AHDB Agronomy Event 2020

11 February 2020

CEREALS & OILSEEDS

Welcome

Richard Meredith
AHDB Cereals & Oilseeds, Knowledge Exchange Manager (West & Wales)

Agronomy 2020

- Morning: Cereals & Oilseeds
- Lunch
- Afternoon: Potatoes

Agenda

AHDB

9:00	**Registration**	All
9:20	**Welcome**	Richard Meredith
9:30	**New fungicide performance**	Steven Kildea
10:10	**Improving yields through using micronutrients**	Steve McGrath
10:50	**A farmers journey**	Steve Klenk
11:30	**Refreshment break**	All
11:50	**Bio-pesticides and their potential benefit for field crops**	Dave Chandler
12:30	**Systematic approaches to soil management**	Jane Rickson
13:10	**Close & lunch**	Richard Meredith

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Agronomy 2020

AHDB

AHDB Update

11 February 2020

CEREALS & OILSEEDS

AHDB

- We are a statutory levy board funded by farmers, growers and processors in the supply chain.
- Our purpose is to equip levy payers with evidence-based information and tools to grow, become more competitive and sustainable.

INDEPENDENT

BEEF & LAMB | CEREALS & OILSEEDS | DAIRY | HORTICULTURE | PORK | POTATOES

How to feed back…

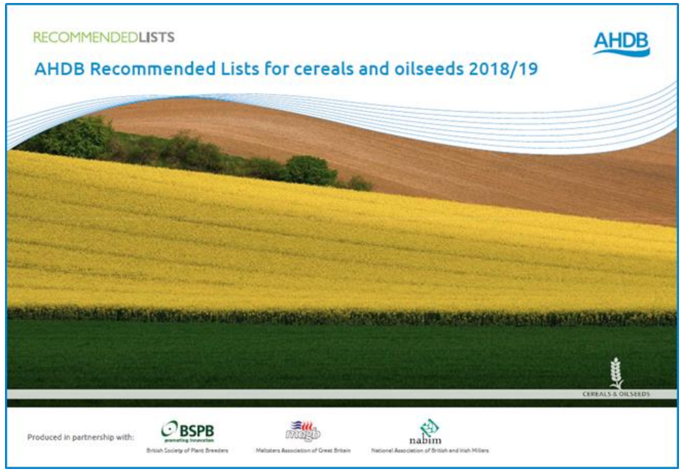
Knowledge gaps

CEREALS & OILSEEDS

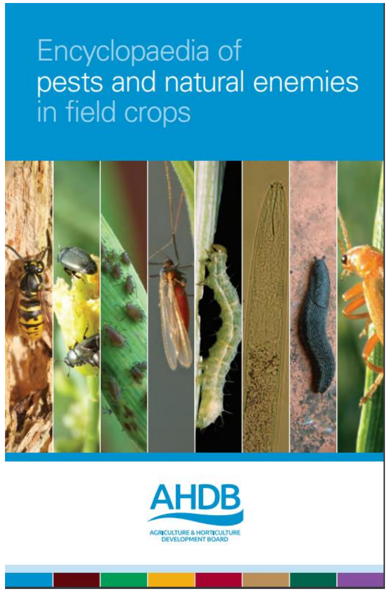
Research

CEREALS & OILSEEDS

Research



- Pests
- Soil
- Diseases
- Weeds
- Quality
- Nutrient management
- Varieties
- Business Planning



