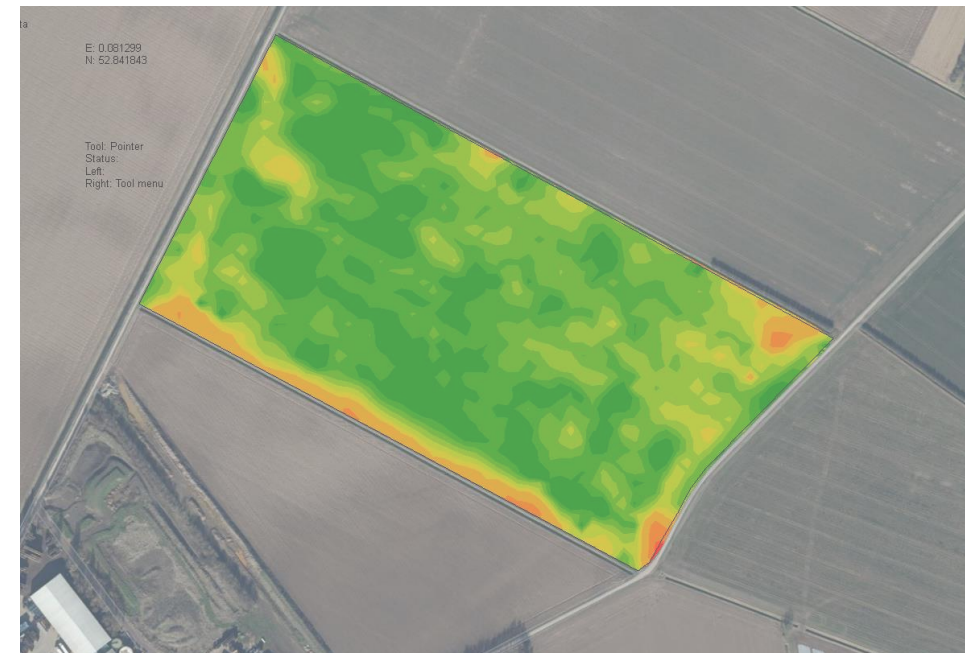
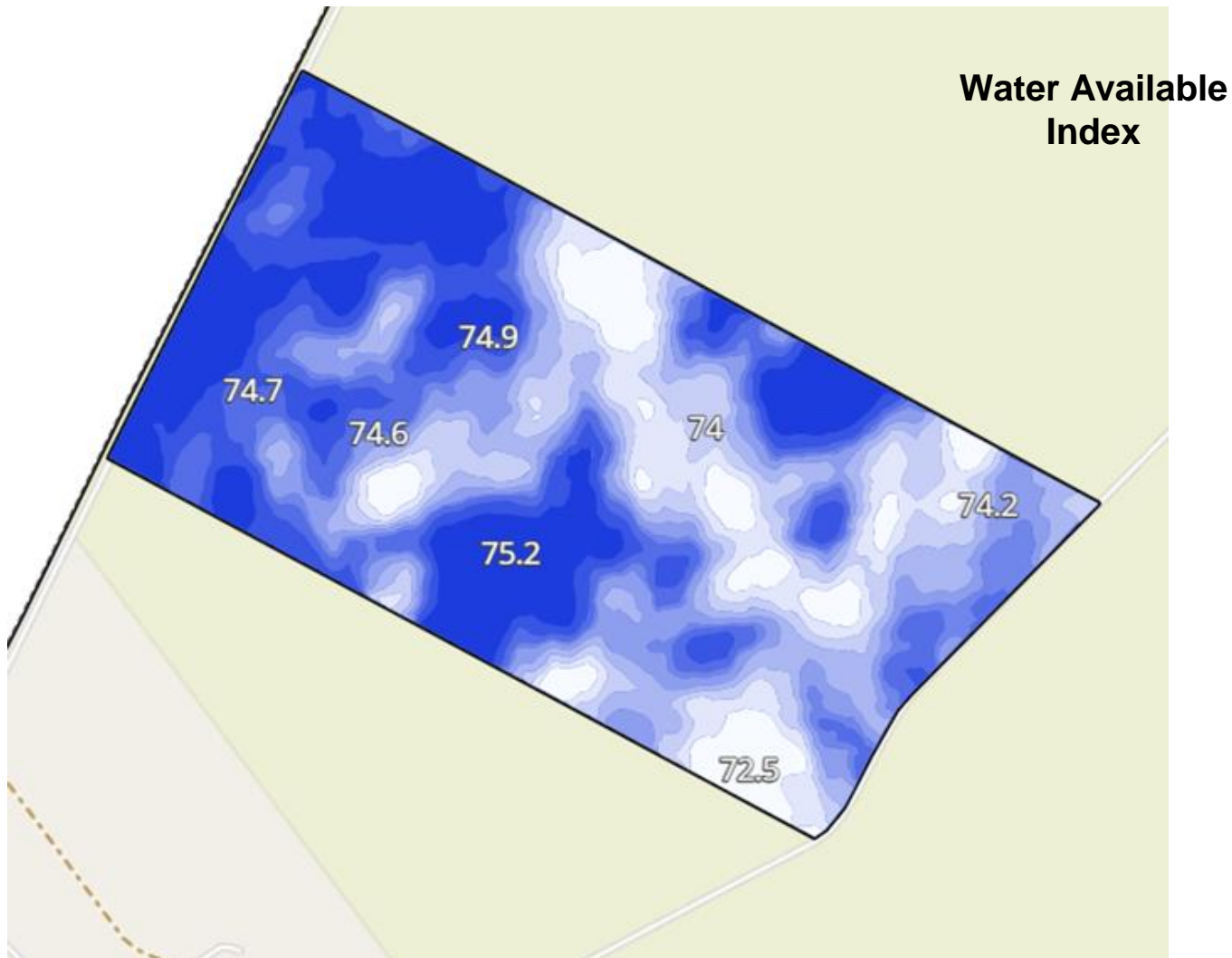
# 2021 Trials Soil Optix Scan



