

# Variable Rate N in UK

Daniel Kindred

***Ag*ronomics**



# Whats happening in UK?

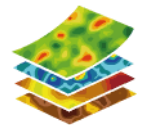
- Commercial VRA N services in UK
  - Yara N sensor
  - SOYL – satellites
  - Rhiza – Planet satellites
  - Hummingbird – UAVs
  - Omnia – Plant vision sensor
  - AgLeader – Optrx sensor



Precision  
Decisions



Hummingbird  
Technologies



Omnia  
Precision Agronomy

# ADAS work & interests

- Auto-N

## Auto-N Project 2010-2015 *AHDB Project Report 561*



- PNAG – OSR



- Commercial work
  - Helping clients develop & test services

# ADAS Approach to VRA N

- Using crop to inform SNS estimate
- Previous yield maps /satellite imagery to inform yield potential/N Demand
- Canopy Management approach to adjust spatially & temporally
  - Each unit of GAI = 30kg N for cereals  
50kg for OSR







## Auto-N Project 2010-2015

LINK project LK09134, HGCA project RD-2008-3350

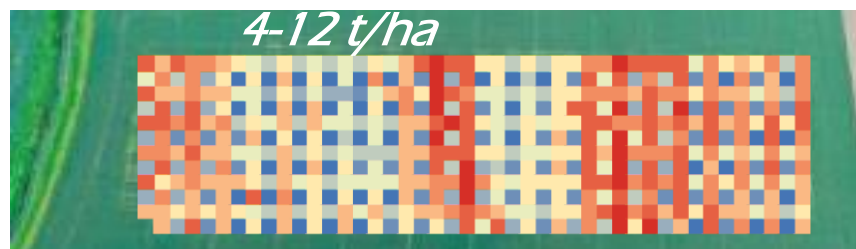


Flawborough, Nottinghamshire UK 2010

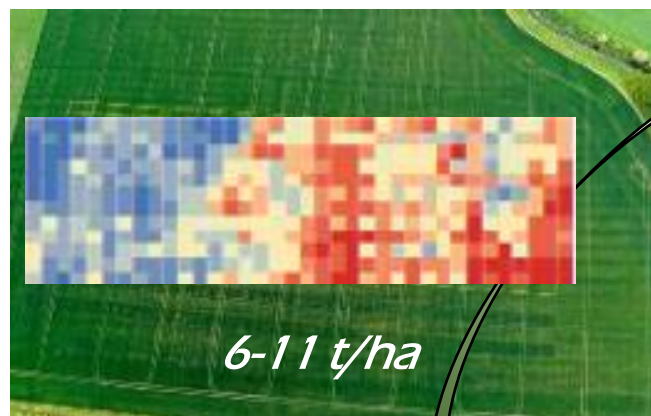


# Analysing Chessboard trials

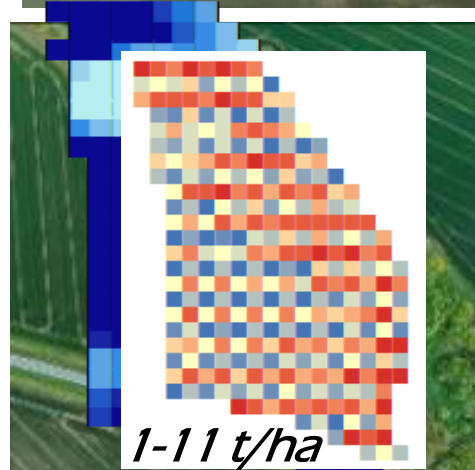
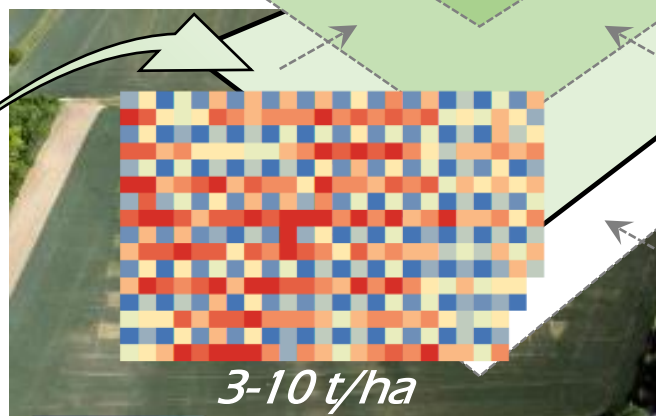
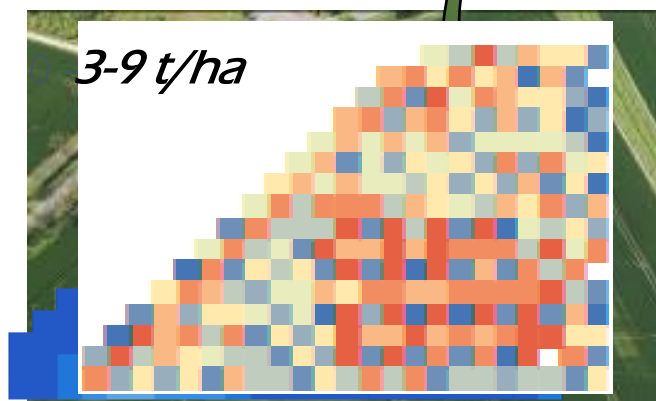
2010



