



Yield stagnation or yield growth ?

- on-farm innovation ... with “Agronomics”

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Cambridge, UK



Conference on top yields, Middelfart, Denmark, November 2016



Yields drive profits

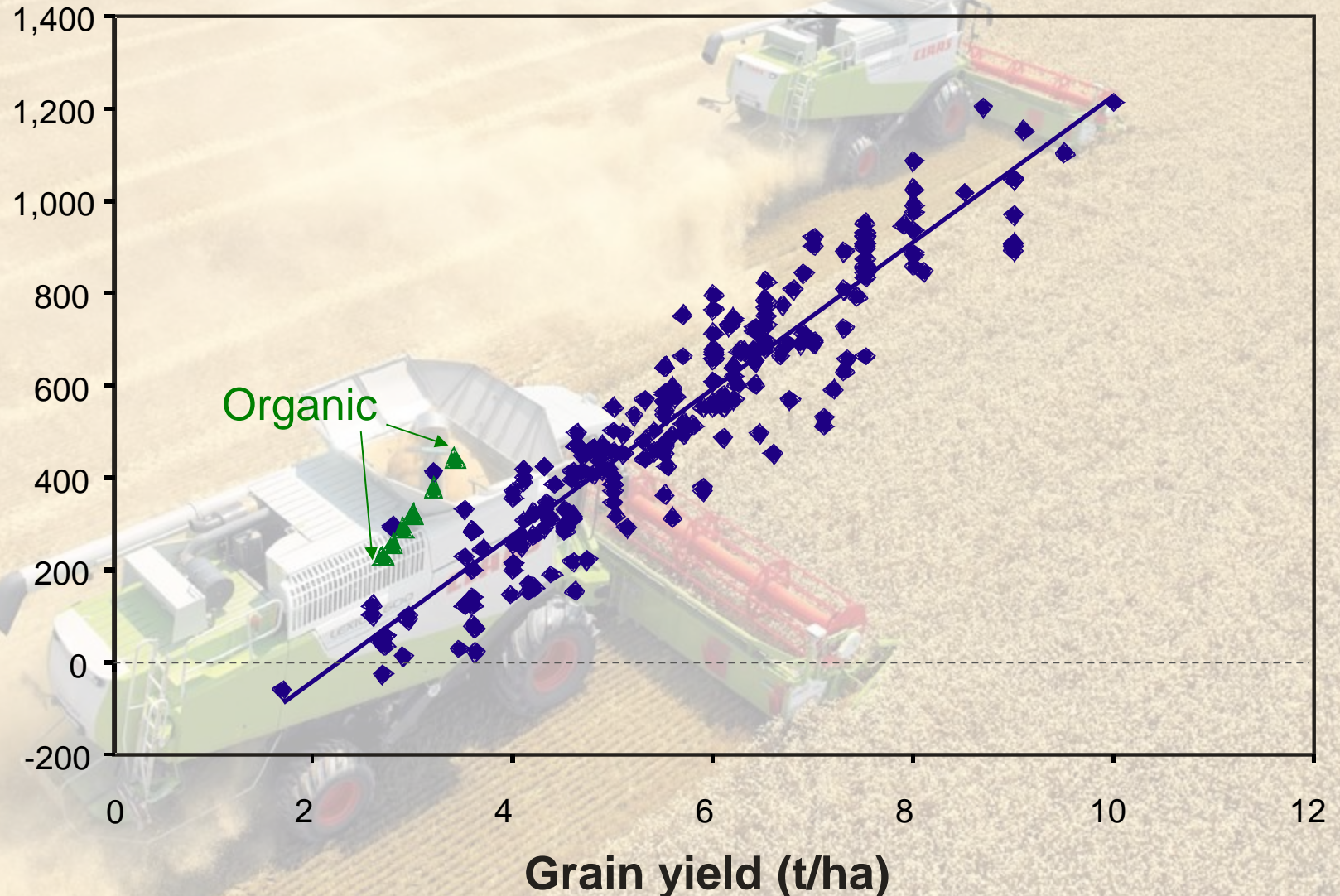
data courtesy of

in vivo
AgroSolutions

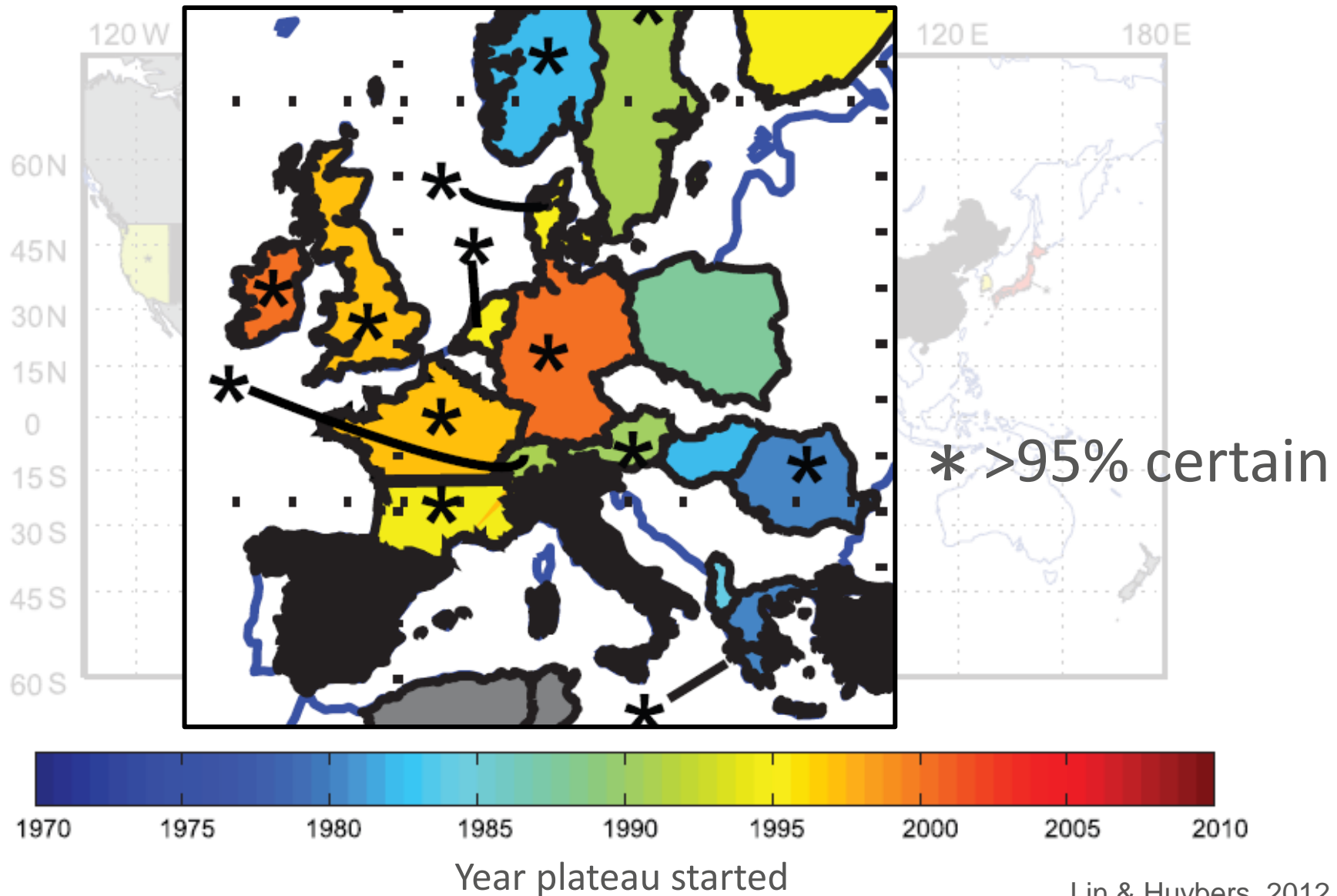
265 farms in France

Gross margin, € / ha

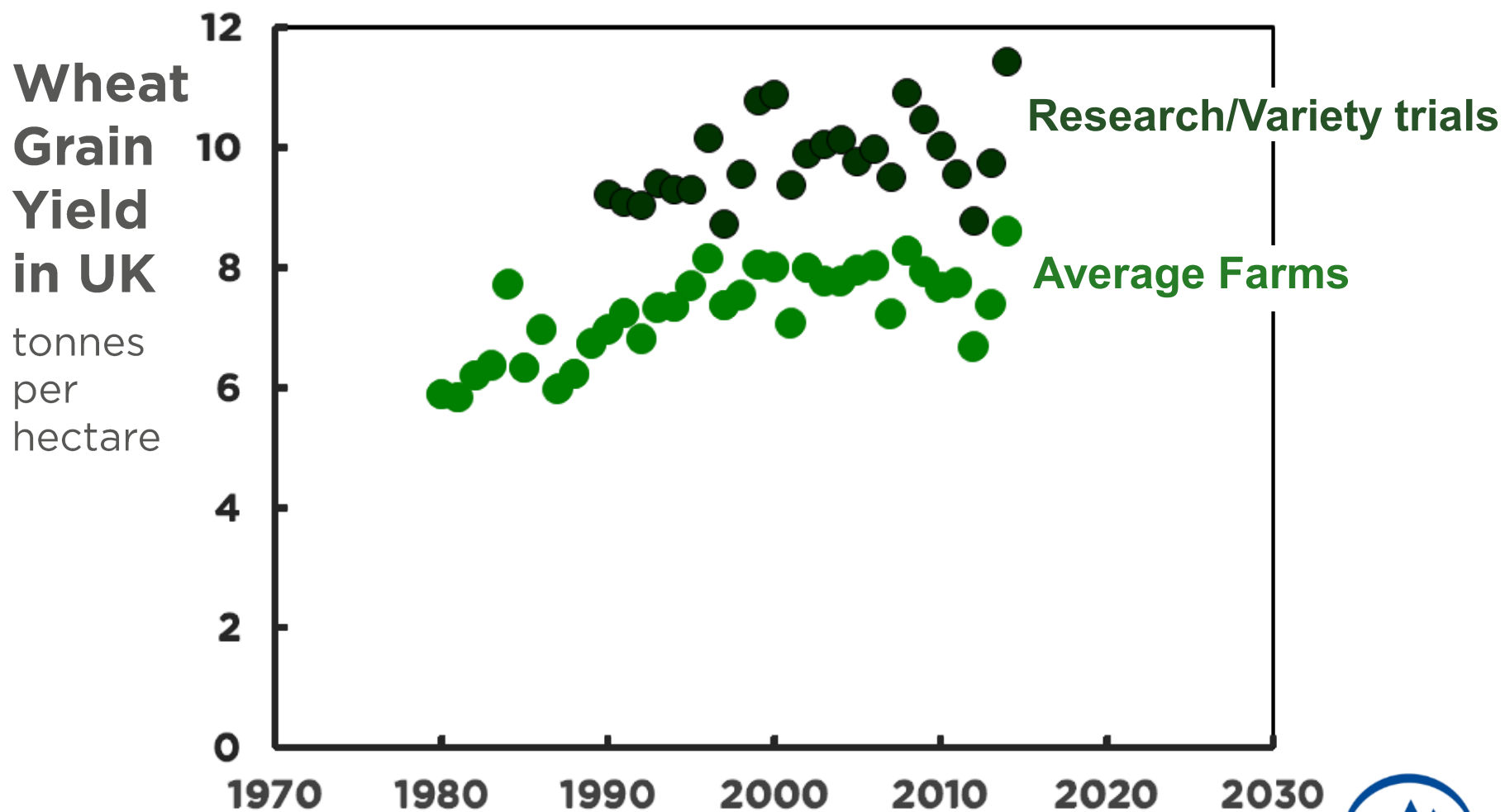
Soft wheat in 2012



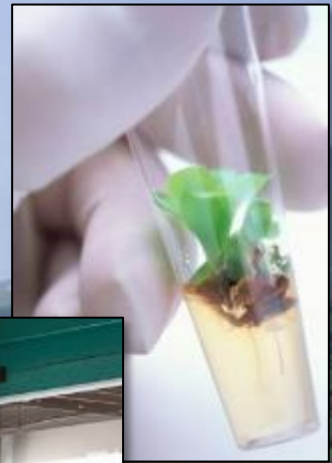
Wheat yields stagnating around the world



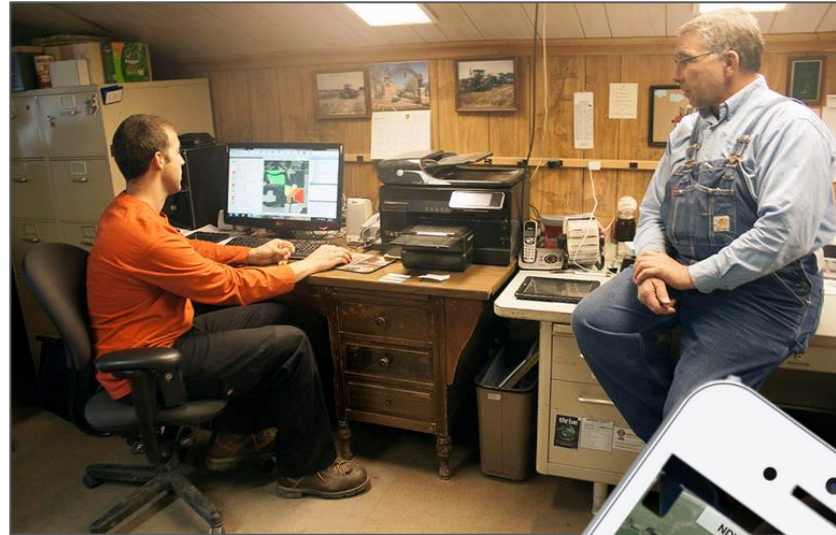
Wheat yields stagnating in the UK



Crop-Science Disconnections



Opportunity 1: Digital farm records



Analysis Options - Field cropping by Crop and variety

Title	Options	Order	Filters	Style	Chart Settings	Chart Styles	
Column				Caption	Visible	Filter	Order
Business (All)				Business (All)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Business (Main)				Business (Main)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Business (Main) Account Reference				Business (Main) Account Reference	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Crop				Crop	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Crop End Use				Crop End Use	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Crop Group				Crop Group	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Crop Reference				Crop Reference	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Crop Residue				Crop Residue	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Crop Sequence				Crop Sequence	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cropping Record Active				Cropping Record Active	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Descriptor				Descriptor	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Field Defined Name				Field Defined Name	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Field Group				Field Group	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