# 2021 Trials Soil Optix Scan



# 2021 Trials Soil Optix Scan



# Yield Predictions

2021 007 HTK

Variety: Peas Vining Crop: Peas Vining Working ha: 20.68

007 HTK

Order

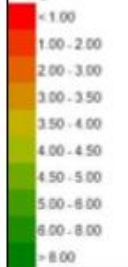
Product	Units	Date	Area (ha)	Rate	Quantity	Moisture%
Dry Yield	t	Actual: 30/06/2021	19.95	5.063	101.000	

Peas Vining/Peas Vining

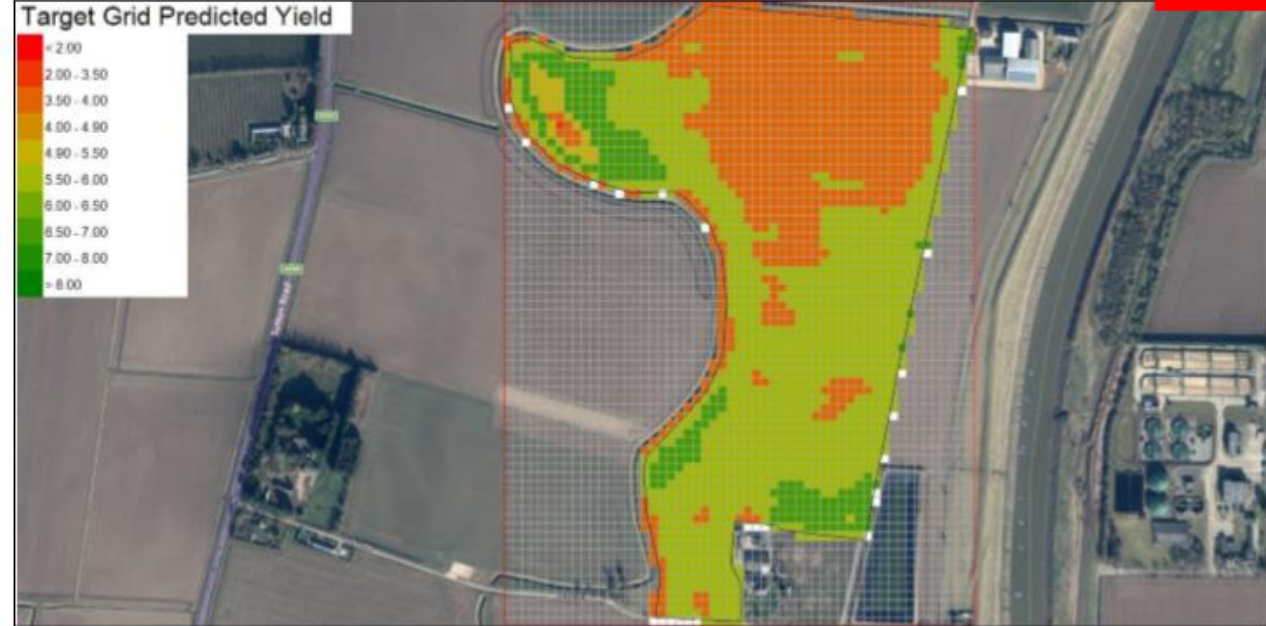
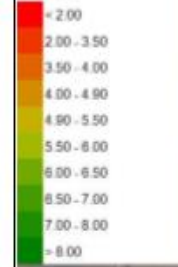
20.68 ha

Share required:

Dry Yield



Target Grid Predicted Yield



Date

Share Used

4.46%

# Yield Predictions

2021 006 HTK

Variety: Peas Vining Crop: Peas Vining Working ha: 7.56

Product	Units	Date	Area (ha)	Rate	Quantity	Moisture%
Dry Yield	t	Actual: 30/06/2021	7.17	5.718	41.000	