2011



2012



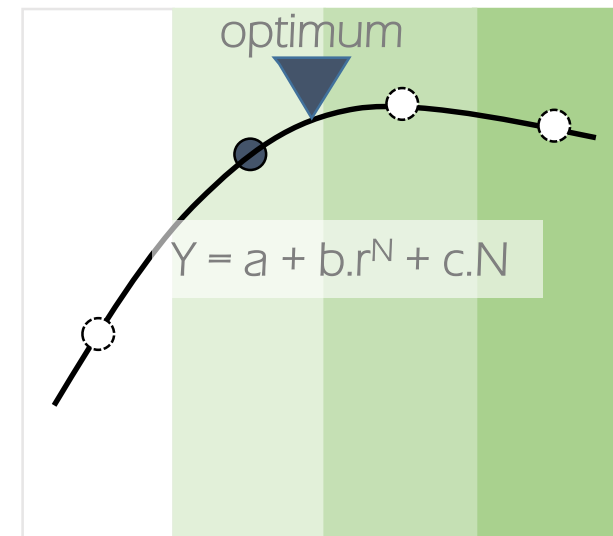
217 - >360 kg/ha

3-10 t/ha

1-11 t/ha

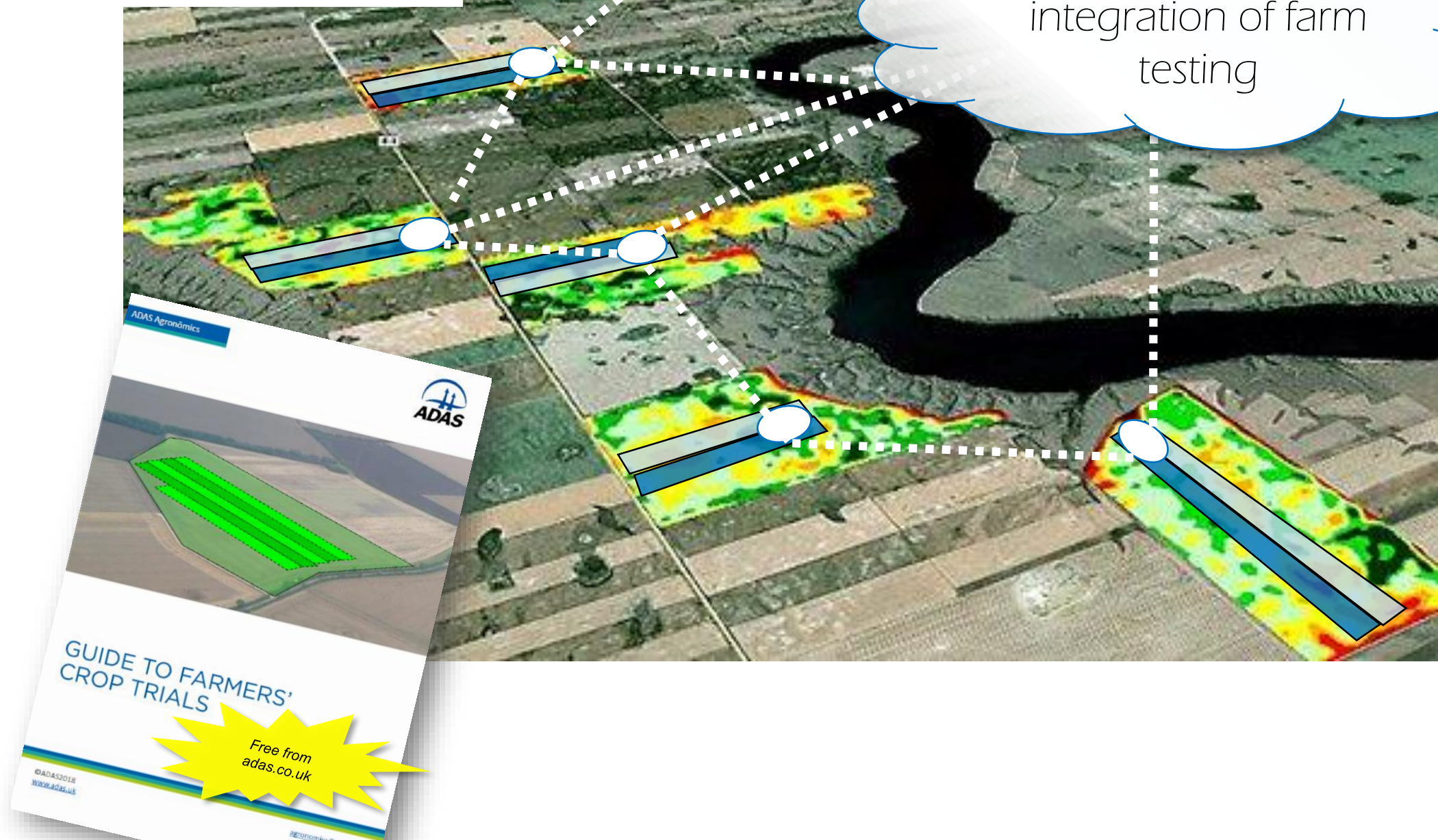
3-9 t/ha

kriged



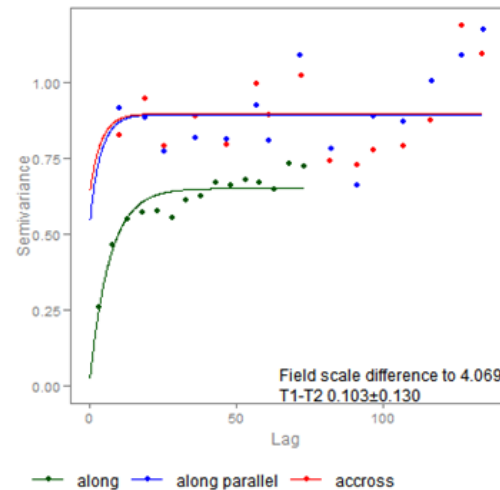
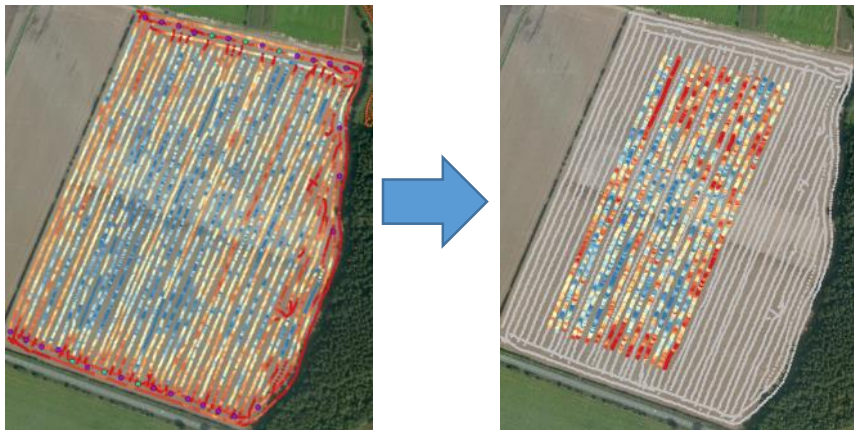


# Agronomics



## Statistical analysis of yield data using ADAS Agronomics approach

- Cleaned dataset analysed using spatial discontinuity analysis



- Takes into account underlying spatial variation in field

Marchant, Rudolph, Roques, Kindred, Gillingham, Welham, Coleman & Sylvester-Bradley., 2018.  
Establishing the precision and robustness of farmers crop experiments. *Field Crops Research*. 230, 31-45

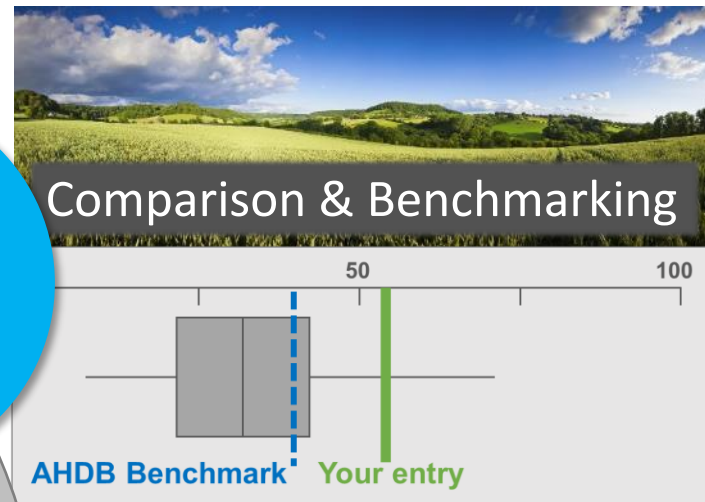






Science,  
**Concepts**  
& understanding

**Metrics**  
Measures  
Data &  
Targets

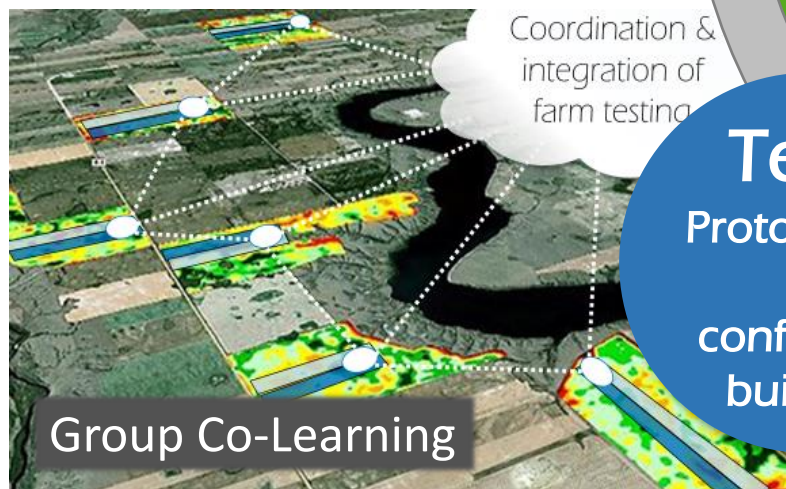


any  
farm-centric  
innovation  
network

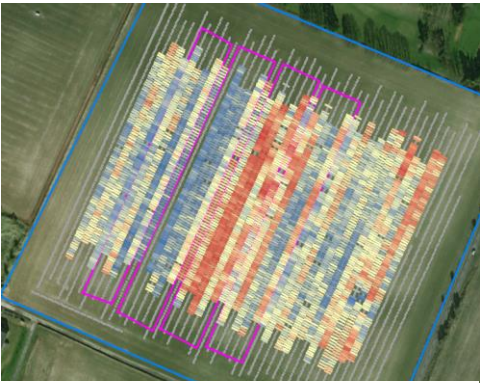
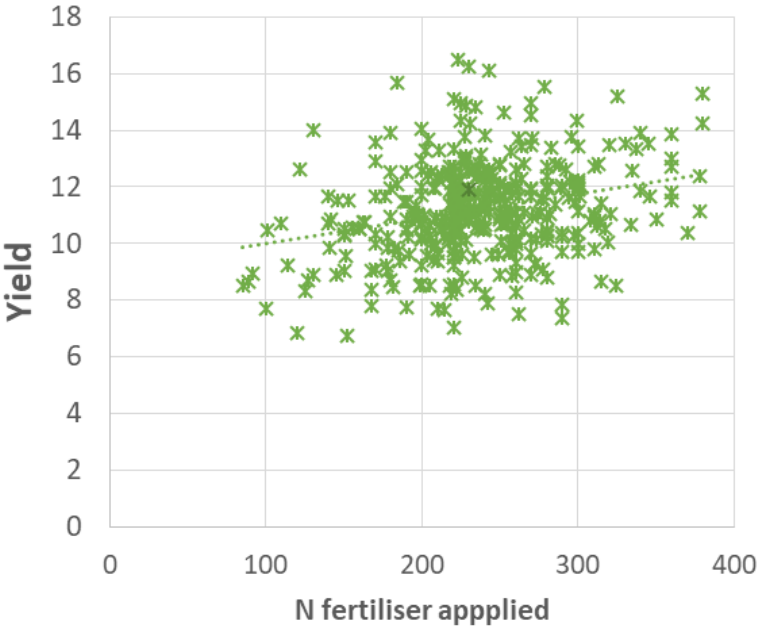
**Tests**  
Prototyping,  
&  
confidence  
building

**Designs**  
Ideas .. &  
Questions

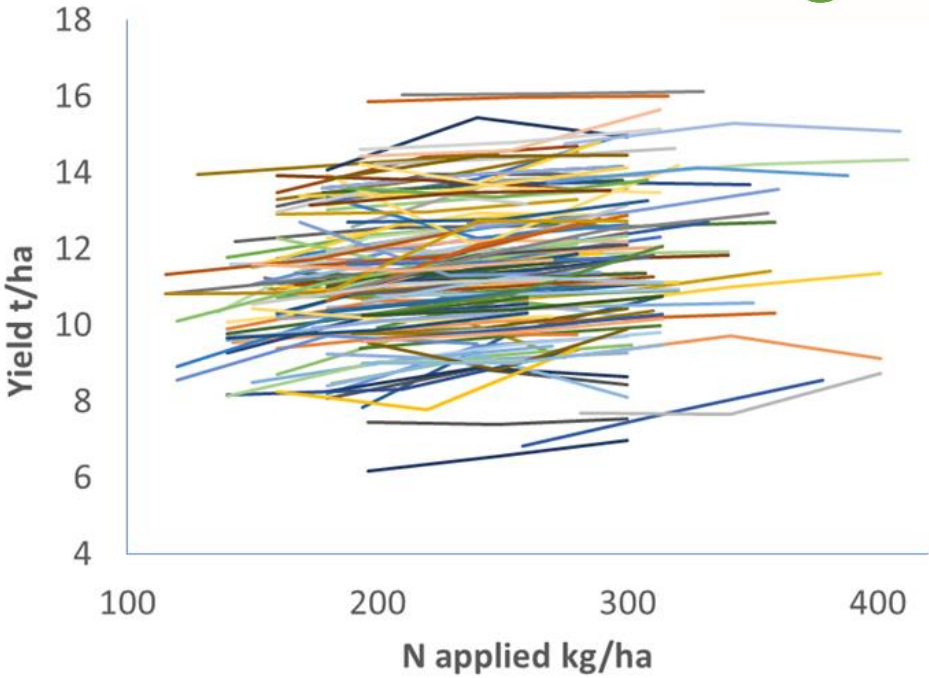
Facilitated  
Summarising,  
& Designing



# Variation in yield mostly not due to variability in N applied



**Agronomics**





# ADAS Plans

- Writing paper on Precision Farming and VRA N for Defra
  - Happy to involve co-authors
  - [Kate.storer@adas.co.uk](mailto:Kate.storer@adas.co.uk)
- H2020 Thematic Network on Balanced Nutrition
  - farm-centric involving farm data and farm trials
  - January submission(!)
  - [Sarah.Kendall@adas.co.uk](mailto:Sarah.Kendall@adas.co.uk)
- Intereg North Sea proposal on VR N?
  - [Kate.storer@adas.co.uk](mailto:Kate.storer@adas.co.uk)
- COFE
- ICPA – OFE Community
- EU Plans for H2020 Precision Farming projects – recent JRC report