For all research, visit: ahdb.org.uk

Research

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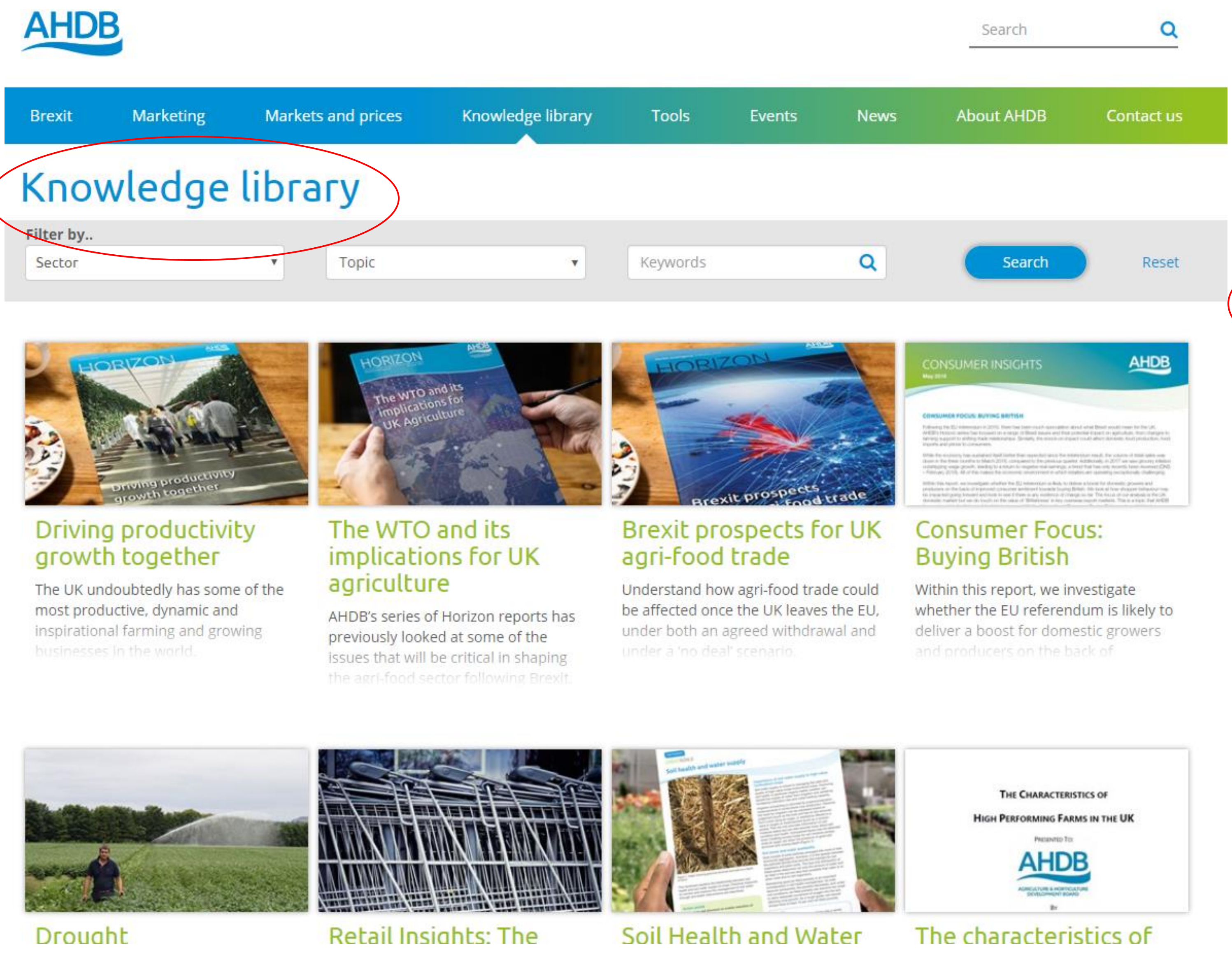

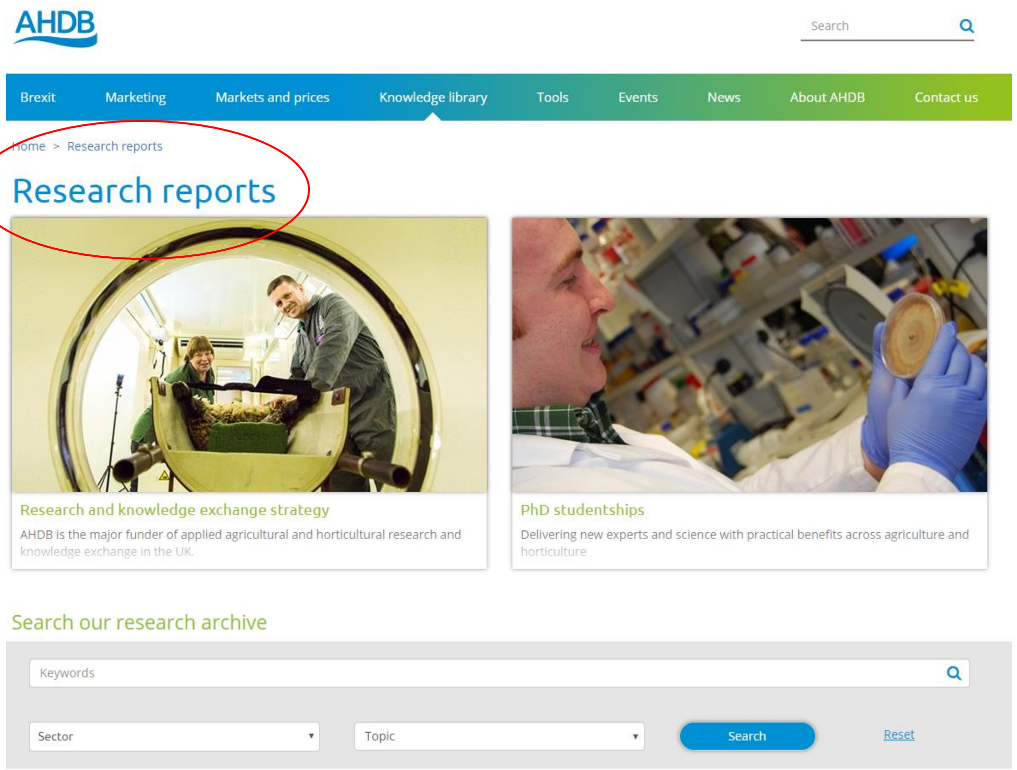

Wheat and barley disease management guide

Coming later this year…

Oilseed rape disease management guide

GREATSOILS

Download AHDB's new guide on the principles of soil management

Learn more about:

- *Soil health*
- *Soil texture and structure*
- *Cation exchange capacity*
- *Soil organic matter*
- *Soil biology*

www.ahdb.org.uk/greatsoils

Coming very soon…

Arable soil management guide

RB209 – Key changes

- Greater emphasis on soil and grain analysis
- Guidance on grain sampling
- Alignment of standard yields for N and P/K recommendations

RB209 – Key changes

- Reduction in P offtake in winter wheat
- Grain P offtake updated
- P and K recommendation tables revised
- Download the RB209 app

New publications

FACTSHEET

AHDB

Cereal straw – incorporate or sell?