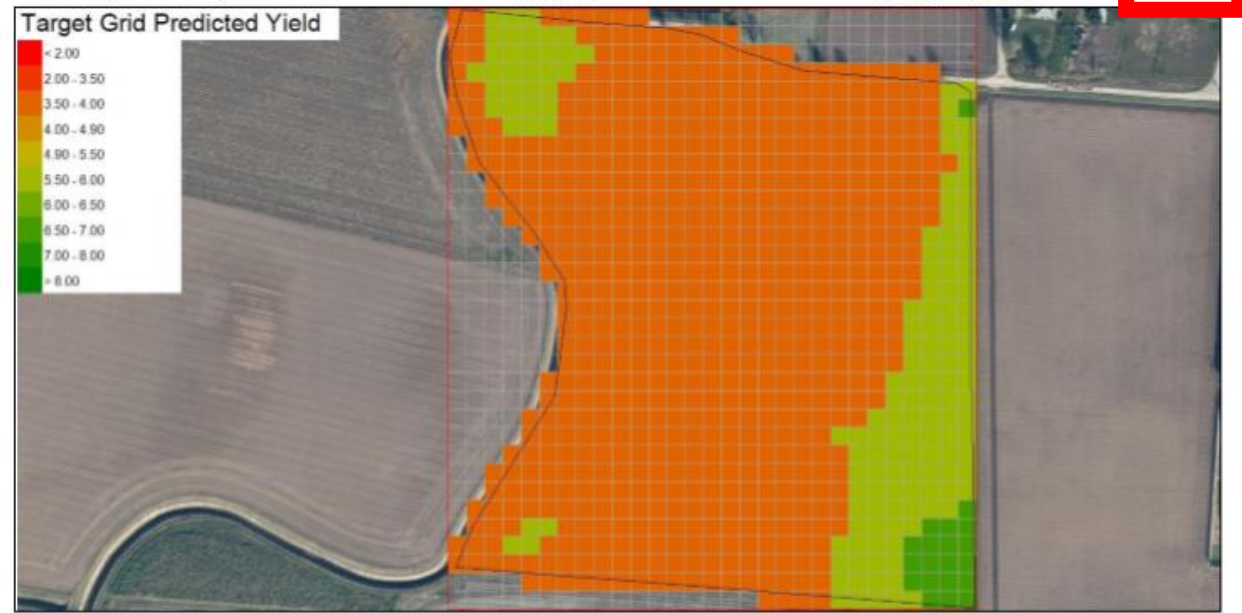
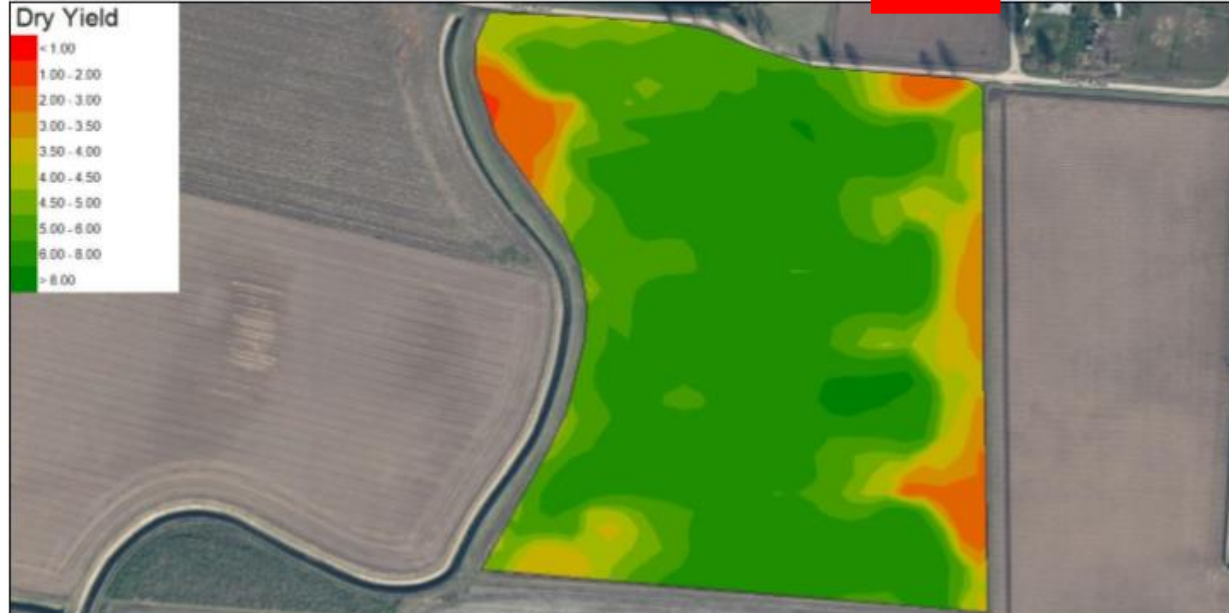
006 HTK