# Thank you

***Ag*ronomics**

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## Multiple Sensors to obtain spatial information





# Auto-N Approach

Start with the best *Principles* for N management

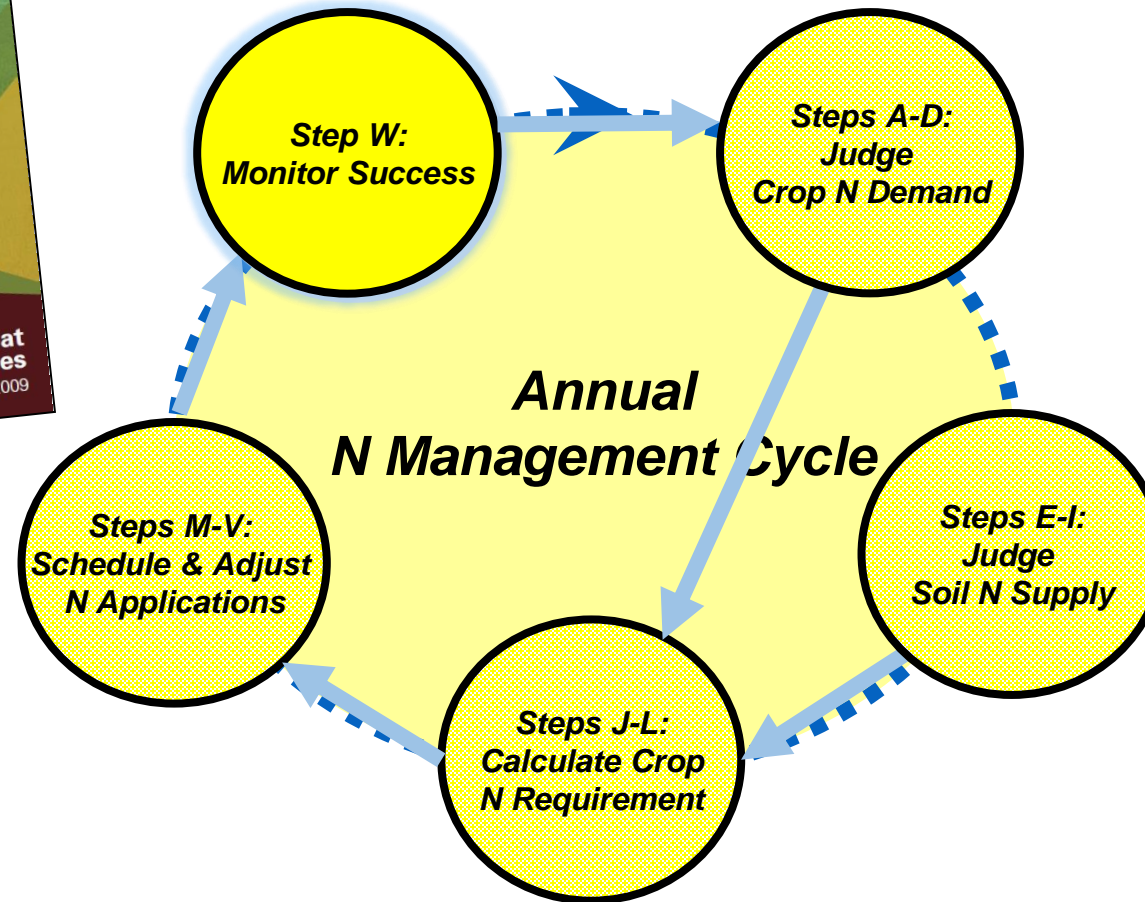
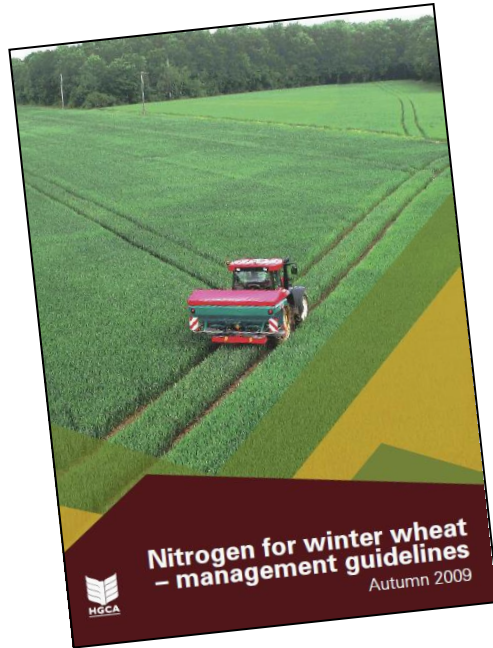
Use available technologies to provide relevant information