Cereal straw has become an increasingly versatile and valuable commodity. Today, straw markets include renewable energy systems, for both domestic heating and power generation, overwinter carrot production and mushroom production. This is in addition to its traditional use as livestock bedding. At the same time, the incentives to chop straw have increased. Soil health is one of the main drivers, with many aiming to reap the longer-term benefits associated with straw incorporation. Another key reason cited for incorporating straw is that it is an 'easier' option, for some.

The increase in demand for straw has seen prices respond. In the last decade, big bale straw prices in excess of £40/t have become more frequent. Volatile demand (e.g. spikes in consumption for animal bedding during long, cold winters) and supply also result in significant short-term price fluctuations.

This publication looks at the pros and cons associated with the decision to either incorporate or sell straw. It provides examples of how to value straw, especially its nutrient value, and looks at the implications to other farm operations. Armed with a better understanding of the monetary and non-monetary implications, this publication will help you decide on the best option for your farm business.

Big square baled barley straw — Big square baled wheat straw

Big bale straw prices

Source: British Hay & Straw Merchants' Association/Defra, British Hay & Straw Merchants' Association/Farmers Weekly

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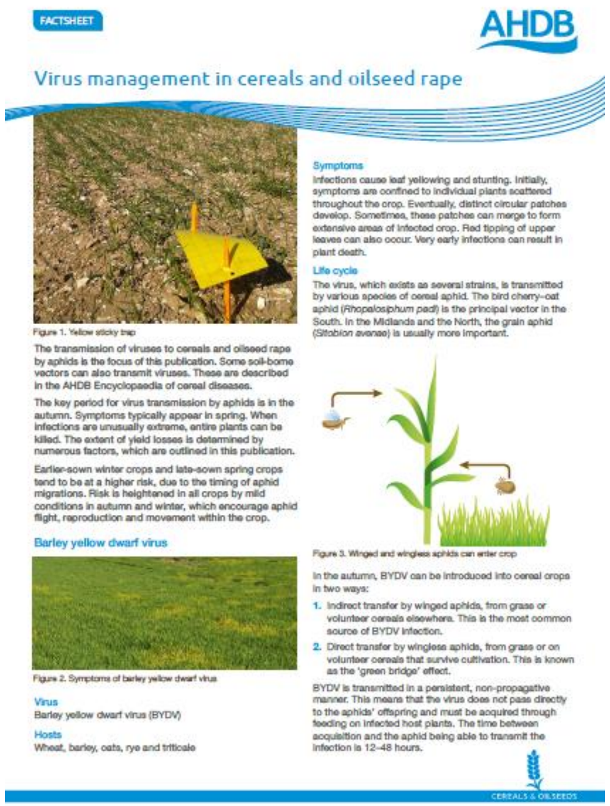

FACTSHEET

AHDB

Virus management in cereals and oilseed rape

Figure 1. Yellow sticky trap

The transmission of viruses to cereals and oilseed rape by aphids is the focus of this publication. Some soil-borne vectors can also transmit viruses. These are described in the AHDB Encyclopaedia of cereal diseases.

The key period for virus transmission by aphids is in the autumn. Symptoms typically appear in spring. When infections are unusually extreme, entire plants can be killed. The extent of yield losses is determined by numerous factors, which are outlined in this publication.

Earlier-sown winter crops and late-sown spring crops tend to be at a higher risk, due to the timing of aphid migrations. Risk is heightened in all crops by mild conditions in autumn and winter, which encourage aphid flight, reproduction and movement within the crop.

Barley yellow dwarf virus

Figure 2. Symptoms of barley yellow dwarf virus

Virus

Barley yellow dwarf virus (BYDV)

Hosts

Wheat, barley, oats, rye and triticale

Symptoms

Infections cause leaf yellowing and stunting. Initially, symptoms are confined to individual plants scattered throughout the crop. Eventually, distinct circular patches develop. Sometimes, these patches can merge to form extensive areas of infected crop. Red tipping of upper leaves can also occur. Very early infections can result in plant death.

Life cycle

The virus, which exists as several strains, is transmitted by various species of cereal aphid. The bird cherry–oat aphid (*Rhopalosiphum padi*) is the principal vector in the South. In the Midlands and the North, the grain aphid (*Sitobion avenae*) is usually more important.

Figure 3. Winged and wingless aphids can enter crop

In the autumn, BYDV can be introduced into cereal crops in two ways:

1. Indirect transfer by winged aphids, from grass or volunteer cereals elsewhere. This is the most common source of BYDV infection.
2. Direct transfer by wingless aphids, from grass or on volunteer cereals that survive cultivation. This is known as the 'green bridge' effect.

BYDV is transmitted in a persistent, non-propagative manner. This means that the virus does not pass directly to the aphids' offspring and must be acquired through feeding on infected host plants. The time between acquisition and the aphid being able to transmit the infection is 12–48 hours.