Peas Vining/Peas Vining

7.56 ha

Share required:

Order  34.18

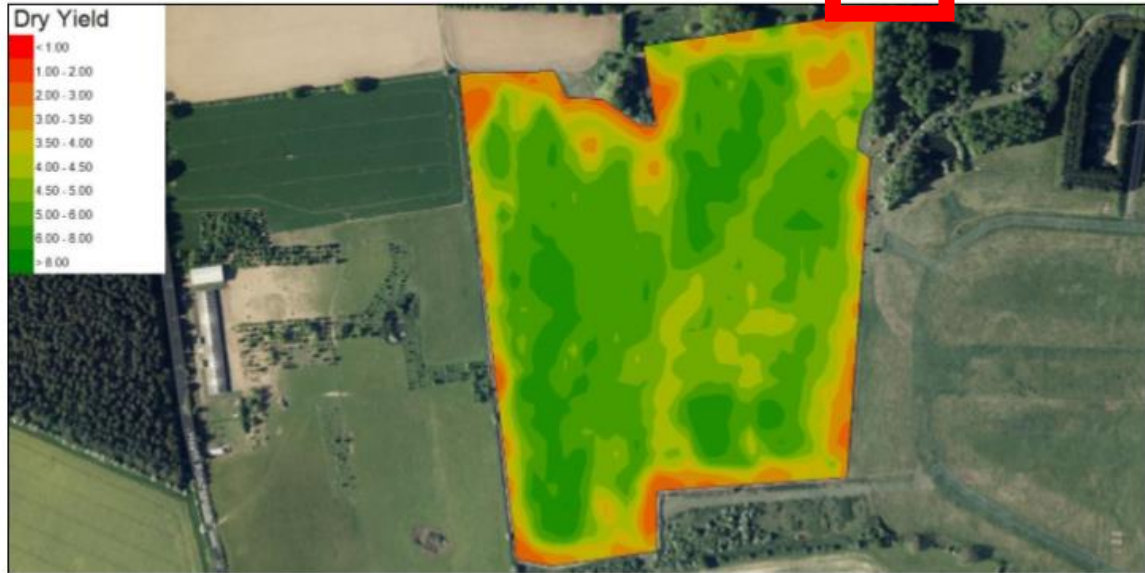


19.95%

# Yield Predictions

2021 028 HTK Variety: Peas Vining Crop: Peas Vining Working ha: 16.29

Product	Units	Date	Area (ha)	Rate	Quantity	Moisture%
Dry Yield	t	Actual: 30/06/2021	16.29	4.297	70.000	



Date  
028 HTK

Share Used  
On

Peas Vining/Peas Vining 16.29 ha

Share required: 68.62



Date

Share Used

2.01%



# Thank You

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[www.hmcpeas.co.uk](http://www.hmcpeas.co.uk)