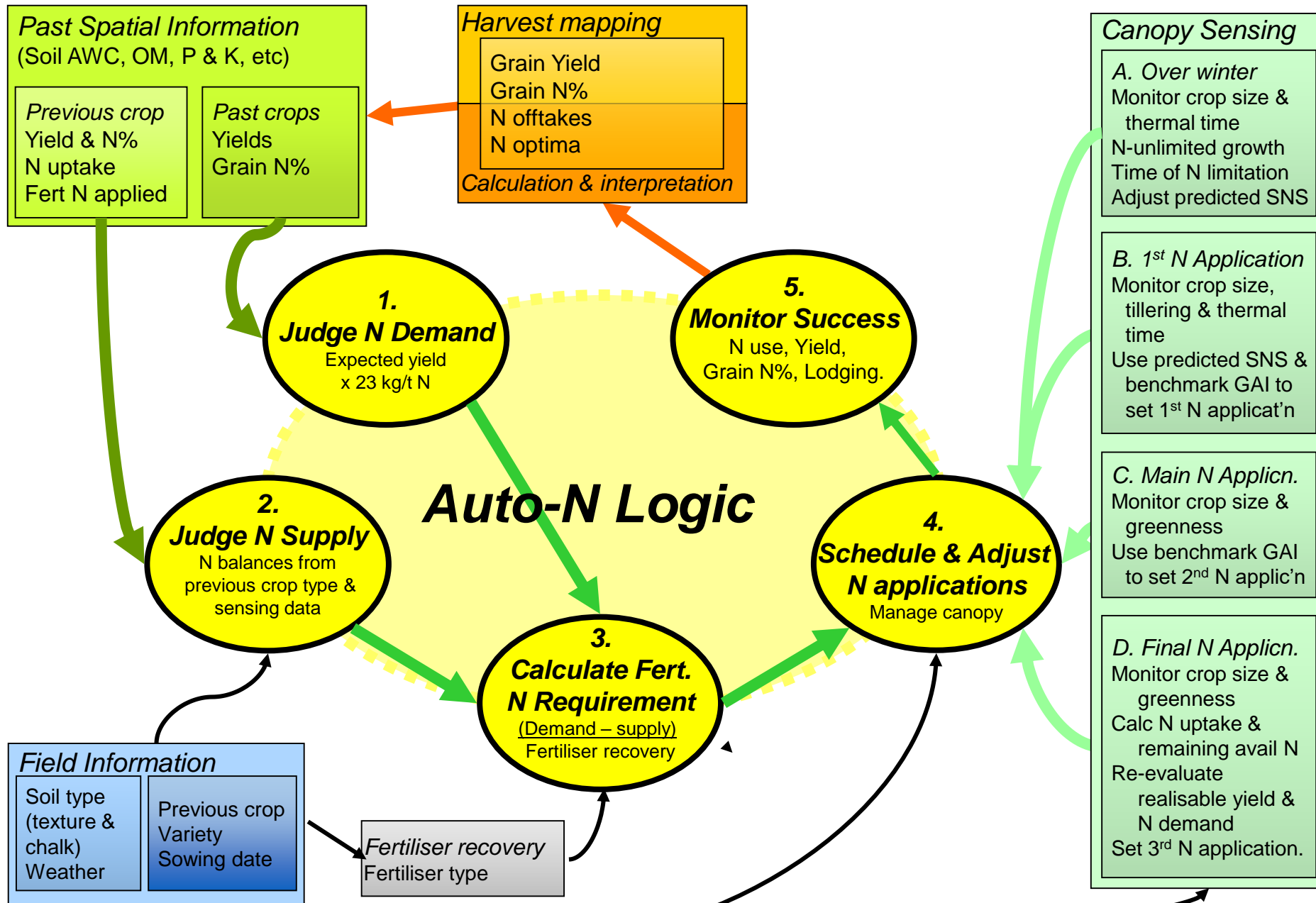
Develop the logic for interpretation





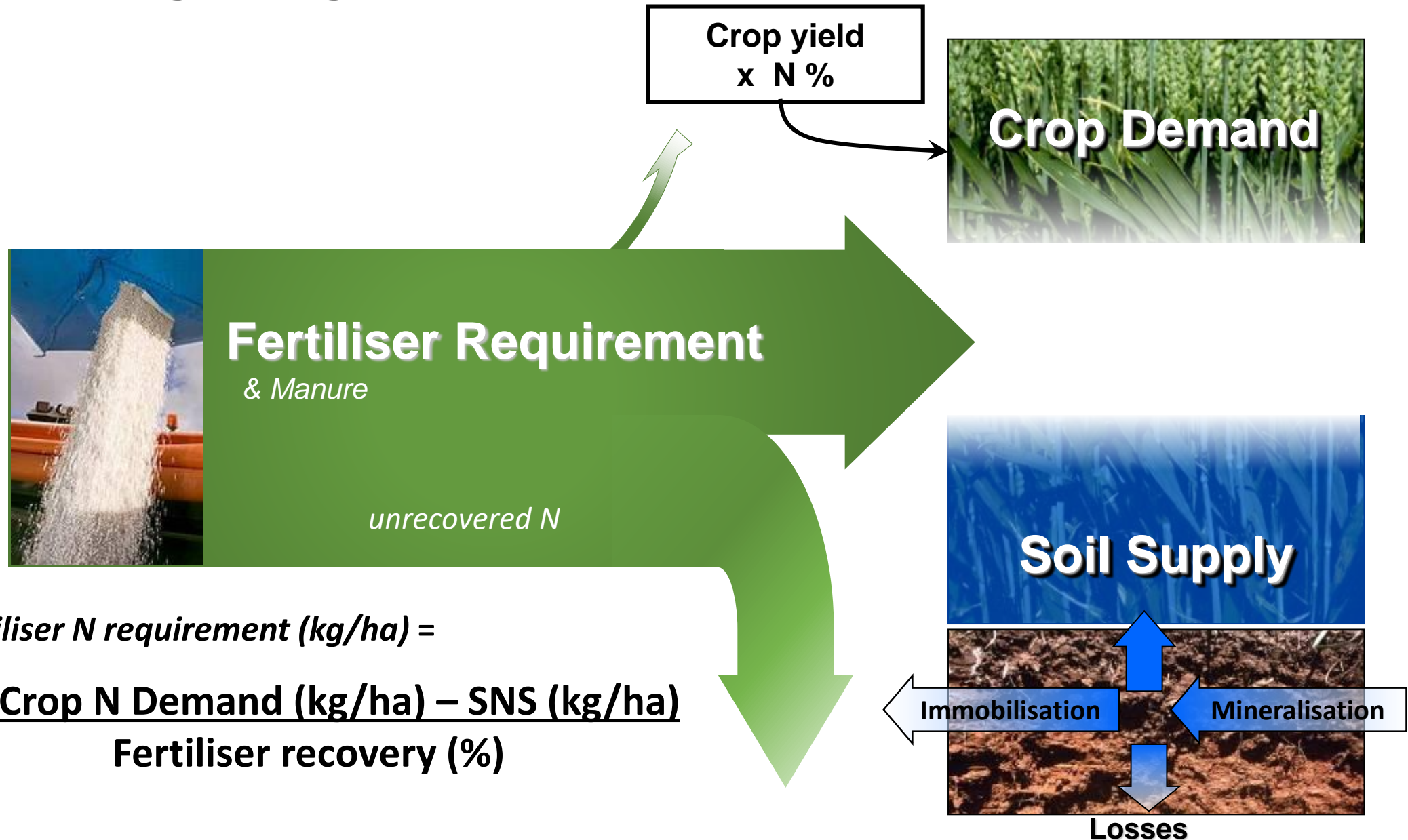
# HGCA Guidelines



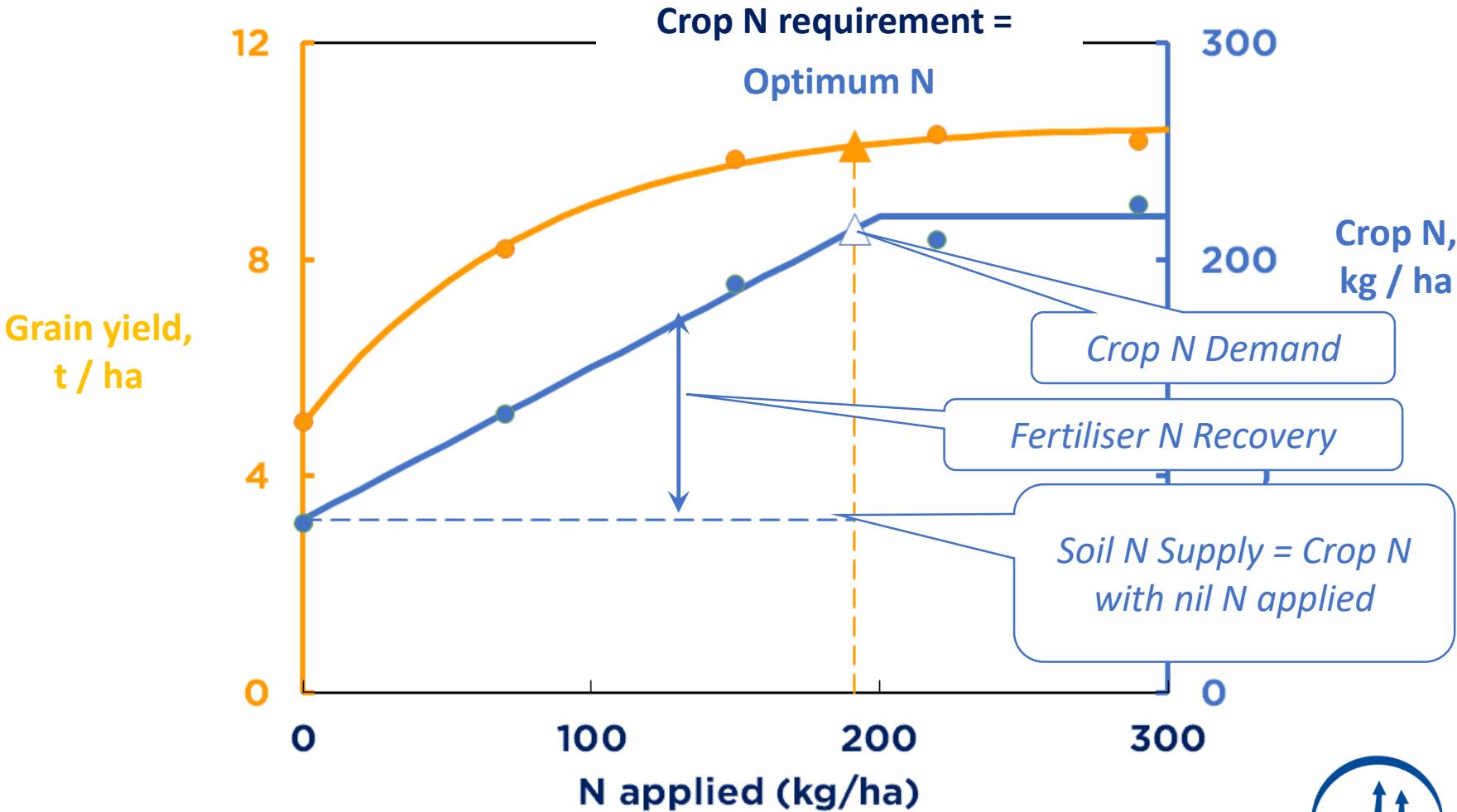




# Calculating Nitrogen requirements



# Measuring N Requirement – economic N optima





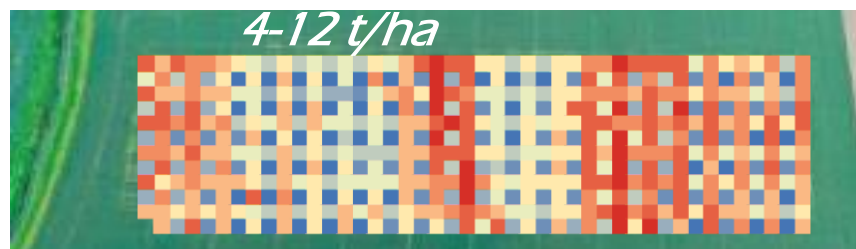


**Auto-N Project 2010-2015** LINK project LK09134, HGCA project RD-2008-3350

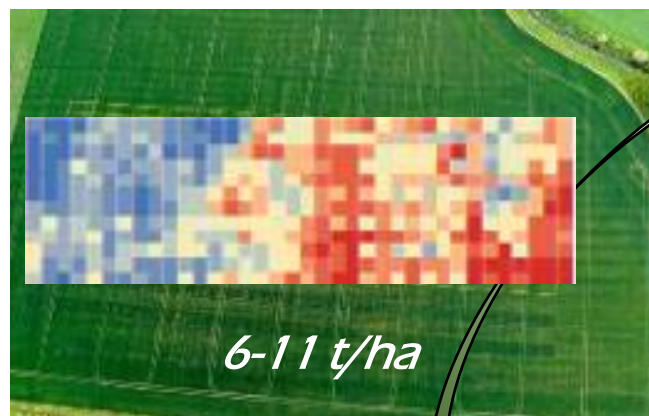


# Analysing Chessboard trials

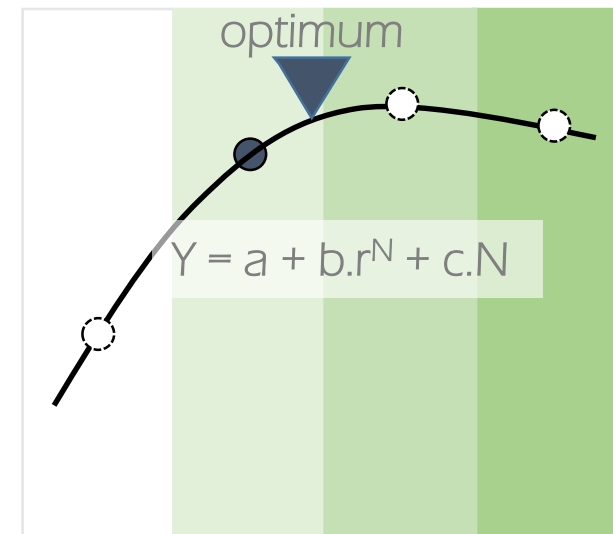