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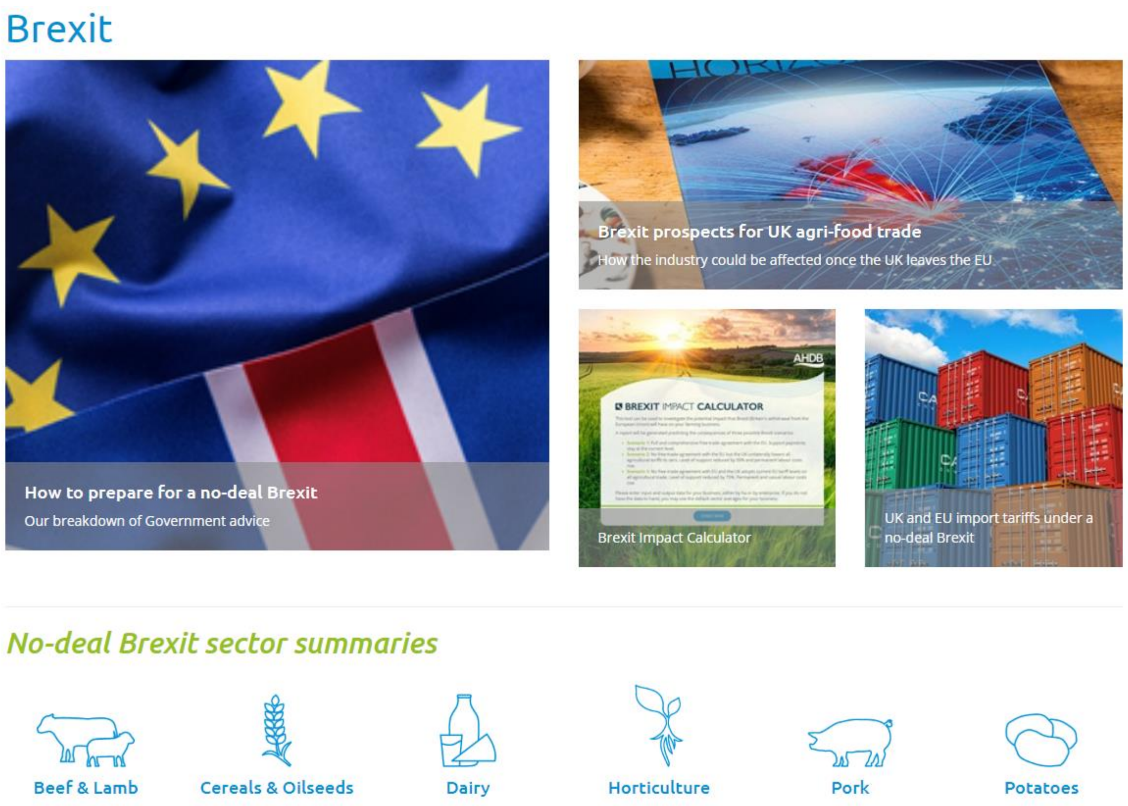
Wider tools

- Business management
- Markets
- Brexit (ahdb.org.uk/Brexit)



Tools available at **ahdb.org.uk**

Horizon Reports

Knowledge Exchange

CEREALS & OILSEEDS

Farm Excellence

- **Strategic Farms – Putting research into practice**
  - Focus on improving arable productivity through the formal testing and demonstrating of innovative practices on a field or farm scale. They aim to drive the adoption of innovation.
  - 3 open meetings per year over 6 years, plus closed group visits
- **Monitor Farms – Farmer Led, Farmer Driven**
  - Cover a wide range of activity aimed at business, technical and personal development. They aim to address current issues identified on the host farm.
  - 4 to 6 open meetings per year over 3 years, plus closed benchmarking sessions

Research → Strategic Farms → Monitor Farms → Wider Industry

West & Wales – Cereals & Oilseeds

Hereford Monitor Farm

Loppington Monitor Farm

Pembrokeshire Monitor Farm

Strategic Cereals Farm West

Hereford Monitor Farm
2014 - 2017

Cardiff Monitor Farm
2014 - 2017

Bridgnorth Monitor Farm
2016 - 2019

Cereals and Oilseeds – Strategic Farm West

- West Host = Rob Fox, Squab Hall Farm
- **Open Day Day = Tuesday 2nd June**
- Harvest 2020 Demonstrations

For all details, visit: https://ahdb.org.uk/farm-excellence/strategic_cereal_farm_west

Subscriptions and Publications

AHDB

ahdb.org.uk/keeping-in-touch

- Crop Research News
- Market Analysis
- Aphid News
- Grain Outlook
- New publications alerts
- Recommended List

Webinars and AHDB Podcasts

Amy Hughes, AHDB Beef & Lamb

Steve West, AHDB Dairy

Bill Watts, AHDB Potatoes

Angela Cliff, AHDB Pork

AHDB Horticulture

New Fungicide Performance 2019
Septoria & Ramularia

Steven Kildea, Teagasc CELUP, Oak Park Crops Research

POTATOES

Protecting Yield Potential

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The application of chlorothalonil is not permitted from May 20th 2020