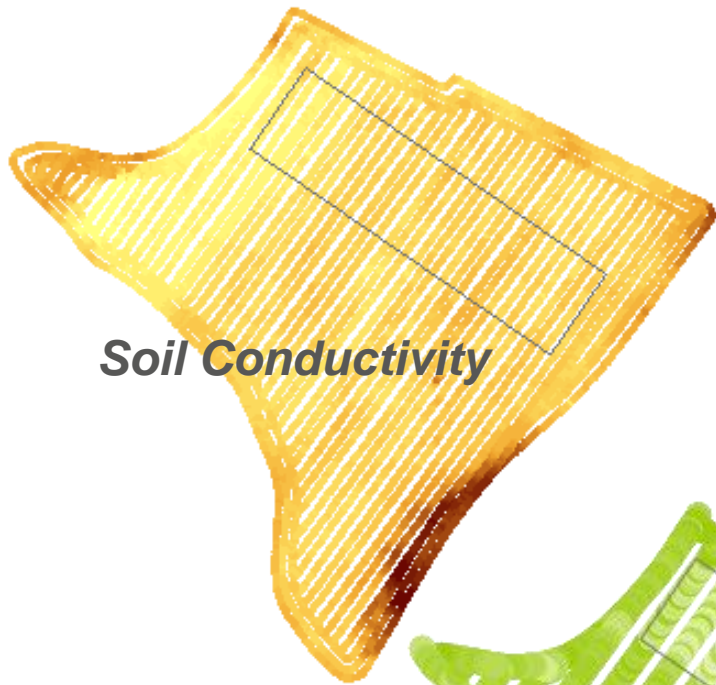


Opportunity 2: Multiple Sensors

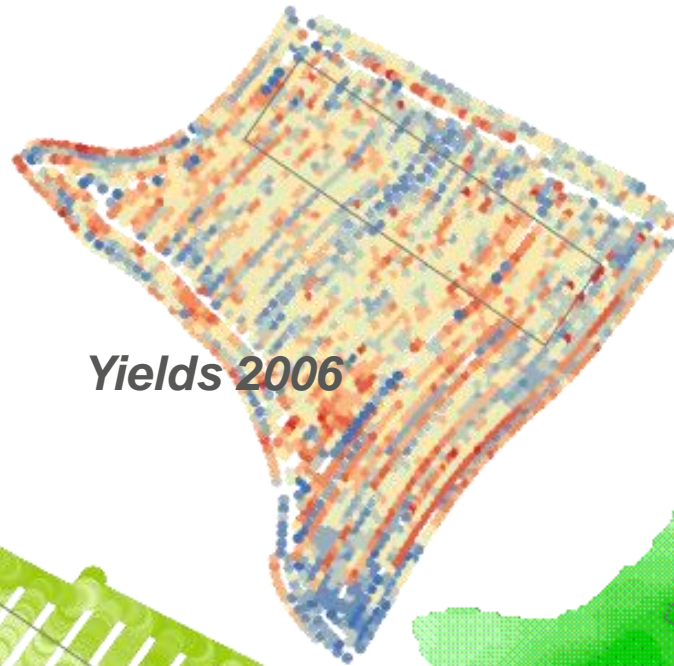


Opportunity 3: GPS ... mapping ...

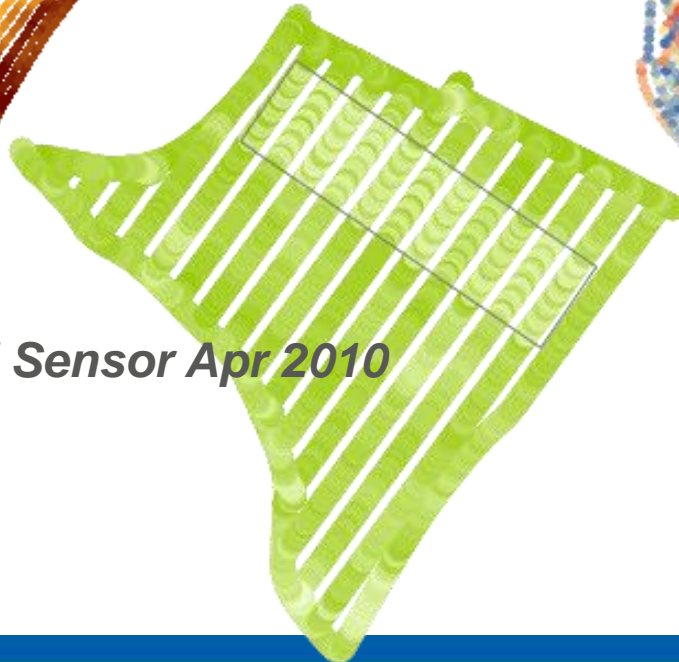
... soil knowledge ... & variable agronomy



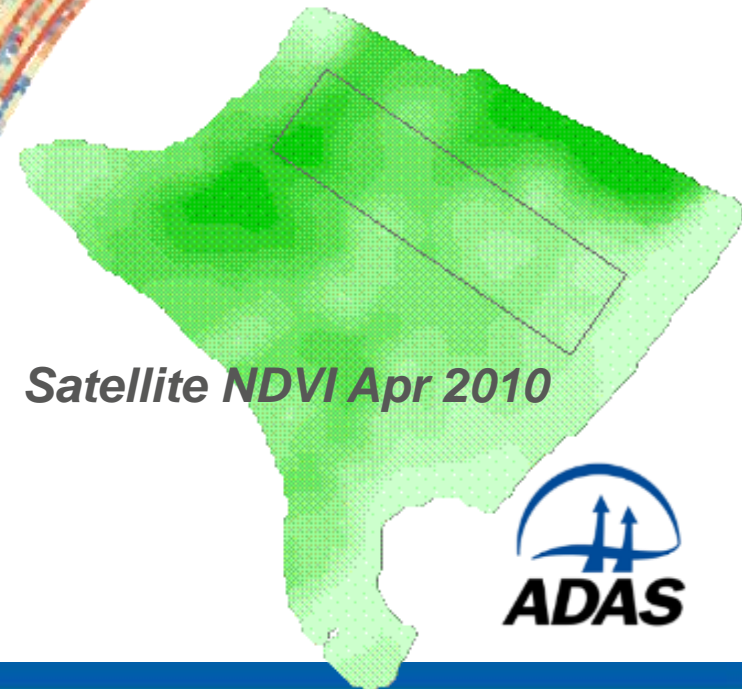
Soil Conductivity



Yields 2006



N Sensor Apr 2010



Satellite NDVI Apr 2010

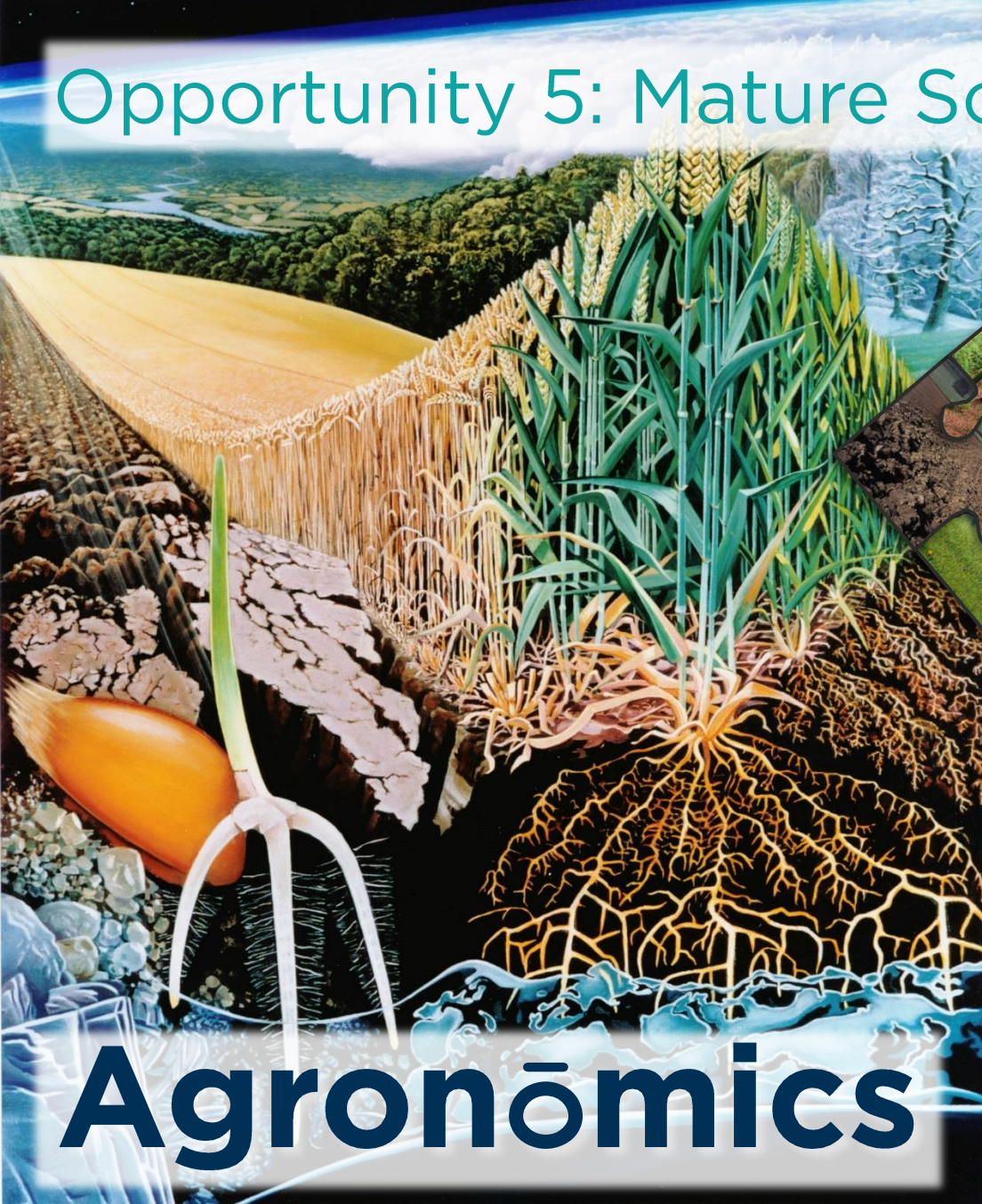
Opportunity 4: Strong Networks & modern media