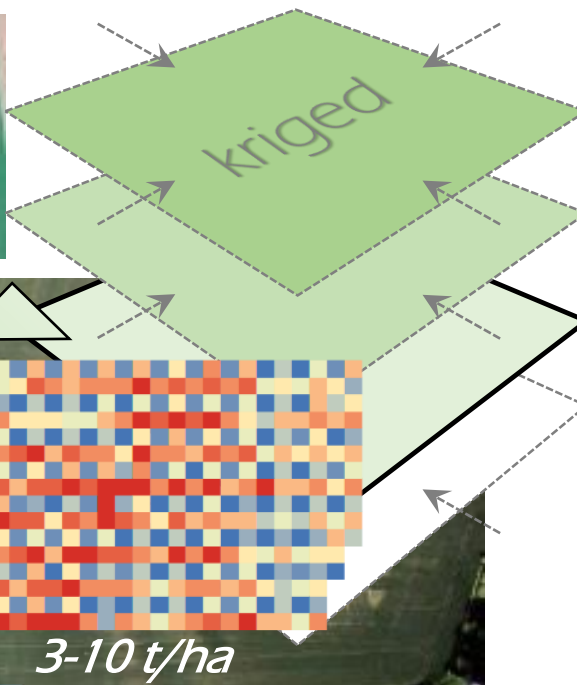
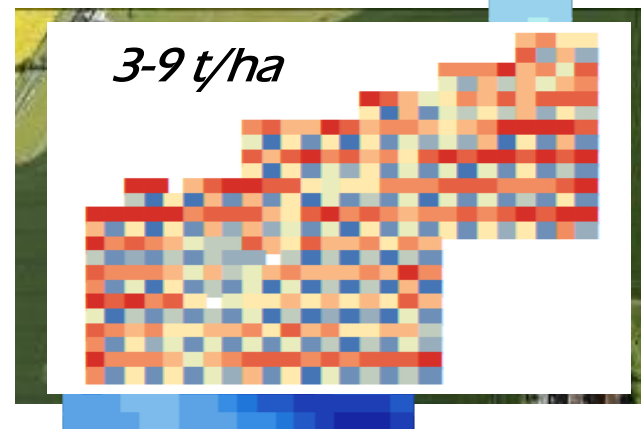
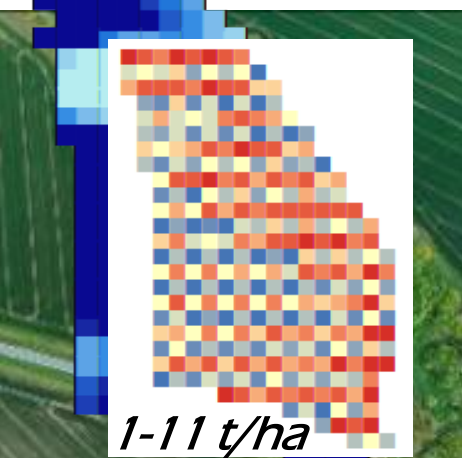
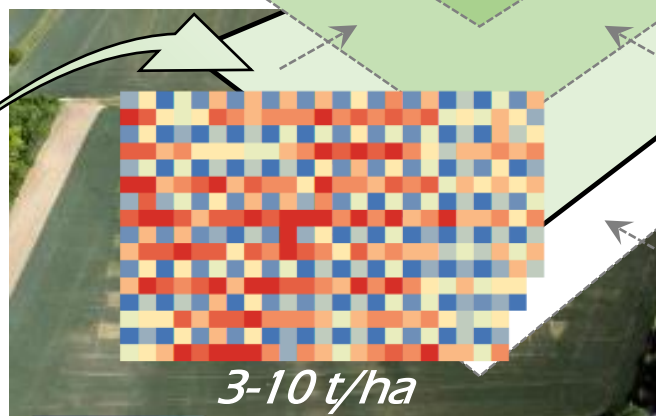
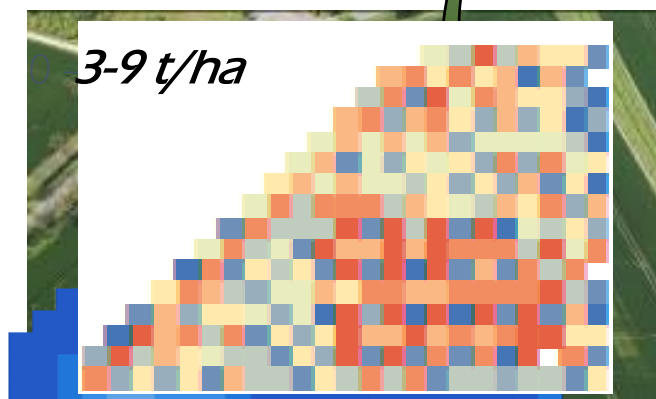
2010



2011



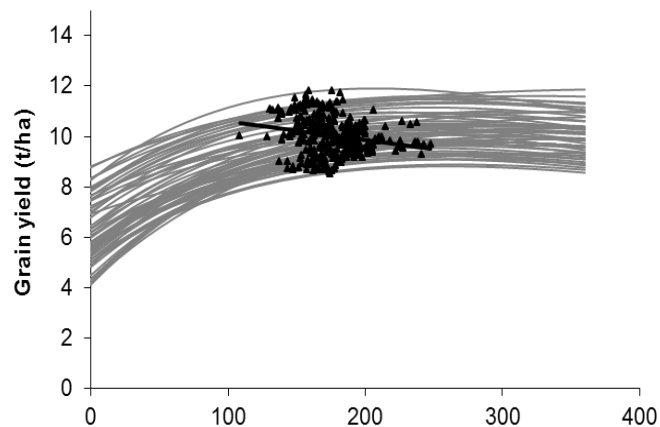
2012



217 - >360 kg/ha

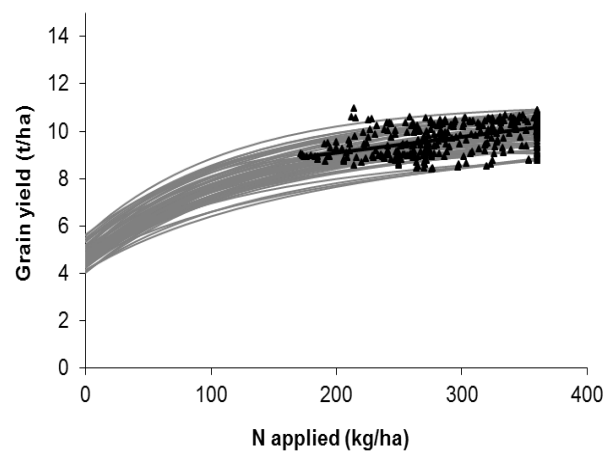
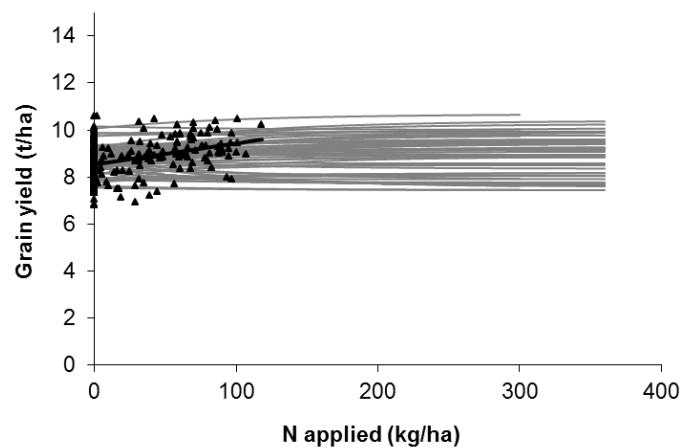


2010

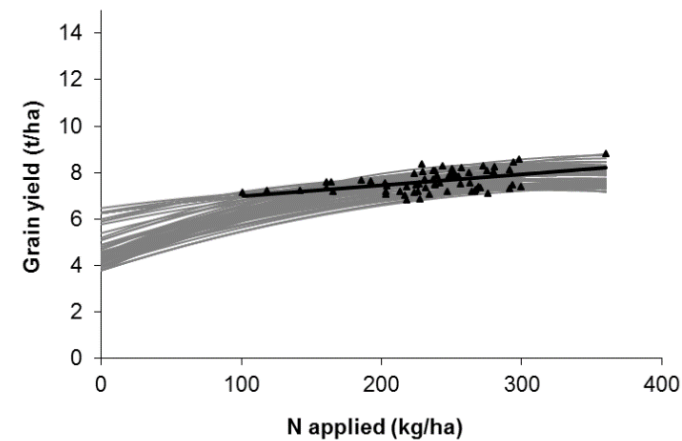
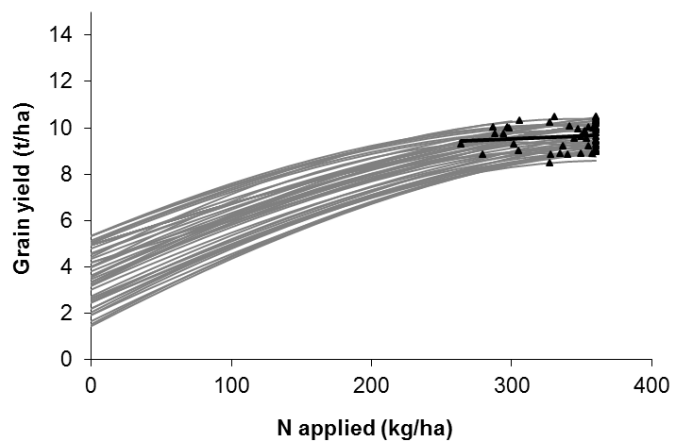
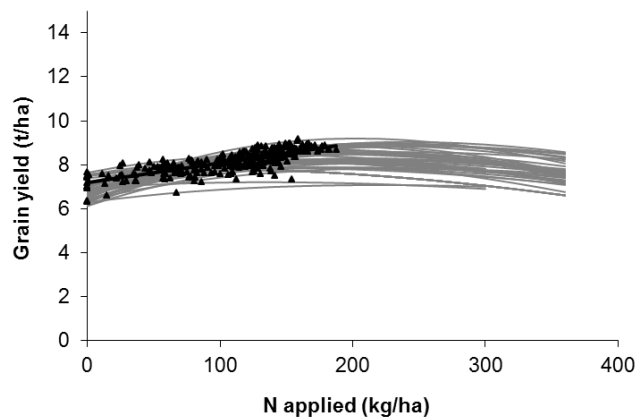