CTL based products registered in Ireland

Product*	PCS No.	Product	PCS No.	Product	PCS No.
Barclay Avoca	4458	Daconil	5748	Amistar Opti	5068
Jupital	4503	UNIPRO CTL	5944	Ortiva Opti	5992
Rover 500	4467	Spirodor	5934	Proceed	5519
Balear 720 SC	4411	Cavaterra	5059	Treoris	5310
Abringo	4239	Phyton	5019	Aylora	5311
Joules	4784	Orchid B	5058	Fielder SE	4251
Muti-Star 500	4812	Chlorthalis	5193	Fezan Plus	4468
Supreme	4841	Bravado	6013	Crafter	5345
CT 500	5302	Bravo 500	3452	Tonga	6285
Stefonil	5351	Curator	5069	Cigal Plus	6061
Renew Chlorothalonil	5362	Vertik	5071		
Farmco Chlorothalonil	5593	Perseo	5750		

*On PCRD database Nov 2019

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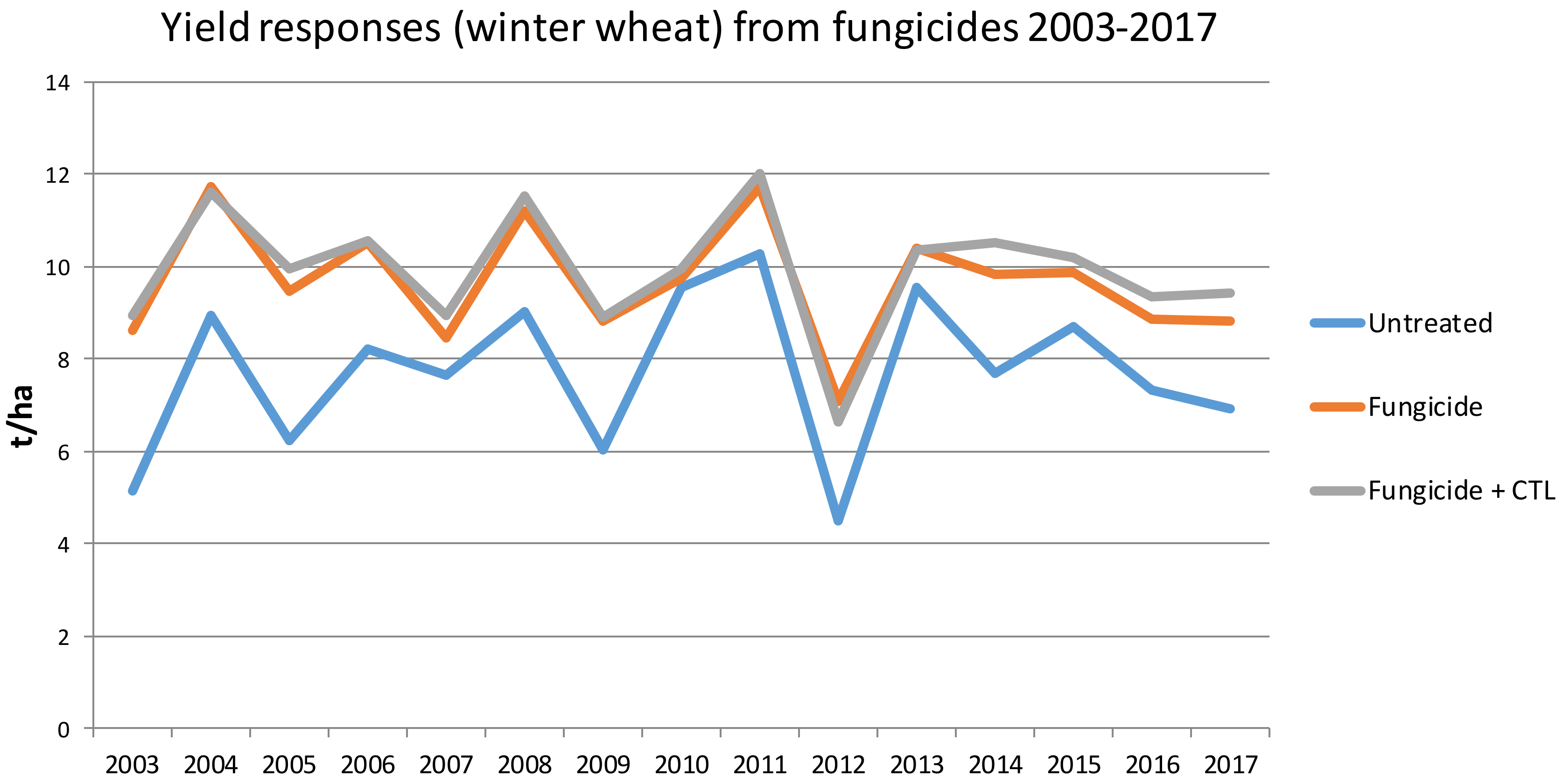
Should we be concerned?

1. **What diseases are a problem?**
    - Septoria tritici blotch of winter wheat
    - Ramularia leaf blotch of winter & spring barley
    - Chocolate spot of winter & spring beans

2. **Are there solutions?**
    - Variety
    - Agronomy
    - Chemistry (NEW and old)