# INNO-VEG, our project's story

Main achievements of the project



@InnoVeg  
#INNOVEG



1  
project

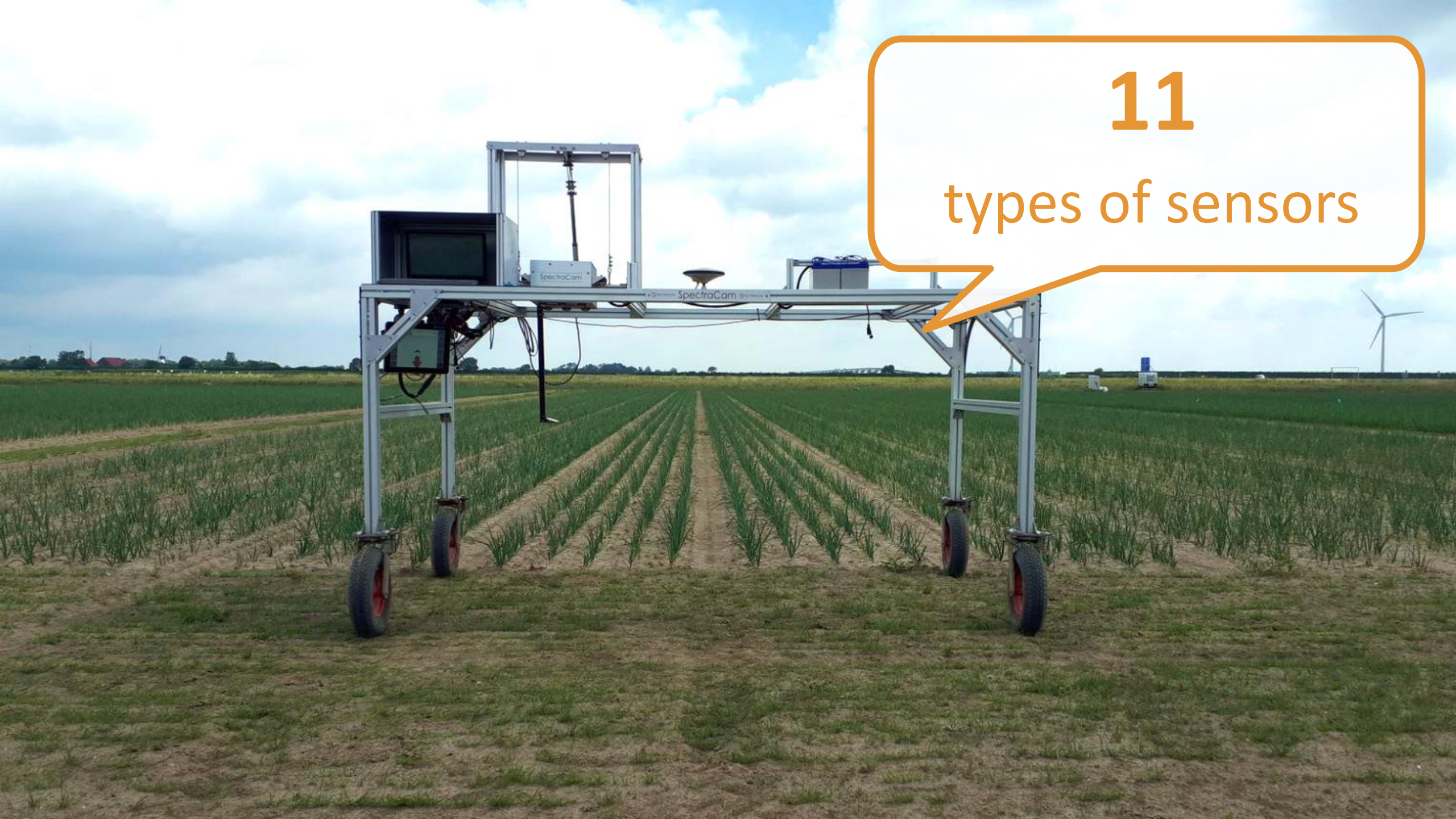
4  
partners





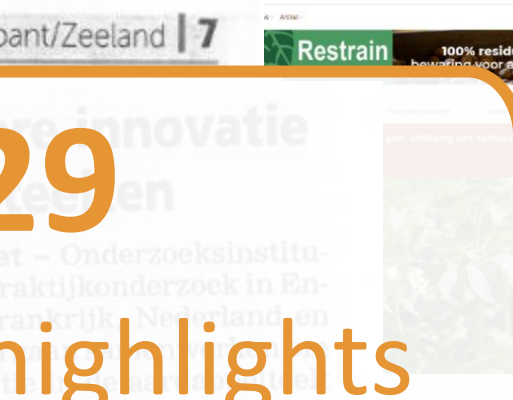
11

types of sensors





**13**  
crops



29  
media highlights

**EU project aims to cut cost of g**  
A grower approach

**Met dronebeelden de opbrengst vergelijken in eigen veldproeven**

**De variabiliteit in een veld heeft vaak een groter effect op de opbrengst dan proeven die we aanleggen. Daarom werd de Agronomics-methode ontwikkeld, een analyse die nieuwe behandelingen vergelijkt met de standaardaanpak van de boer, rekening houdende met de variabiliteit in het veld. Zo kan met dronebeelden eenvoudig en efficiënt het effect van een behandeling op de opbrengst inschatten.**

**Remote sensing' brengt verschillen in opbrengst in kaart**  
Je kan de variabiliteit van je veld in kaart brengen met data van vorige jaren (satellietbeelden, dronebeelden, opbrengsttafelen) of met een bodemscaan. De prof in meerdere herhalingen aanleggen is ook een optie om fouten te vermijden.  
Met behulp van 'remote sensing' zijn potentiële verschillen in opbrengst tussen de behandelingen te visualiseren, nog vóór het gewas wordt geoogst. Remote sensing maakt gebruik van drones of satellieten die het licht meten dat reflecteert op je gewassen. Satellietbeelden zijn via verschillende platformen beschikbaar: zoals bijvoorbeeld het online Watch-It-Grow-platform (https://watchgrow.be/).

**INNO-VEG-protocol poot groenteteeltexperimenten te stimuleren**  
De partners van het Interreg-project INNO-VEG willen de inzet van sensortechniek bij experimenten in de groente- en aardappelteelt stimuleren. Zij hebben daartoe een protocol gelanceerd dat als leidraad dient voor de inzet van drones. Ook bevat het protocol informatie over het beheer en de interpretatie van de meetgegevens. Sensortechnologie vermindert veldproefkosten en kan op langere termijn door landbouwers zelf ingezet worden of bijvoorbeeld verschillende bemestingsstrategieën te testen.