# Chessboard N responses

2011

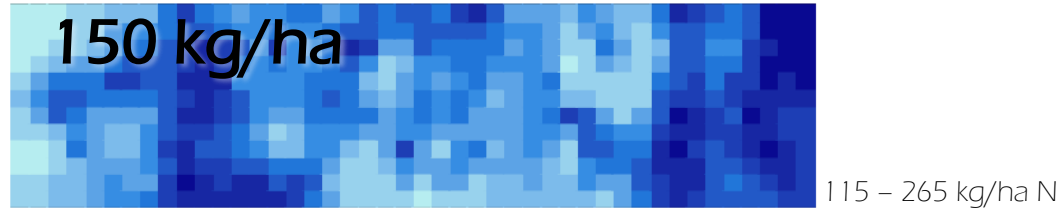


2012

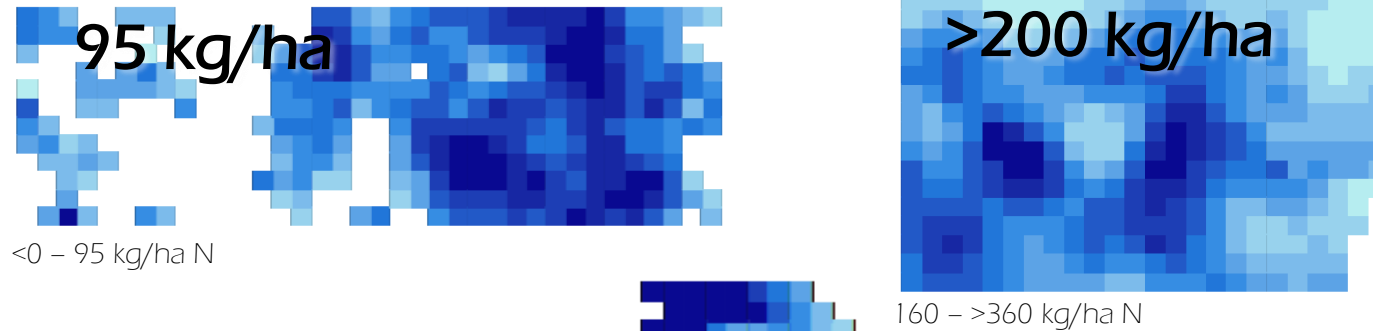


# In-field ranges of N requirements i.e. N optima

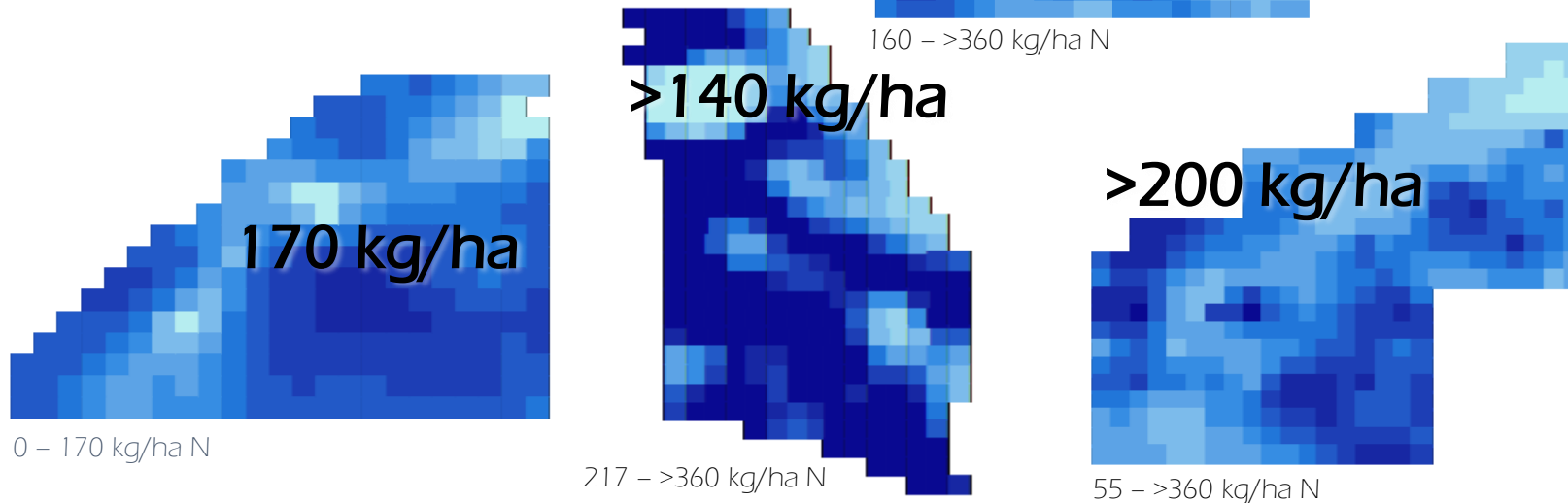
2010



2011

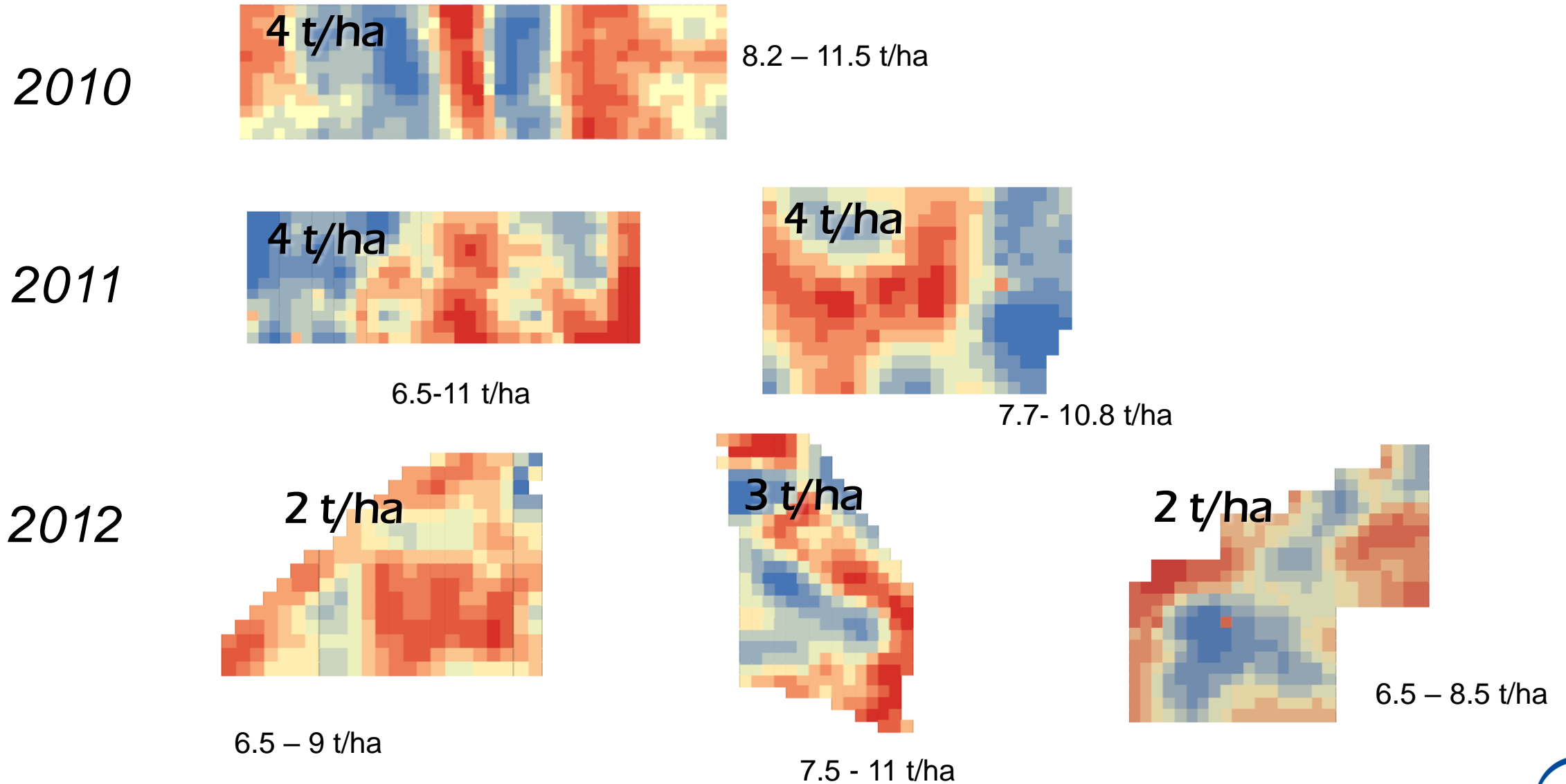


2012





# Variation in yield at optima



# Variation in SNS

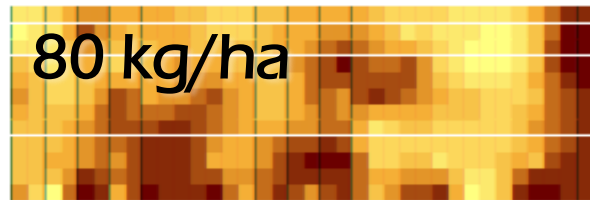
(Total N uptake at zero-N)