The problem – WHEAT

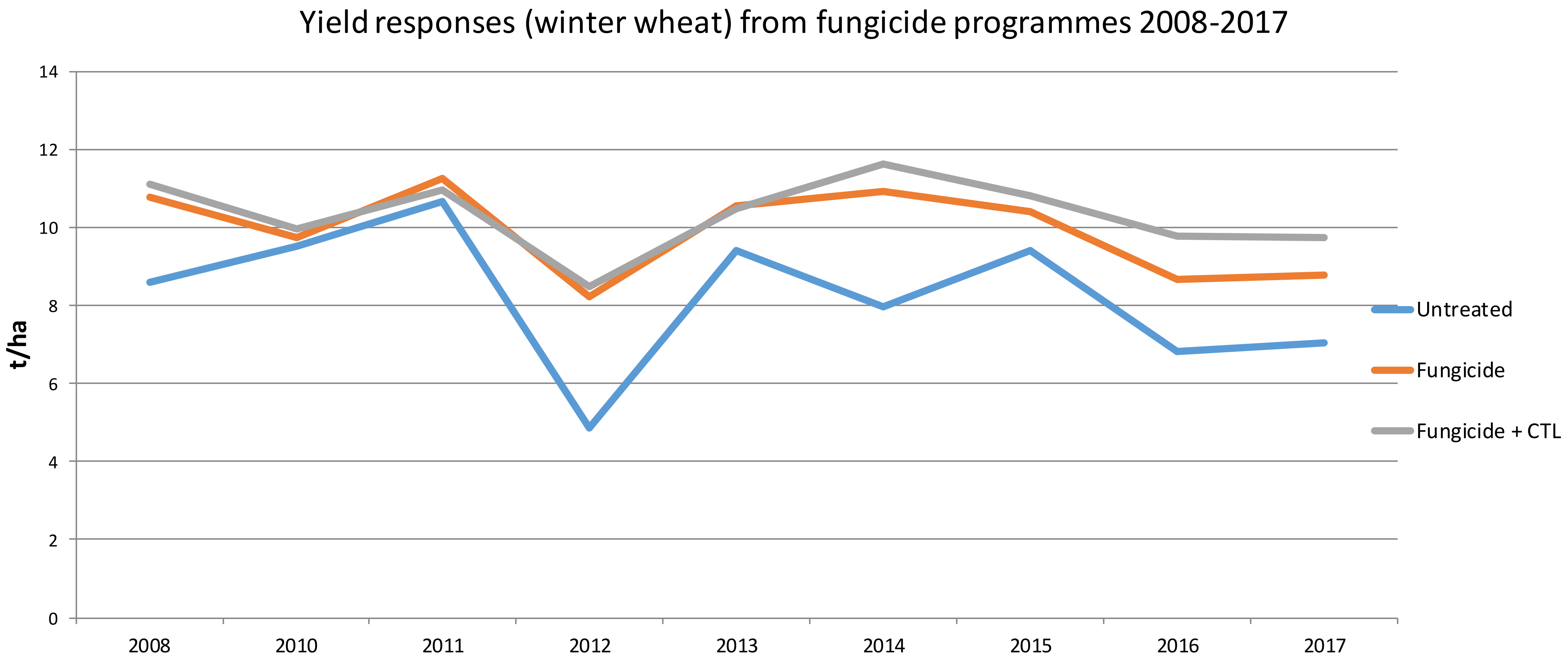


<u>Teagasc Wheat Fungicide Trials 2003-2017</u>

- 73 Trials
- 154 Direct comparisons
- Significant Year x CTL interaction (*P*<0.001)

Teagasc
Agriculture and Food Development Authority

The problem – WHEAT



<u>Teagasc Wheat Fungicide Trials 2003-2017</u>

- 27 Trials
- 45 Direct comparisons (SDHI & SDHI/azole 75-100% rates)
- Significant Year x CTL interaction (*P*<0.001)

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The problem – BARLEY

Kildalton 16/07/2019

Why is SEPTORIA a problem?

- **Varietal Resistance** – improving but still require protection (not sole factor determining a variety in Ireland)

- **Agronomic practises** – cost/benefit (e.g. how late to we need to delay planting)