**ASSESSING THE PERFORMANCE OF LEAKS AND OTHER FIELD VEGETABLE**  
Crop sensing technology is a useful proxy for yield when assessing crop performance in on-farm research, says ADAS soil scientist Lizzie Sago.  
She has been working with farmers-based specialist and the creator of a farmer-led demonstration by setting up a test crop trial to test outcomes of different sowing application rates for nitrogen (N) normally applied in March prior to sowing winter-sown leeks to give yield and colour.  
Lizzie says: "One of the limitations of the drone data is that it doesn't tell us what the yield difference is, but it tells us where the small plots are very well, so they can be used to complete the information with the drone-collected data. Together they can produce a proxy yield map."  
"This work built on previous evaluation and crop protection to generate data to evaluate the suitability of crop sensing data to assess treatment differences in field experiments. The INNO-VEG innovation network focuses on facilitating innovation by realising the value of crop sensing technology in the delivery of field vegetable and potato research. We invite anyone with an interest in this area to register with the network via the project registration.org/innovatnetwork."  
Lizzie adds that the INNO-VEG project has also been undertaking work on N mapping, noting that with increasing fertilizer costs, more interest is being taken in understanding the main drivers for N-use efficiency.  
"There is a need to view costs in context, for example, proportion of crop value and N cost in crops such as leeks is of course very different to that of cereals crops."  
"Because fertilizer N costs are still a relatively small proportion of the total crop value, the increase in N price hasn't really impacted on the optimum N rate for leeks. However, I would

**INNO-VEG: Using crop sensing technology to assess onion yields**  
EG is a 4-year EU funded project which is investigating the use of crop sensing data to assess yield in field vegetable crops including onions. The project has shown a good relationship between Vegetation Indices (calculated from crop canopy data) and marketable onion yields. Growers can use this technology to quantify within field yield variability and the impact of treatments on onion yields.  
nning and vegetation indices  
sion is simply the process of using sensors to collect data on crop growth. Sensors can be handheld, tractor mounted, or satellite based.  
nt or reflected will vary across the light spectrum (at different wavelengths) depending on crop characteristics in reflectance at specific wavelengths can be expressed as a Vegetation Index. These can be characterized in many ways, but the most well-known is the Normalised Difference Vegetation Index (NDVI). Since reflectance from the crop is determined by the size and its canopy, Vegetation Indices have been shown to correlate well with characteristics such as above ground biomass and crop vigour.  
ot experiments – 2019  
D-VEG project ran six onion experiments across UK, Belgium and Ireland in 2019. These experiments used small plots to assess there was a relationship between Vegetation Indices and yield. The sales showed a strong and statistically significant relationship all calculated Vegetation Indices and marketable yield.  
Relationship (maximum R<sup>2</sup> values of 0.90) between the Vegetation and marketable yield was obtained from measurements taken just to onion tops started to bend over. The proportion of variation in yield explained by the Vegetation Indices tended to increase up until this then dropped significantly after the tops had bent over.  
ale experiments – 2020  
the project set up three field scale experiments on onions in the UK (Netherlands). A key advantage of using crop sensing data to assess its is the ability to upscale from small plots to field scale, as data collected relatively easily from field areas using drones or tractor sensors.  
K, INNO-VEG partner ADAS worked with Sam Rix from Rix Farm to test whether crop sensing could be used to assess the effect of nitrogen rate on onion performance. There were two fertilizer N rate treatments: the Farm standard N rate of 13 was compared to a Low N rate of 40 kg N/ha. The treatment was applied to plots 1 metre wide (24 m x 100 m) in the farm's fertilizer spreader.  
mounted MicaSense RedEdge 3 multispectral sensor was used to collect reflectance data. Yield measurements were taken in 12 points in the field to ground truth the crop reflectance measurements and derive a relationship between Vegetation and yield. A predicted yield map was created based on the relationship between NDVI and marketable yield (Figure 1). Predicted yield map showed that the average marketable yield from the farm standard N rate was 71 t/ha and the yield of the farm standard N rate over the low N rate was 12 t/ha ± 1.4 (95% confidence interval).  
statistics were used to analyse the spatial Vegetation Index data and assess the impact of treatments. All Vegetation from both scan dates were significantly higher from the farm standard N rate than the lower N rate.  
eriment has shown that Vegetation Index data collected from field scale experiments can be used to successfully test the effect of treatments on onion yields.  
ale experiments – 2021  
son, ADAS are again working with Sam Rix to assess the impact of starter fertilizer treatments applied by the farm on yields. Results will be available later this year.