2010



60 – 180 kg N/ha

2011

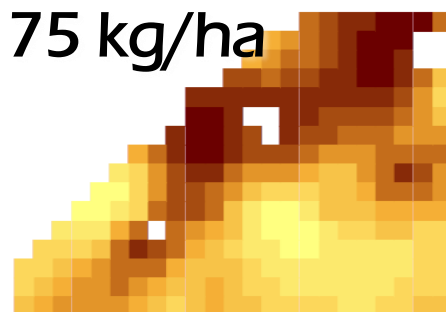


95 – 175 kg N/ha



65 – 100 kg N/ha

2012



125 – 200 kg N/ha



25-100 kg N/ha

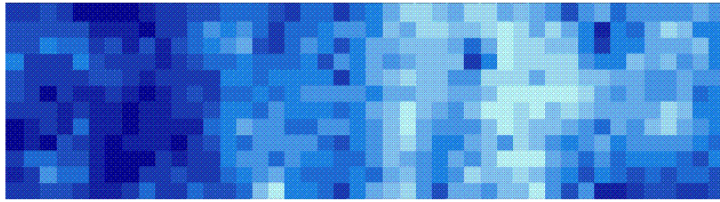


70 – 190 kg N/ha



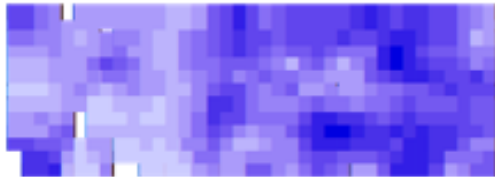
# Variation in Fertiliser recovery

2010

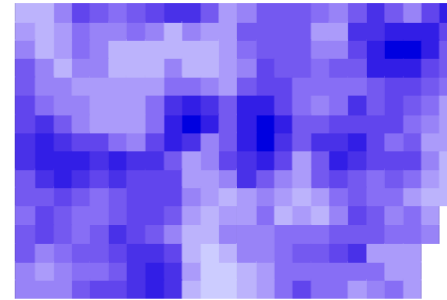


35 – 80%

2011

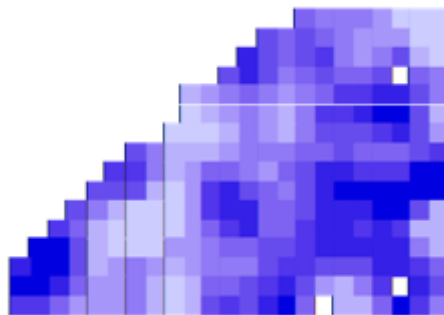


0 – 47%

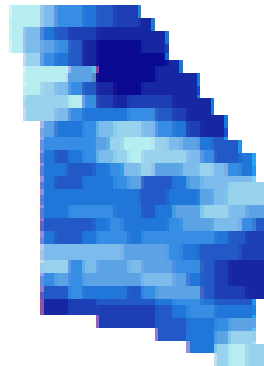


30 – 79%

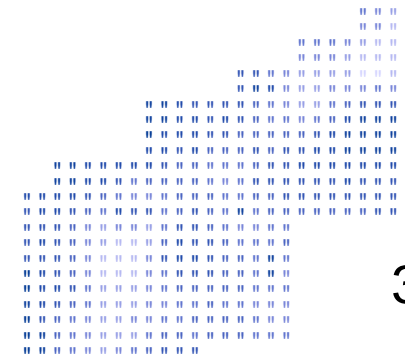
2012



40 – 95%



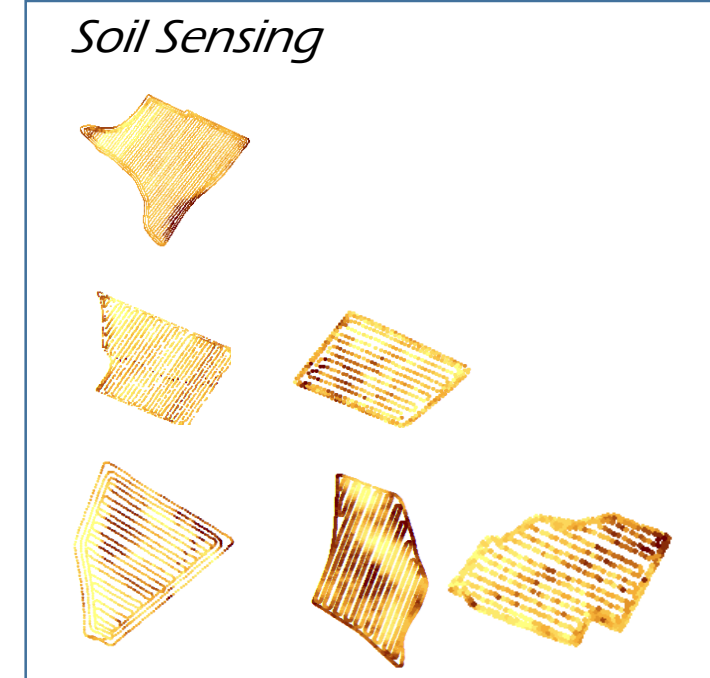
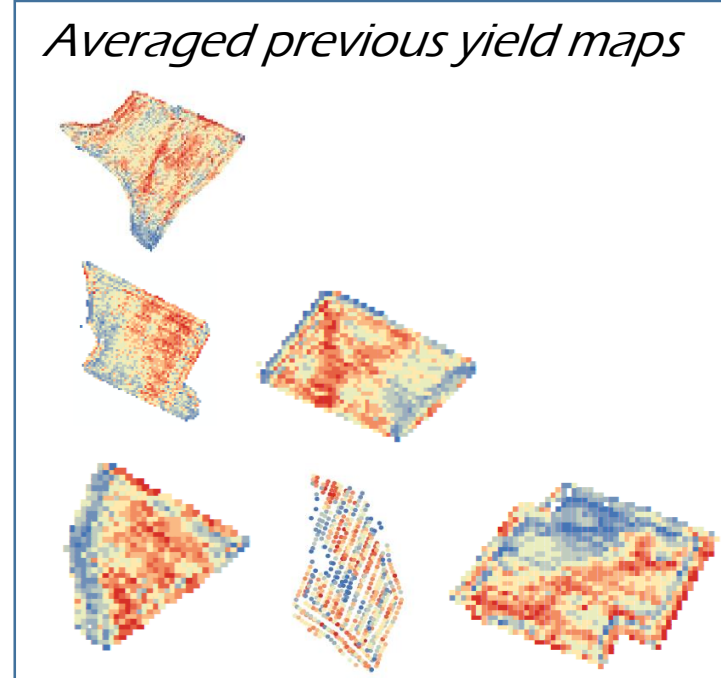
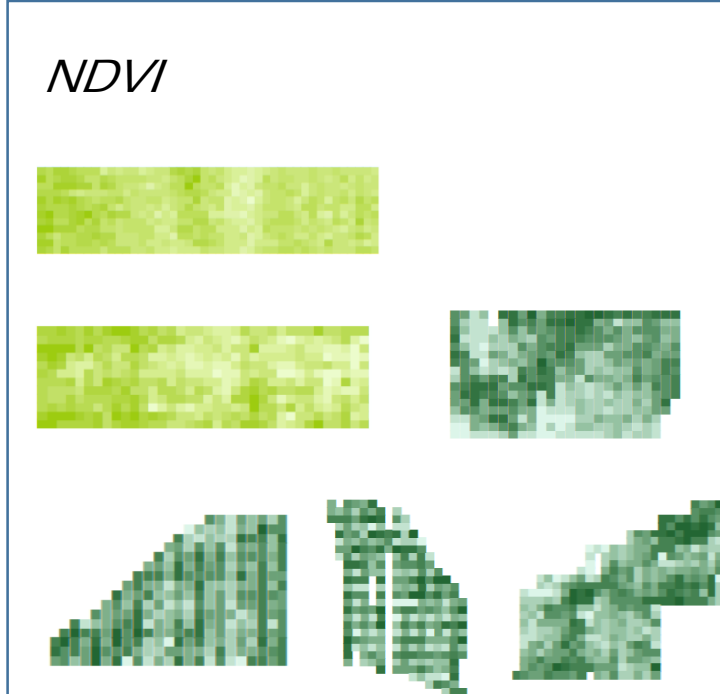
37- 60%



35 – 80%

# Conclusions from chessboards

- Large spatial variation in yield, N requirement, SNS & fertiliser recovery
  - SNS generally most important driver of N requirement,
    - ... but positively related to yield potential (crop demand) and interacts with recovery
      - Makes predicting N optima challenging
- Supports general principles of variable rate system
  - ...Sensing in early spring relates to SNS.
  - ...Yield mapping and later sensing can inform crop N demand.



# Benefits of variable rate N

<b>Site</b>	<b><i>N optima kg/ha</i></b>	<b><i>Average N optima</i></b>	<b><i>Profit foregone vs flat 200 kg N/ha</i></b>	<b><i>Profit foregone vs accurate flat rate</i></b>	<b><i>Yield gained vs 200 kg/ha flat rate (t/ha)</i></b>	<b><i>Yield gained vs accurate flat rate (t/ha)</i></b>
<b>Flawboro 2010</b>	115-265	185	£7	£4	-0.1	0.03
<b>Flawboro 2011</b>	0-95	10	£191	<£1	0	0.13
<b>Burford 2011</b>	162->360	264	£6	£5	0.23	0.04
<b>Burford 2012</b>	53->360	219	£23	£8	0.34	0.04
<b>Bedfordia 2012</b>	0-171	93	£51	£13	0.06	0.1
<b>Shipton 2012</b>	207->360	322	£195	£23	1.56	0.12



# Learnings

- Yield impact of optimal N application surprisingly small
  - So economic benefits of variable rate modest
    - ... assuming average N application for field is accurate
  - Most important is to get accurate average N rate for farm and field
- N limitation is not the major driver of spatial variation in yield
  - ... What is???
- Greatest power of Precision Farming is to enable farmers to test decisions
  - Spatial experimentation at field scale is a powerful research tool

**Ag**ronomics

*Farmer-centric research to develop farm-tailored decision-making*

<http://www.adas.uk/services/agronomics>

**Lear**N

*On-Farm Testing of N management, AHDB project 2013 – 2018*

[https://cereals.ahdb.org.uk/publications/2018/august/08/using-farm-experience-to-improve-n-management-for-wheat-\(learn\).aspx](https://cereals.ahdb.org.uk/publications/2018/august/08/using-farm-experience-to-improve-n-management-for-wheat-(learn).aspx)