- Agricultural Societies
- Agronomy Groups
- Supply / Marketing groups
- Distributor groups
- Trials centres
- Social media networks
- Monitor Farms, Field Labs., etc.

AHDB Cereals & Oilseeds Monitor Farm, Suffolk, November 2014



Opportunity 5: Mature Science



Agronomics

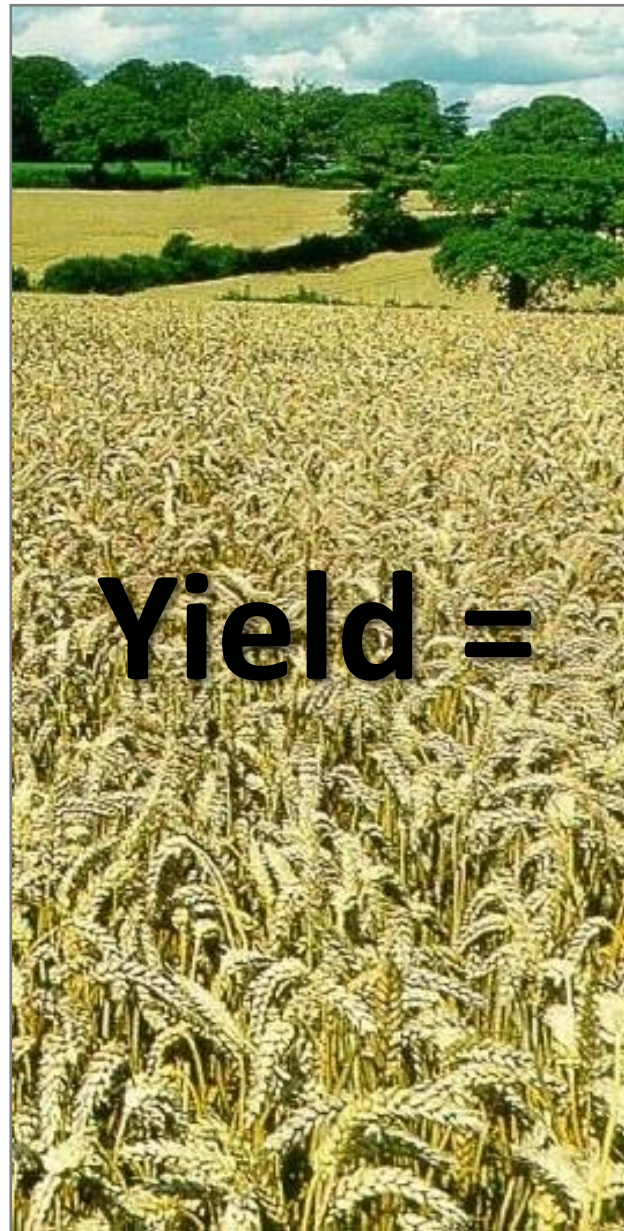


"We harvest energy"

*Edible
energy*

Leaf canopies

Crop metrics:



Yield =

Solar Energy

Resources

TJ / ha

x Capture

%

x Conversion

tonnes / TJ

Water

mm

%

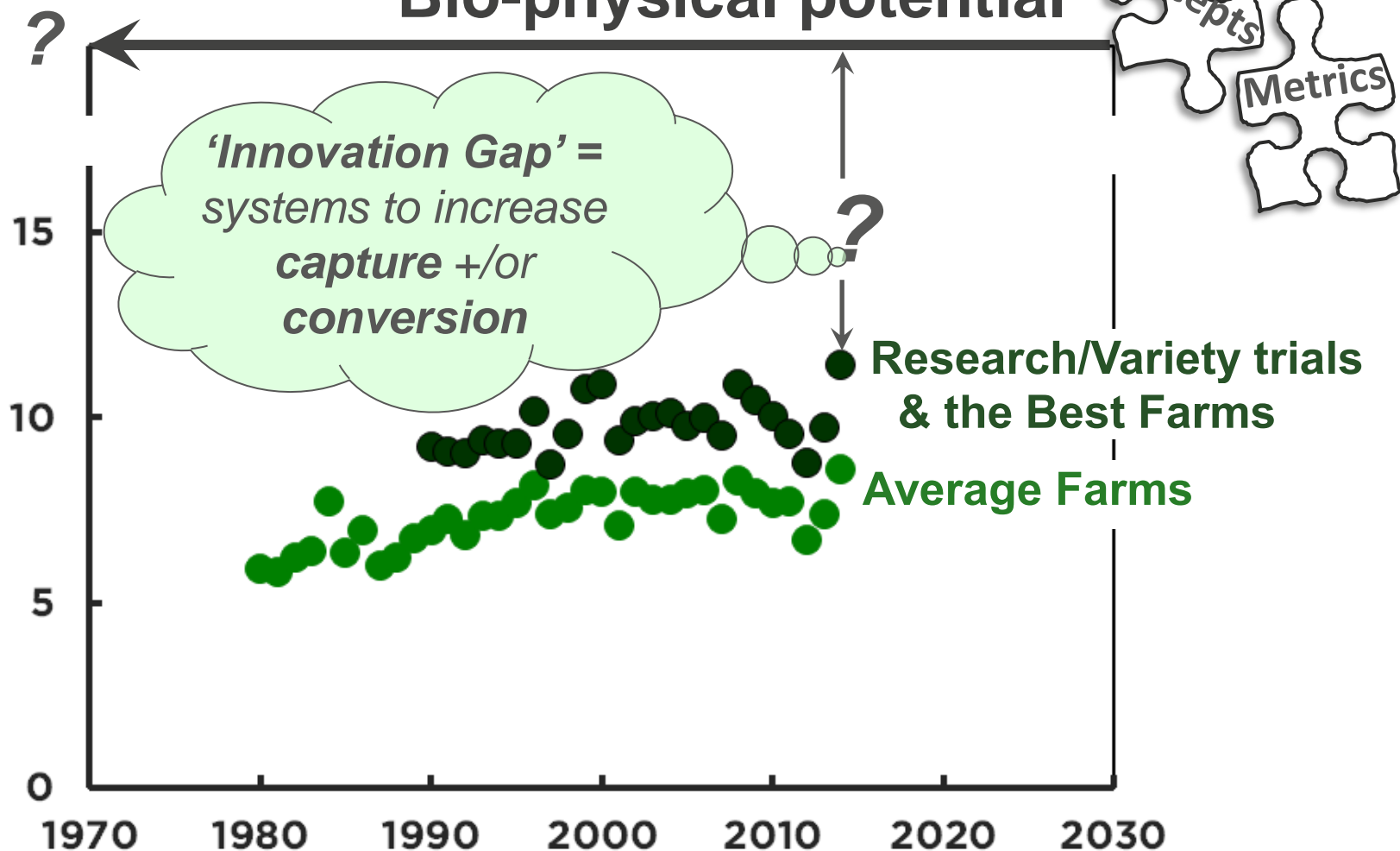
t/ha/mm



Bio-physical potential

Wheat
Grain
Yield
in UK

tonnes
per
hectare



Example: Understanding 'Yield'