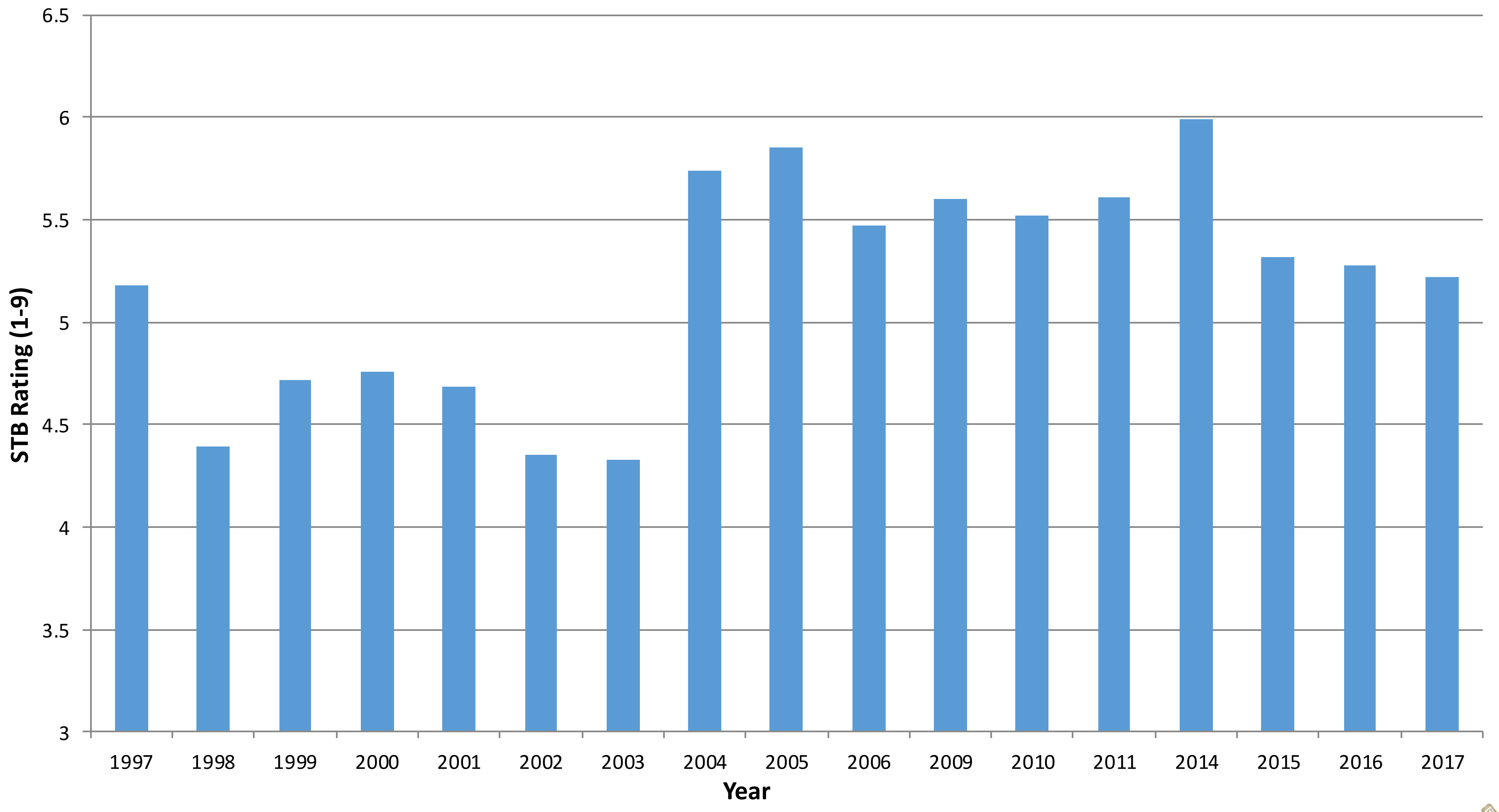
- **Nutrition** – limited capacity to impact disease development?

- **Fungicides** – *Z. tritici* has demonstrated quite an ability to become resistant

- CTL has provided a consistent/inexpensive "backup" to all of above

Varietal Resistance improving...BUT

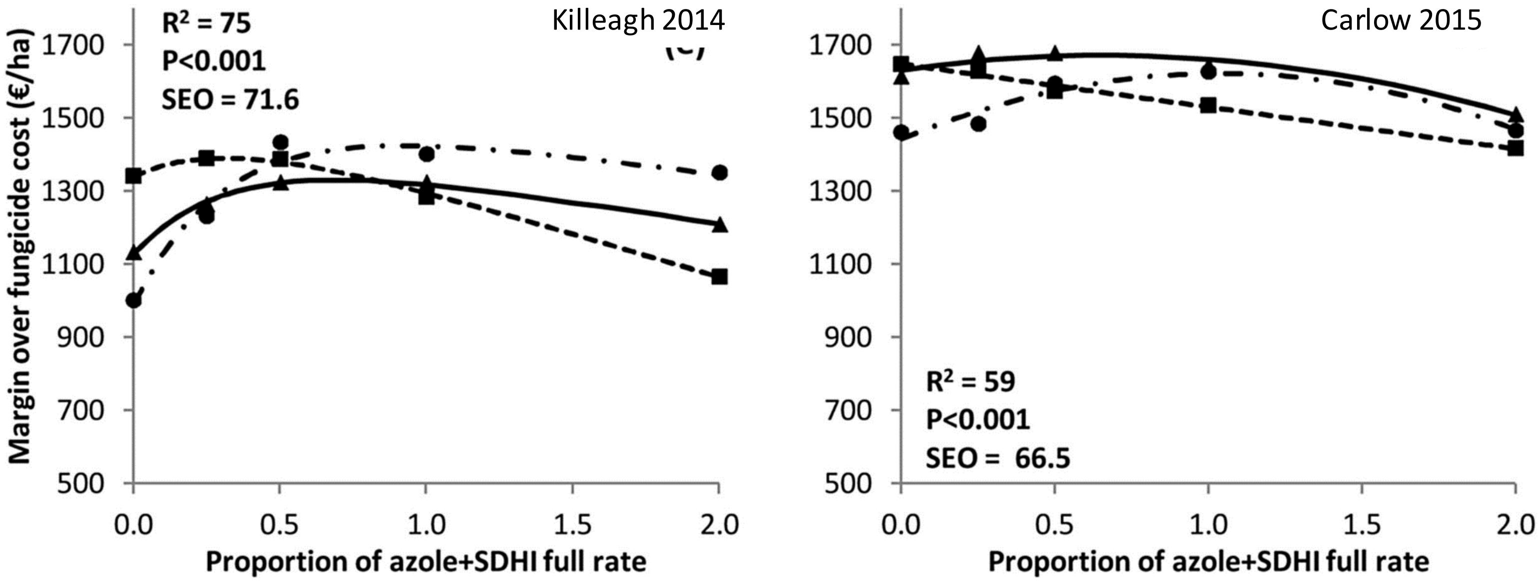
Majority of wheat grown in Ireland is moderately susceptible to STB