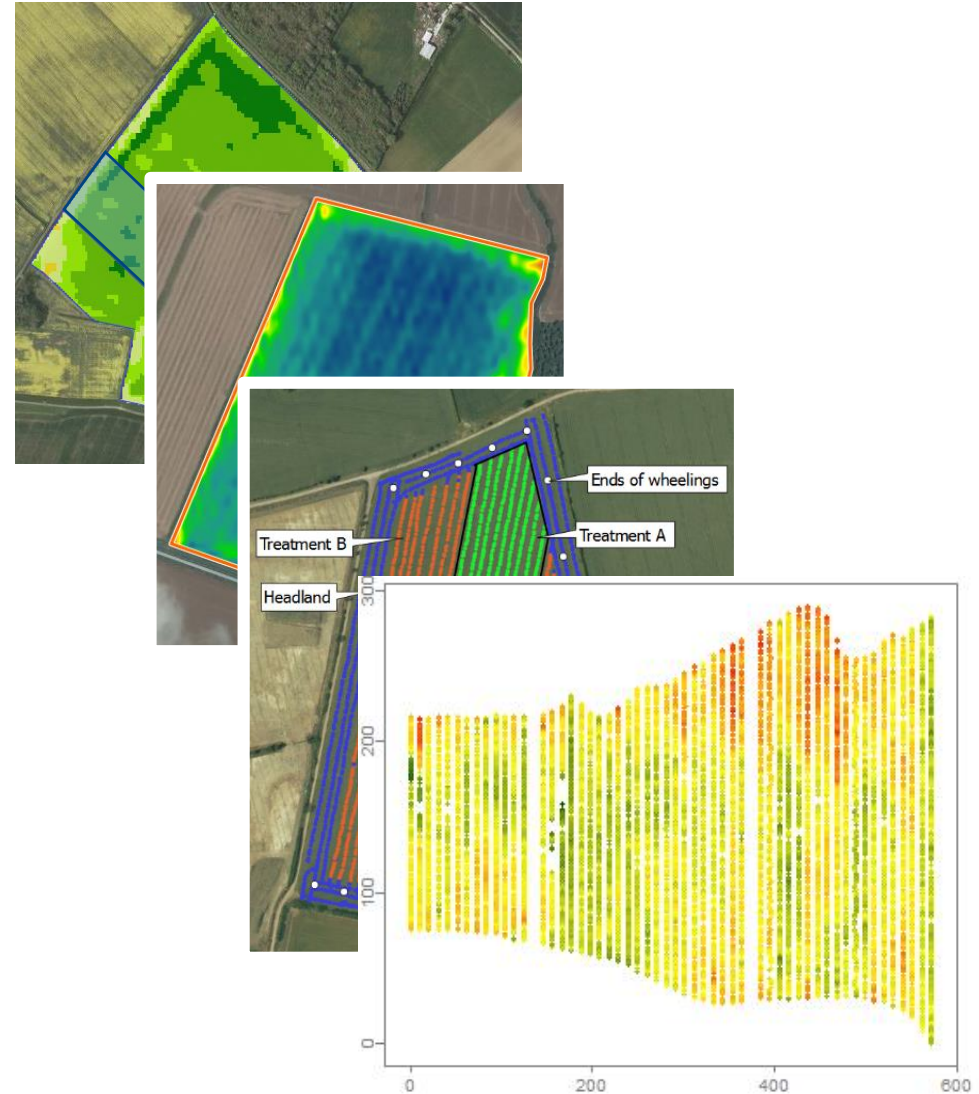
# Agronōmics: Farmer-centric research to develop farm-tailored decision making

- Farmer networks
- Precision farming
- Remote sensing
- Data sharing



# Agronōmics approach

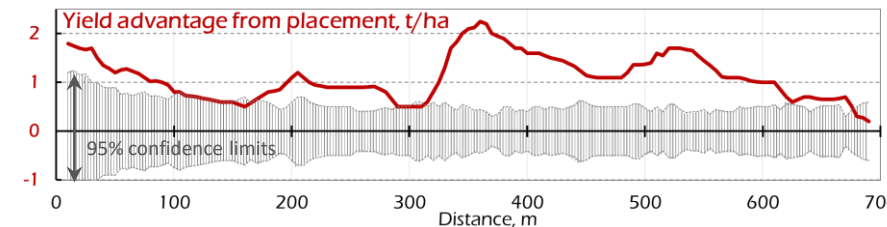
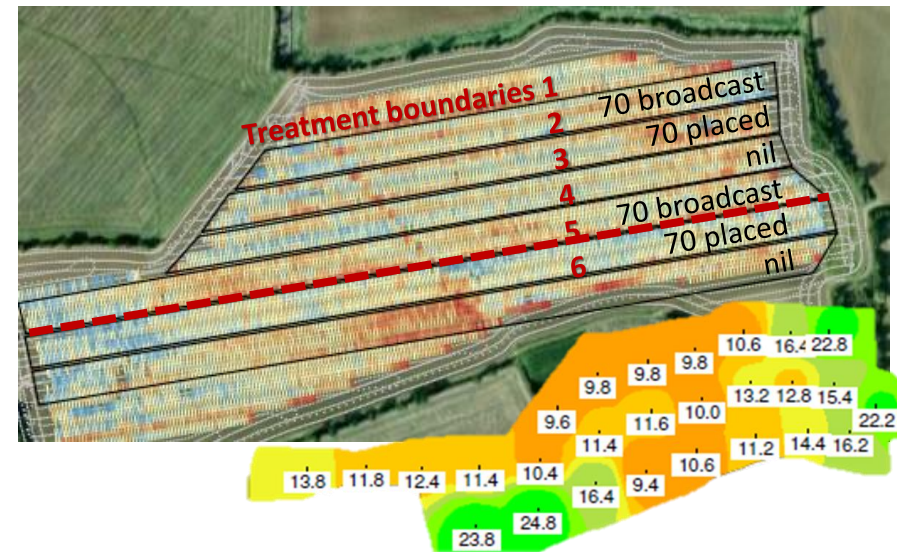
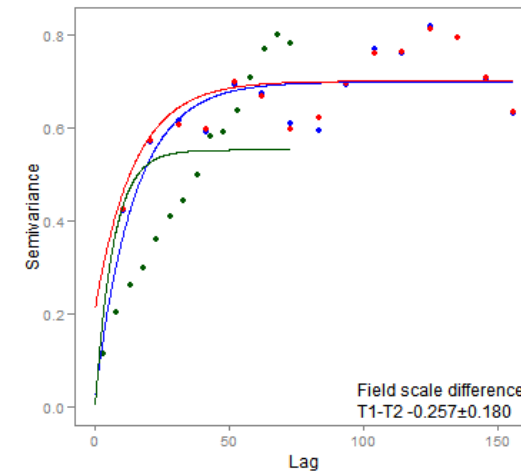
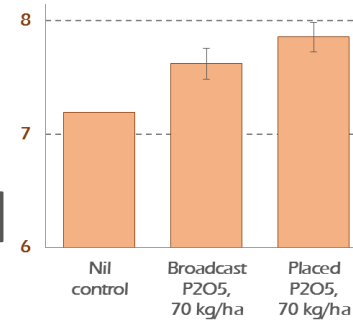
1. Fair trial designs
2. In-season monitoring
3. Assigning data to treatments
4. Data cleaning and correction





# Agronōmics approach

4. Statistical analysis
5. Interpretation of spatial and treatment effects
6. Bespoke reporting



Name: [redacted]  
Address: [redacted]  
Postcode: [redacted]  
email@address.com

Field / Site: Field name: [redacted]  
Grid Ref: [redacted]  
Variety: [redacted]  
Soil type: [redacted]

Thank you for joining the TRAIL SERIES. This report contains the results of your trial, comparing AAA fungicide programme at T1 and T2 with your choice of alternative products, described here as the 'firm standard' treatment. Additional information about the crop is provided in your separate TRS report.

Treatments	NEW PRODUCT	Treatments 2
T1 (2 Apr)	AAA 1.0 + CTL 1.0	BBB 1.0 + CTL 1.0
T2 (14 May)	AAA 1.25 + CTL 1.0	CCC 1.25 + CTL 1.0
T3 (14 Jun)	Proline 0.8 + Treacur 250 0.5	

**Pre-harvest observations**  
The NDVI (Normalised Difference Vegetation Index) maps below show differences in plant vigor, which is a combination of leaf area and its greenness. There were no visible differences in NDVI caused by the treatments, and the field was reasonably even so it was a fair test of the two treatments.

In spring 2017 disease pressures were generally considered to be below average, with spring rainfall between 10% and 50% of the 1961-2020 average across most of the country, which limited the spread of Septoria across the plant to the seed forming leaf layers. The exception was in the south west, where higher rainfall caused severe Septoria pressure at many sites. Where weaker fungicide programmes were employed there were some reports of brown rust coming into susceptible varieties in late June. The persistent disease issue across the UK during 2017 was powdery mildew which manifested early successfully in the bottom of crops in many regions, and required specific miticide applications in some cases.

**Yield results**  
The average measured yield of the firm standard treatment was 9.50 t/ha. The AAA treatment placed 0.89 t/ha less than the firm standard treatment, which was a significant difference at the 95% confidence level.  
The difference between treatments appears to have resulted mainly from a higher number of fertile shoots per m<sup>2</sup> in the firm standard treatment, rather than from effects on grain number per ear or thousand grain weight, suggesting that the firm standard was better at promoting tiller survival but may not have extended the grain-filling period. The firm standard treatment also had a higher total biomass, but a lower harvest index than the AAA treatment.

Character	UNIT	NEW PRODUCT	Firm standard
Fertile shoots i.e. ears	#/m <sup>2</sup>	394	437
Spikelets	#/ear	7094	8209
Grains	#/m <sup>2</sup>	27.8	36.2
Thousand grain weight	g/1000	40.7	40.5
Grain specific weight	kg/ha	47.4	47.5
Grain protein	% grain DM	11.93	11.71
Total biomass at harvest	t/ha	12.72	13.35
Harvest index	% biomass	37.0	31.6
Total grain yield	t/ha	4.76	4.68
Average grain yield achieved	t/ha	9.34	9.50

Yield (t/ha)  
--- 05.49 - 06.17  
--- 06.17 - 06.86  
--- 06.86 - 07.39  
--- 07.39 - 07.73  
--- 07.73 - 08.07  
--- 08.07 - 08.42  
--- 08.42 - 08.76  
--- 08.76 - 09.10  
--- 09.10 - 09.45  
--- 09.45 - 09.79  
--- 09.79 - 10.14  
--- 10.14 - 10.48  
--- 10.48 - 10.82  
--- 10.82 - 11.16  
--- 11.16 - 11.50  
--- 11.50 - 11.84  
--- 11.84 - 12.18  
--- 12.18 - 12.52  
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--- 15.58 - 15.92  
--- 15.92 - 16.26  
--- 16.26 - 16.60  
--- 16.60 - 16.94  
--- 16.94 - 17.28  
--- 17.28 - 17.62  
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--- 17.96 - 18.30  
--- 18.30 - 18.64  
--- 18.64 - 18.98  
--- 18.98 - 19.32  
--- 19.32 - 19.66  
--- 19.66 - 20.00  
--- 20.00 - 20.34  
--- 20.34 - 20.68  
--- 20.68 - 21.02  
--- 21.02 - 21.36  
--- 21.36 - 21.70  
--- 21.70 - 22.04  
--- 22.04 - 22.38  
--- 22.38 - 22.72  
--- 22.72 - 23.06  
--- 23.06 - 23.40  
--- 23.40 - 23.74  
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--- 27.48 - 27.82  
--- 27.82 - 28.16  
--- 28.16 - 28.50  
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--- 33.26 - 33.60  
--- 33.60 - 33.94  
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--- 35.30 - 35.64  
--- 35.64 - 35.98  
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