Resource-derived
Potential cereal yields

18 t/ha

Concepts

Metrics

Comms

Aims:

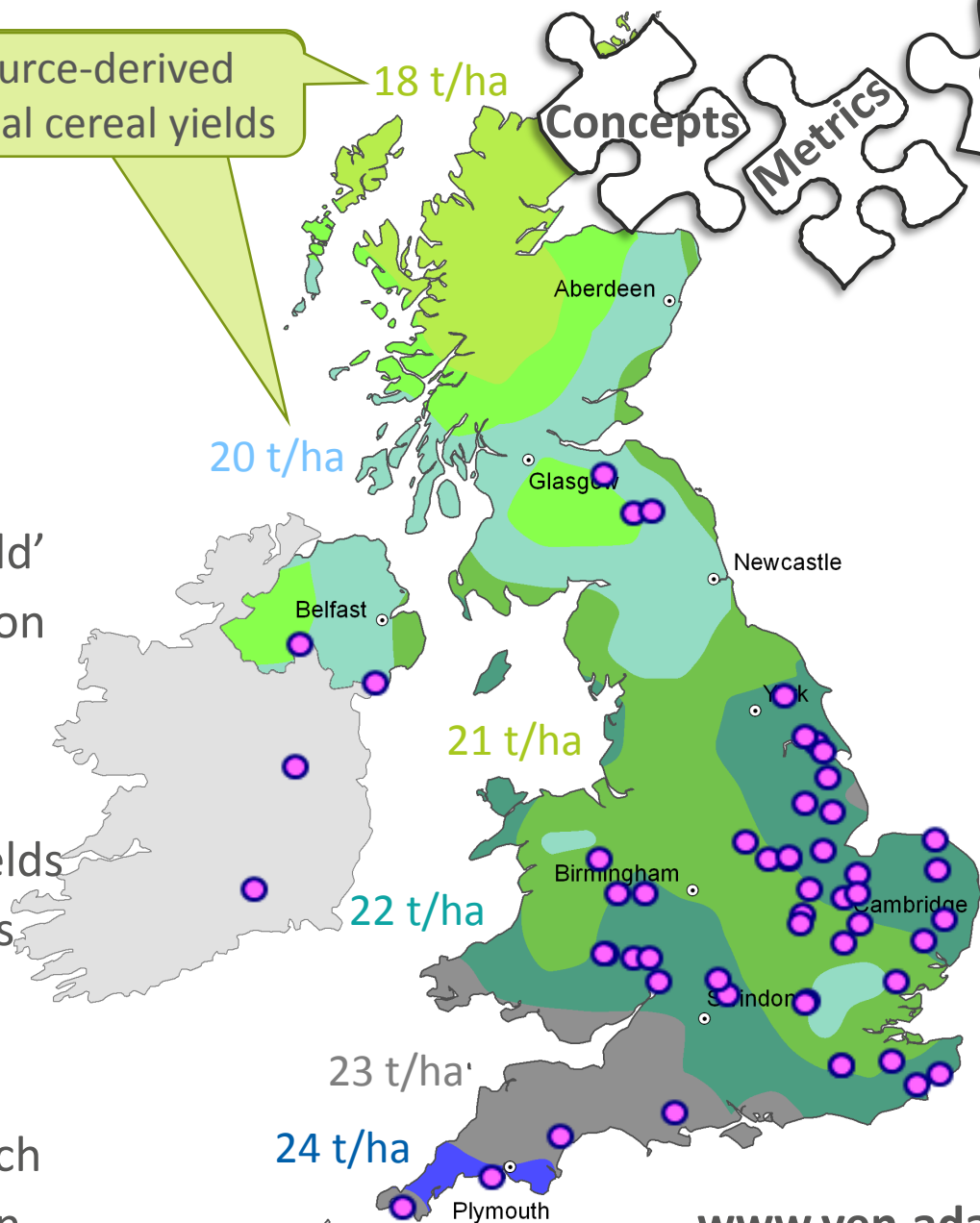
- Identify innovators for 'yield'
- Foster & Energise Innovation

Activities:

- Competition
- Monitoring & analysing yields
- Networking .. Sharing ideas

Ambition:

- Increased yields
- Platform for shared research
- Understand yield formation



www.yen.adas.co.uk



Understanding grain yield



= World Record

	<i>AHDB Benchmarks</i>	<i>2014</i>	<i>2015</i>
Yield, t/ha	11.0	14.5	16.5
Potential, t/ha	~	20.9	21.0
Ears / m ²	460	611	711
Grains / ear	48	46	49
TGW @ 15% MC	50	51	47
Grain protein %	11.6	11.0	11.5
Biomass, t/ha	18.4	22.3	26.2
Harvest Index	51%	54%	54%
N 'uptake', kg/ha	279	339	282



*Tim Lamyman
Worlaby, Lincolnshire*

Photo: 17th July 2014



analysis 2013 – 2015



16.5 t/ha, 2015

54% harvest index

• Ears / m ²	0.15
• Grains / ear	0.01
• Grains / m ²	0.32
• TGW, g	0.12
• Harvest Index	0.00
• Grain N, %DM	0.01
• Biomass, t/ha	0.81
– Straw DM, t/ha	0.48



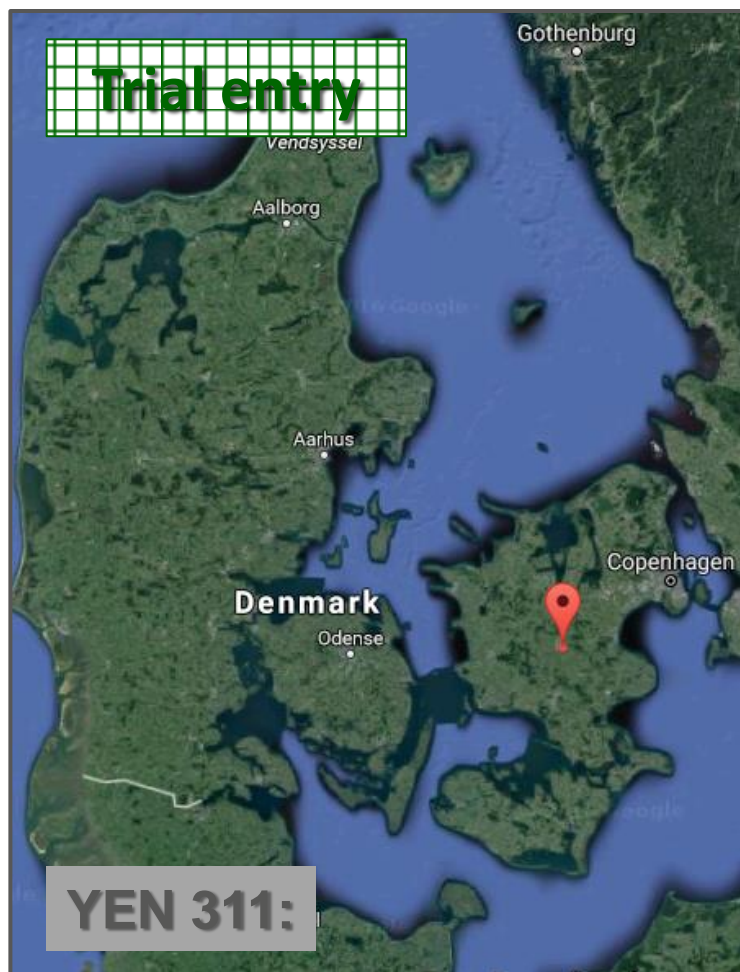
Winners 2016



- Yields:
av. 10.3 t/ha
max 13.0 t/ha
- Biomass
av. 16.8 t/ha
max 23.4 t/ha
- Dull June:-
'Sink'
limitation.