**“On farm trial”, zelf een prof aanleggen op je veld**  
Een nieuwe behandeling uittesten met minimale moeite? Dat is de opzet van 'on farm trials', proeven die boeren zelf aanleggen op hun eigen veld. Dit kan zo simpel zijn als bijvoorbeeld twee rassen met elkaar vergelijken op eenzelfde veld. In een on farm trial zijn er verschillende factoren waarmee je rekening moet houden om tot betrouwbare resultaten te komen. Waar we bij een klassieke prof-

**Hoe rekening met de veldvariabiliteit**  
Wees alert voor de variabiliteit binnen een perceel. Zo kan er bijvoorbeeld een grote variabiliteit zijn ontstaan door twee percelen met een verschillende voorgeschiedenis samen te voegen tot één perceel. Een veld met weinig variabiliteit zal nauwkeurigere resultaten geven, want de variabiliteit heeft vaak een groter effect op de opbrengst dan de behandelingen zelf. Als er veel variabiliteit is, zorg je best dat de proeflocaties dwars op de variabiliteit liggen om niet tot verkeerde conclusies te komen. Als een strook niet samenvalt met een deel waar de opbrengst historisch hoger was, dan zal het resultaat foutief laten uitschijnen dat deze behandeling de beste was.

**EN BREF**  
**Technique**  
**Webinaire INNO-VEG**  
Le projet INNO-VEG a organisé la semaine dernière son premier webinaire sur le thème « Utilisation de capteurs pour phénotyper les cultures de légumes et de pommes de terre au champ ». Au sein de ce projet, en 2019 et 2020, des données expérimentales, pour évaluer la pertinence d'utiliser ces nouvelles technologies basées sur des capteurs, ont été collectées. Ce webinaire a présenté les premiers résultats du projet sur l'utilisation de différents types de capteurs et indices de végétation par les chercheurs d'Arvalis - Institut du végétal en France.



Figure 1. De variabiliteit van het veld kan je in kaart brengen met data van vorige jaren. Als je veel variabiliteit in een veld hebt dan de proeflocaties dwars op de variabiliteit liggen. Hier staan de vijf stroken voor vijf bemestingsstrategieën in afbeelding.



Met de technologie van 'remote sensing' kan er snel een beeld worden gemaakt van de prof in een veld. Hier staat de vijf stroken voor vijf bemestingsstrategieën in afbeelding.

**ADAS au Royaume-Uni, Inagro en Belgique et Delphy aux Pays-Bas.**  
**3<sup>ème</sup> Carrefour Plantes de Pomme de Terre**  
**Mobilisation pour une pomme de terre sans phytos**  
Plus de 150 acteurs de la filière pomme de terre se sont mobilisés autour du thème « Vers une pomme de terre sans produits phytosanitaires » à l'occasion du 3<sup>ème</sup> Carrefour Plantes de Pomme de Terre, porté par InnoPlant2 les 14 et 15 octobre. Ce thème d'actualité se situe dans un contexte de limitation voire de suppression progressive des produits phytopharmaceutiques de synthèse, et de fortes exigences de qualité à un prix abordable.  
L'évaluation des risques sanitaires de la pomme de terre passe par l'épidémiologie, ou surveillance biologique du territoire, une des composantes clés des systèmes de protection intégrés des cultures. L'évaluation conduit ainsi à la gestion des risques par l'intermédiaire d'outils adaptés, notamment dans le cas des nématodes. Plusieurs leviers permettant d'agir pour une pomme de terre sans phytos ont été évoqués : le choix variétal (des sélectionneurs ont identifié des sources génétiques de résistance) ; l'imagerie quantitative et les réseaux de capteurs ; les outils numériques (stations météo connectées ; OAD ; capteurs d'état physique, etc.) ; et les produits de biocontrôle.  
"It was very important to us that the grower knew what they wanted to look at so the data are relevant to them and their business."  
The leek crop was planted in April 2021, for harvesting in July 2022 and split into three harvests: 1st on 1st July, 2nd on 1st August, and the third was left as a control with no applied. The treatments were all applied by the farm with commercial farm equipment, and results were checked both through data input collected from drone flights and small yield sub-plots, which were harvested by hand.  
"A principal analysis is currently underway to determine whether data differences will reflect crop performance, particularly if you want to assess larger whole field areas," says Lizzie.  
"In a bid to encourage farmer-led field trials, she has been leading the EU Interreg 2.5a



38

presentations at  
external events

**Interreg**  EUROPESE LINIE  
**2 Seas Mers Zeeën**  
**INNO-VEG**  
Europees Fonds voor Regionale Ontwikkeling  
Randvoorwaarden voor innovatie  
Smart farming via innovatie op het veld van vollegrondsgroenten en in de aardappelsector  
Projectpartners:  
 