24th November 2016

Jes Hasselbalch *with SEGES at Hejsager, Denmark*



	Benchmark	Entry
TJ/ha SR (% capture)	36 (47%)	37 (39%)
mm H ₂ O (% capture)	444 (83%)	460 (78%)
Ears / m ²	460	442
Grains / ear	48	68
TGW @ 15% MC	50	43
Sp Wt, kg/hl	NA	73
Grain protein %	11.6	11.7
Biomass, t/ha	18.4	18.1
Harvest Index	51%	61%
N 'uptake', kg/ha	189	228
Yield, t/ha (rank)	11.0	13.0 (1 st)
Yield % Potential		61.5% (1 st)



Lessons so far & future development



Value of Crop Competition ... for Knowledge Exchange:

- Promotes use of reliable & appropriate concepts, hence metrics
- Identifies successful practices & possible innovations
- Provides high profile / awareness through 'news' of winners
- Gives recognition to on-farm innovators and leading farmers
- Provides an agenda for industry communication & debate

Value of Crop Competition ... for Research

- Dictates accurate on-farm yield measurement with advisor support
- Building a valuable database ... enabling
- Provides opportunities for engaging
- Can lead to appropriate hypothesis

FUTURE DEVELOPMENTS:

- ***Ability to test ideas***
- ***YENs for Pulses & Oilseeds***
- ***Extend use of concepts & metrics***
- ***Web services for data exchange***
- ***Engagement & networking***
... esp farmer to farmer
- ***Sustainable funding.***

Field Testing Example: Delivering genetics in the UK

<http://cereals.ahdb.org.uk/>

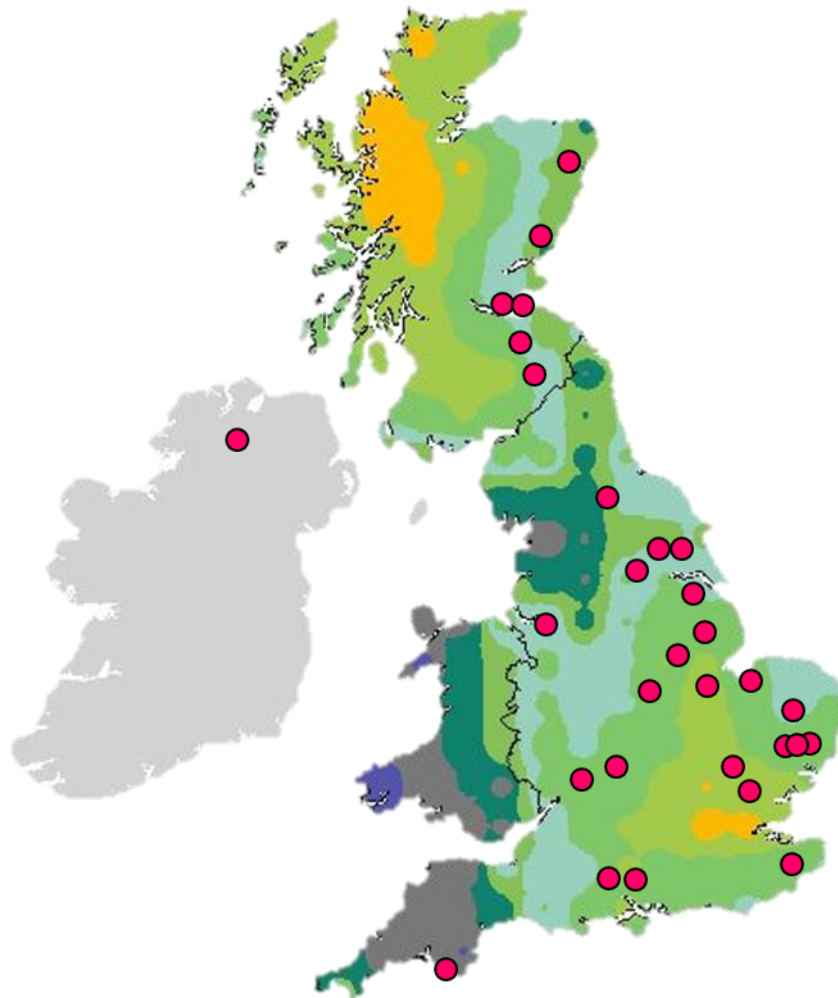


AHDB
CEREALS & OILSEEDS

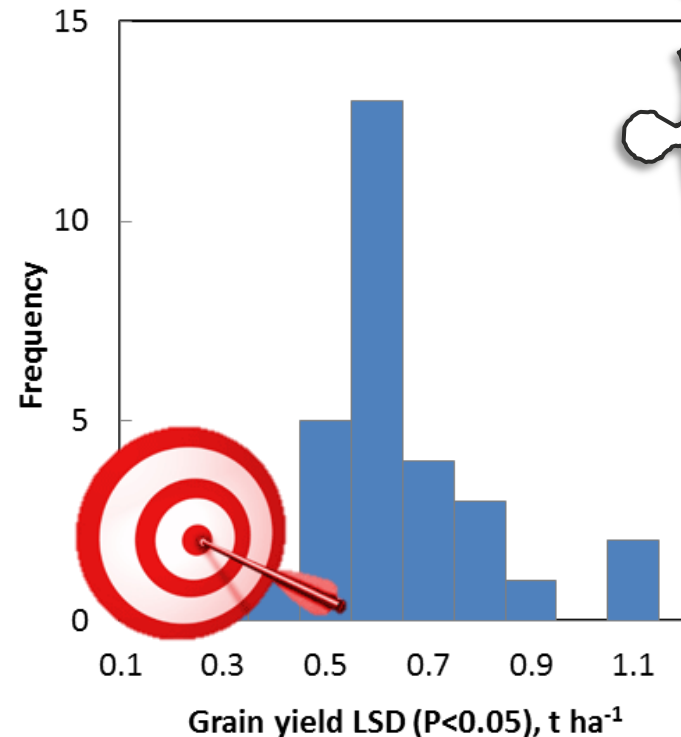
Field Testing Example: Delivering genetics in the UK

30 x conventional trials, 2 reps x 40-50 varieties

PRECISION 2015:



AHDB Recommended List trials, 2015



- Most crop decisions cost <0.3 t ha⁻¹, many cost <0.1 t ha⁻¹
- Multi-site replication required

... Poor information on GxE.

Example: nitrogen



normal
trial

Chessboard trial

0, 120, 240, 360 kg/ha N

Auto-N Project 2010-2014 LINK project LK09134, HGCA project RD-2008-3350

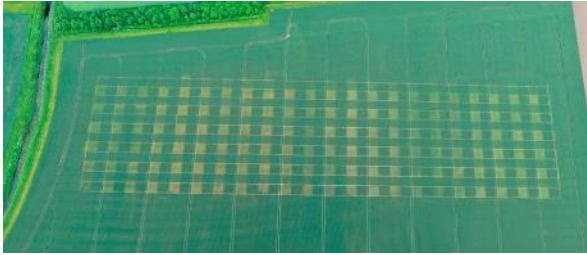


Flawborough, Nottinghamshire UK 2010

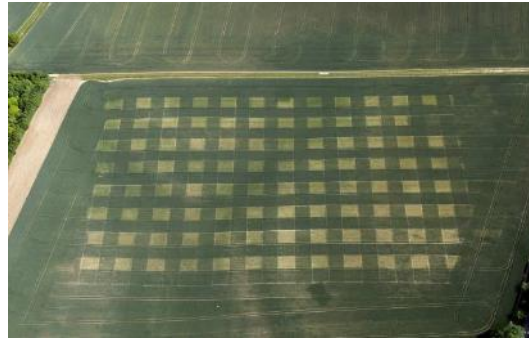
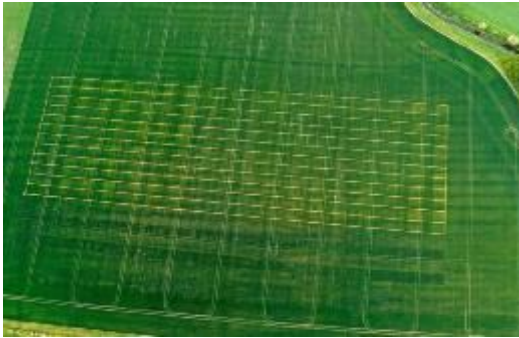
Chessboard trials – testing nitrogen rate



2010



2011



2012



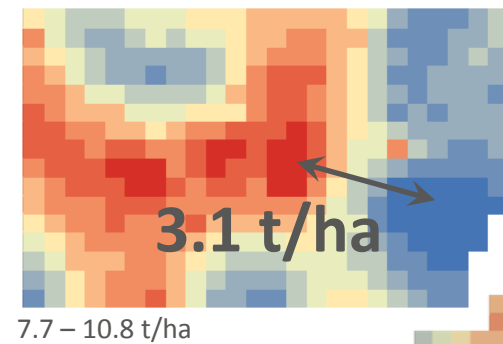
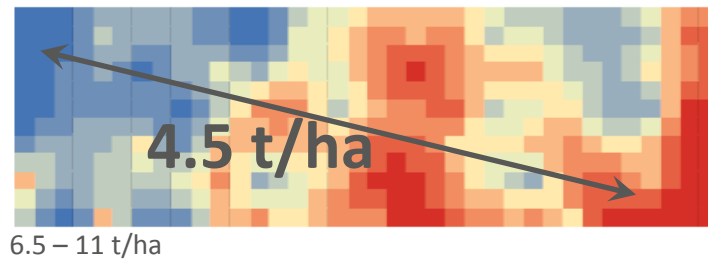
Intra-field variation in 'optimal' yield



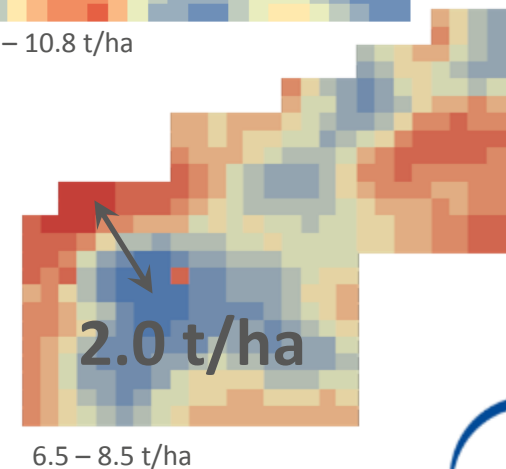
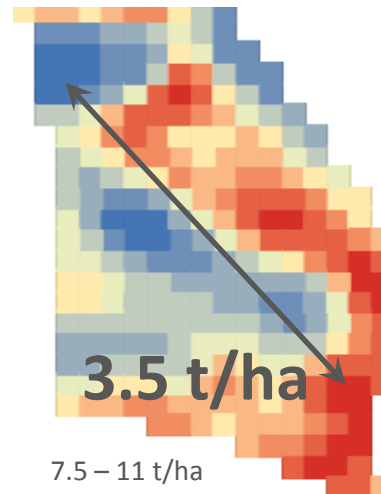
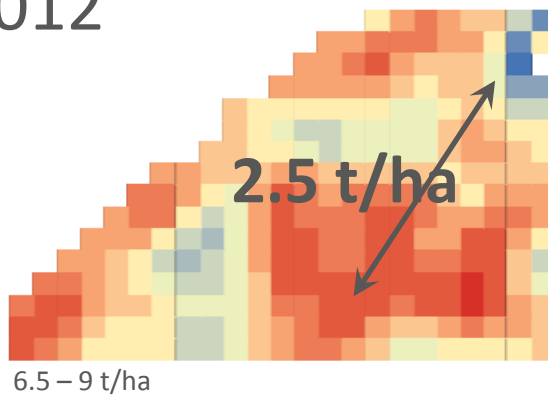
2010



2011



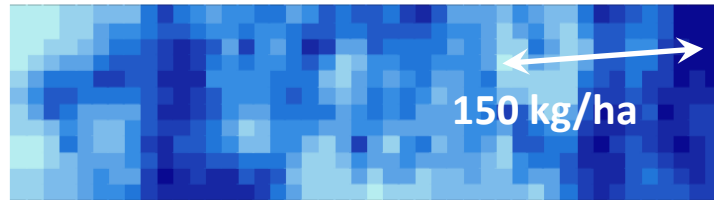
2012



Intra-field variation in Optimum Nitrogen

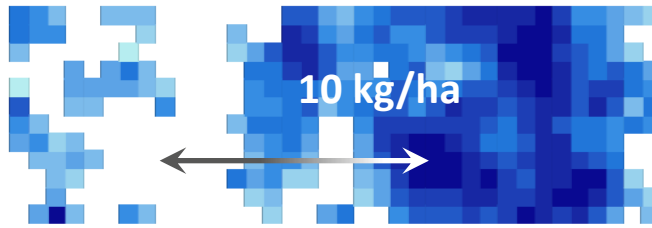


2010

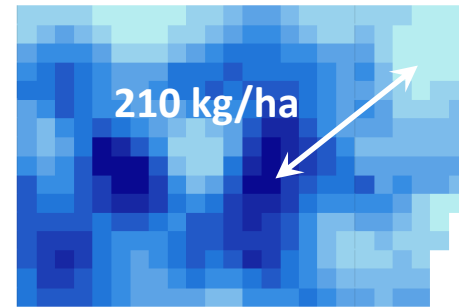


124-293 kg/ha

2011

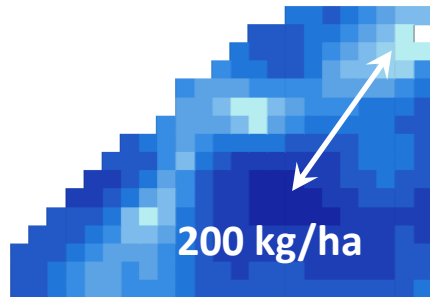


0-12 kg/ha

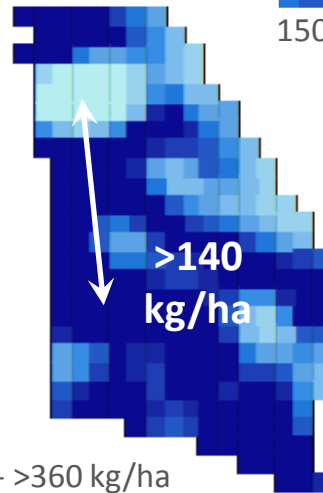


150 - >360 kg/ha

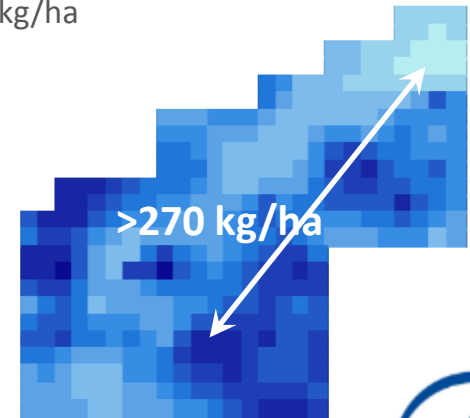
2012



0 - 200 kg/ha



217 - >360 kg/ha



93 - >360 kg/ha

Lessons from Chessboard trials



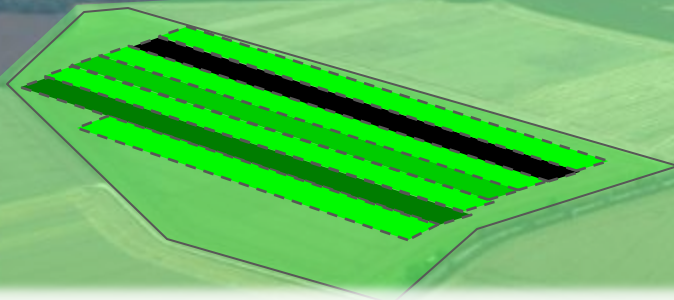
- **High intra-field variation**
 - Variable agronomy can *reduce* profits! .. if predictions not good
 - Importance (& ignorance!) of soil effects
- **Problems with conventional small plot experiments**
 - Unrepresentative of field scale
 - Confound soil variation with farm, weather, genotype
- **Potential for Field-scale Experimentation**
 - GPS and variable applications enable **On-farm Testing**
 - The only way of assessing **Soil Type effects & interactions**
 - ... No confounding factors ... but a statistical challenge
 - Crop & soil sensing technologies are potentially useful
 - ... but measurement issues ... location accuracy, noise, data transfer...