## Protocol

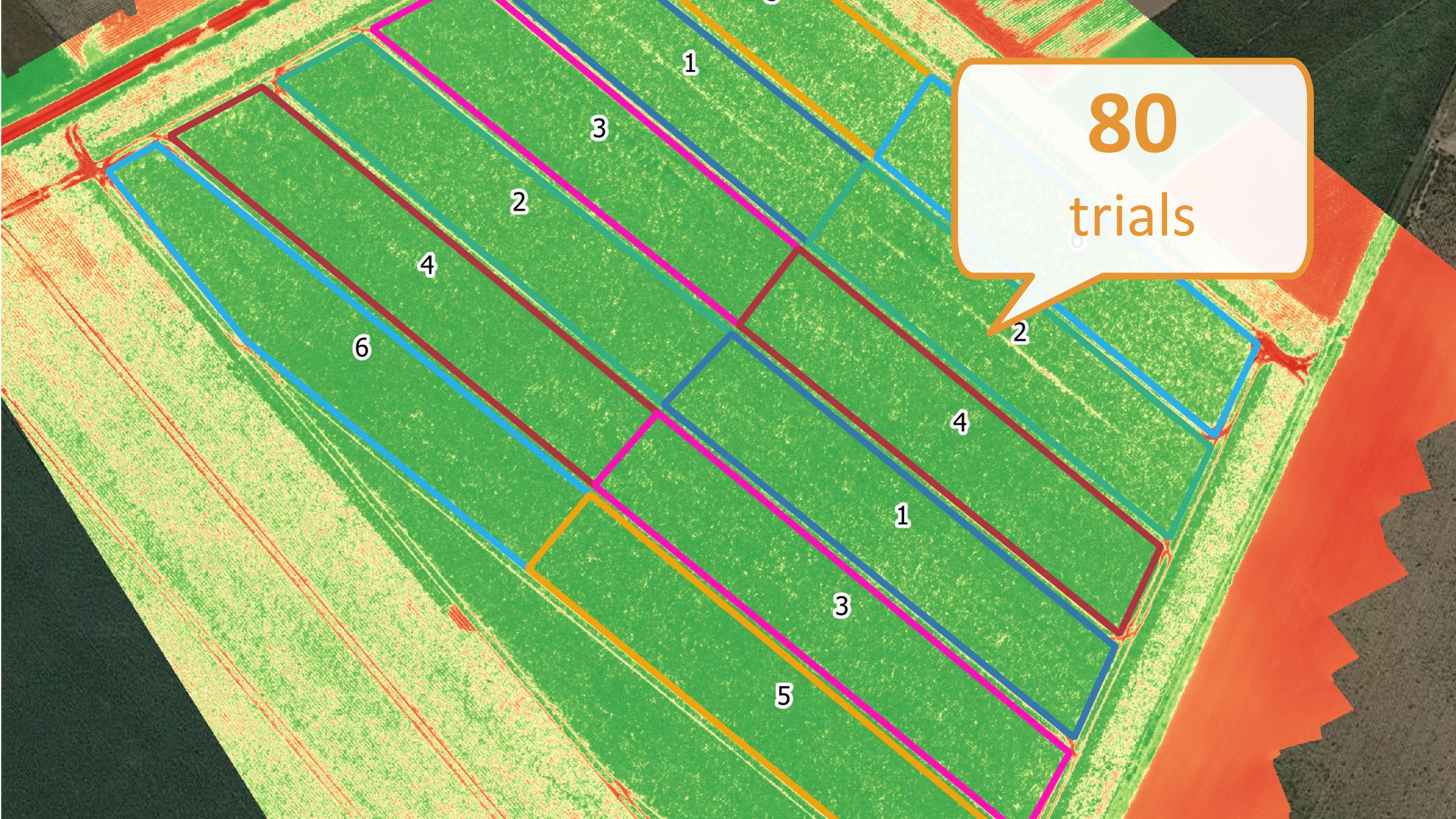
Use of crop sensing data in  
experiments



## INNO-VEG Framework for farmer-led research



40  
pages of  
guidelines



80  
trials

1

3

2

4

6

2

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3

5



INN 211 Tv  
Interreg

INNO-VEG @InnoVeg · 28 sep. 2020  
Join @ADASGroup @Arvalisofficiel @InagroBeitem & @DelphyAkkerbZw for this free #INNOVEG webinar on crop sensing. October 8th at 14:00-15:00 UK, 15:00-16:00 CET.  
For more information and to register: [inno-veg.org/en/Event/Detail...](https://inno-veg.org/en/Event/Detail...)

tion network webinar will take place MT.  
ised by @D... 11:17M

INNO-VEG @InnoVeg · 18 nov. 2020  
Agri-Tech Week 2020 event: crop sensing for field vegetables  
Read about our event last week 📖

348 social media posts

- Startpagina
- Verkennen
- Meldingen

Beric

INNO-VEG 2020 field scale experiments

The #INN together interreg

Watch the years

Vote for I

And don't project a

#video #Vertaling

Afspelen

U en 3 anderen

Jij en 5 anderen

7

24

Jij en INNO-VEG

1

2

4

Interessant



2 622

attendees at  
INNO-VEG events



46 803

people reached via  
communication actions



**250 000**

data points processed  
through agronomics



Framework  
conditions  
for innovation

**What next?**





# What next?

- Project website ([www.inno-veg.org](http://www.inno-veg.org))
  - Guides
  - Videos
- Innovation network
- Agronomics for field vegetables



**Thank you for joining us**

**Any Questions?**

**[www.inno-veg.org](http://www.inno-veg.org)**