Agronōmics

.. enabling Spatial Experimentation, 2013-2017

tests

stats



Aim

- Develop 'line trial' experimental technique
 - Possible high precision of on-farm tests
 - Can test soil interactions
 - Scope to network across farms, regions, systems

Tasks

- Precision Farmer Research Networks
- Statistics for spatial comparison & testing
- Harvesting & treatment equipment
- Software ... lots of software!

Innovate UK
Technology Strategy Board

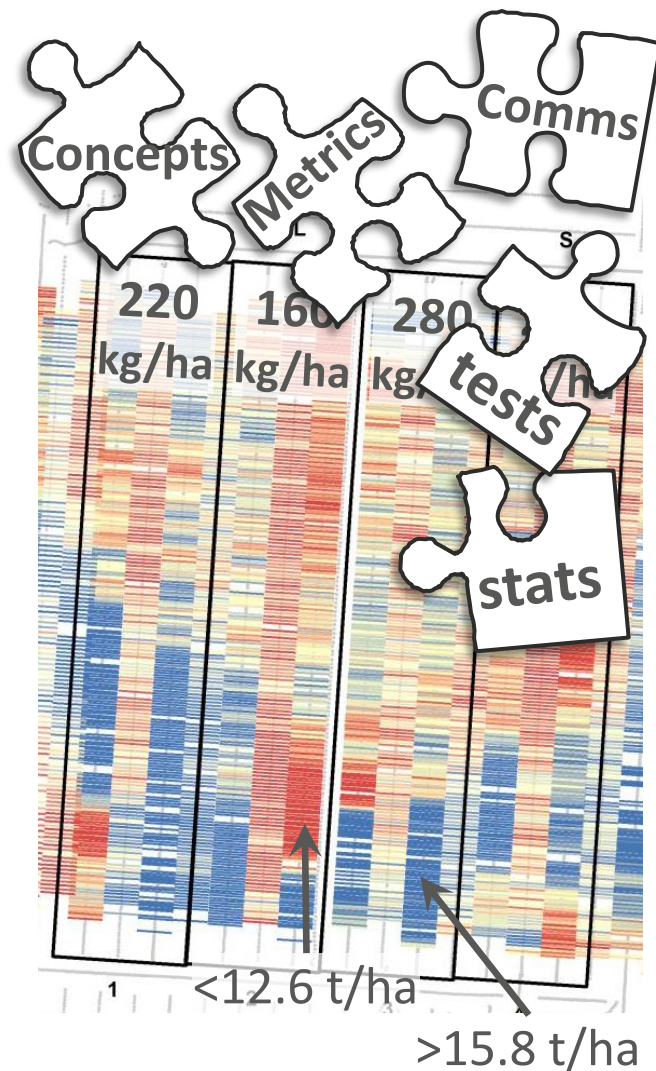


Example:

LearN

On-Farm Testing of N management, 2013 – 2018

- 18 growers across UK, + industry support
 - Regular communications & Annual meetings
- +60kg & -60 kg N/ha tramline comparisons
 - 3 fields per farm ... over 4 years
- Structured testing is evaluating
 - *Sub-Field – Fields / Rotations – Farms – Regions – Seasons*



Agronōmics: lessons so far

- Precision Farming potentially game-changing
- Creates a new high-precision arena for soil & yield research
- Farm Research Networks could address many other factors



CHALLENGES

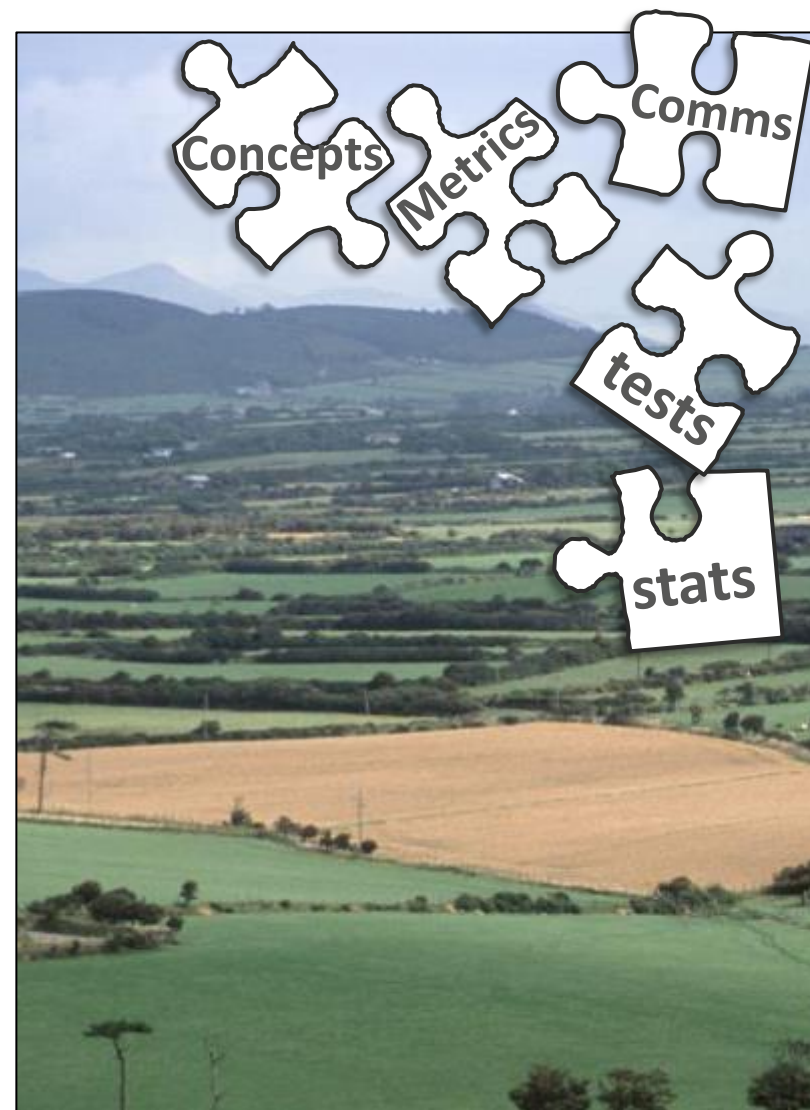
- Value to the farm must be clear
 - Significant investment (time & trouble) required
- Good farm support e.g. for harvesting ‘discipline’, data transfer
- New systems for data exchange, analysis & reporting
- Data processing ... complex & onerous
 - Highly replicated data ... BUT scope for broad-scale replication limited
 - Careful analysis needed to identify treatment effects ... new methods
- Requires new skills and tools (e.g. GIS) for scientific staff.

Agronōmics – Summary

- Game-changing opportunities enabled by modern technologies
 - for industry innovation and progress
 - for crop science and research
 - for education & training
- Needs coordinated investments in ...
 - Communications, Concepts, Metrics
 - Experimentation & Statistics

... Skills, Software, Networking, Equipment
e.g. High Definition yield mapping
- Potential Outcomes:

A new integrated arena of quantitative crop intelligence
... testing novel questions ... & making better yield progress.





Thank you

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