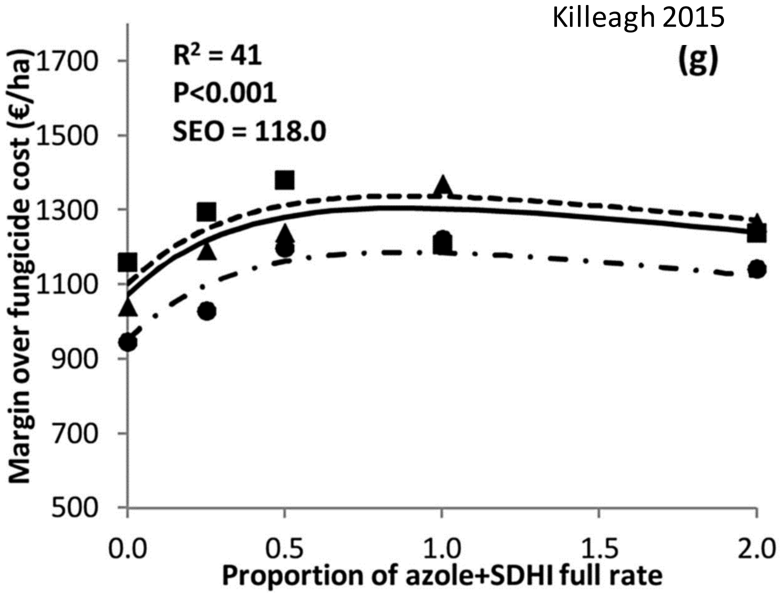


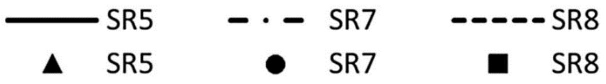
Based on annual STB rating x seed availability

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

We need very high levels of STB resistance







And this was when azoles/SDHIs worked well!

Lynch et al. (2017) Field Crops Research 204: 89-100

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So how will we manage without CTL?

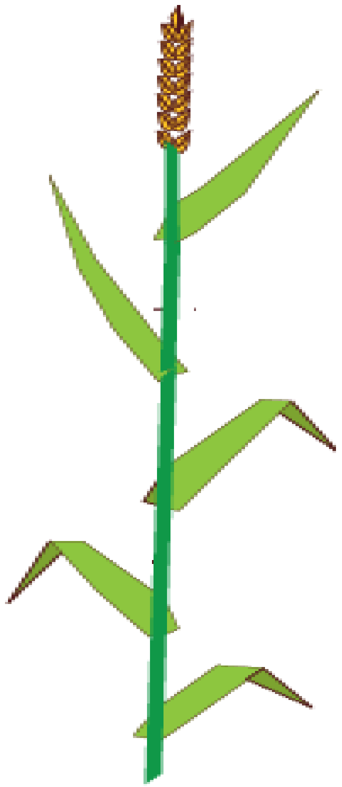
1. **Know your risk**
   - Strengths & weakness of variety?
   - When & where is it being grown?
   - Know strengths & weakness of fungicides

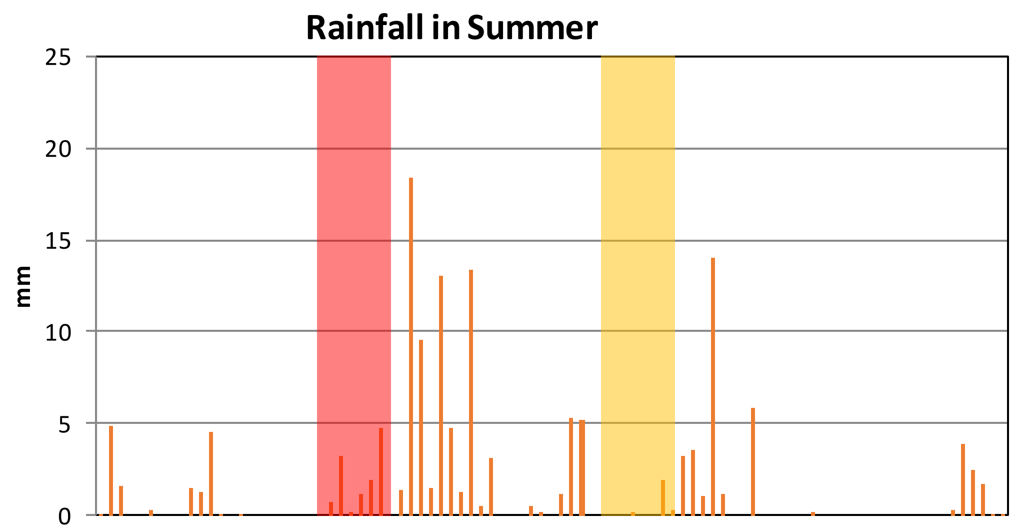
2. **Know your crop**
   - What growth stage – timings critical
   - What is disease pressure?

3. **Know your fungicide**
   - What can I expect from the fungicide, new or old?
   - Alternative multisites!

What should we expect from a fungicide?

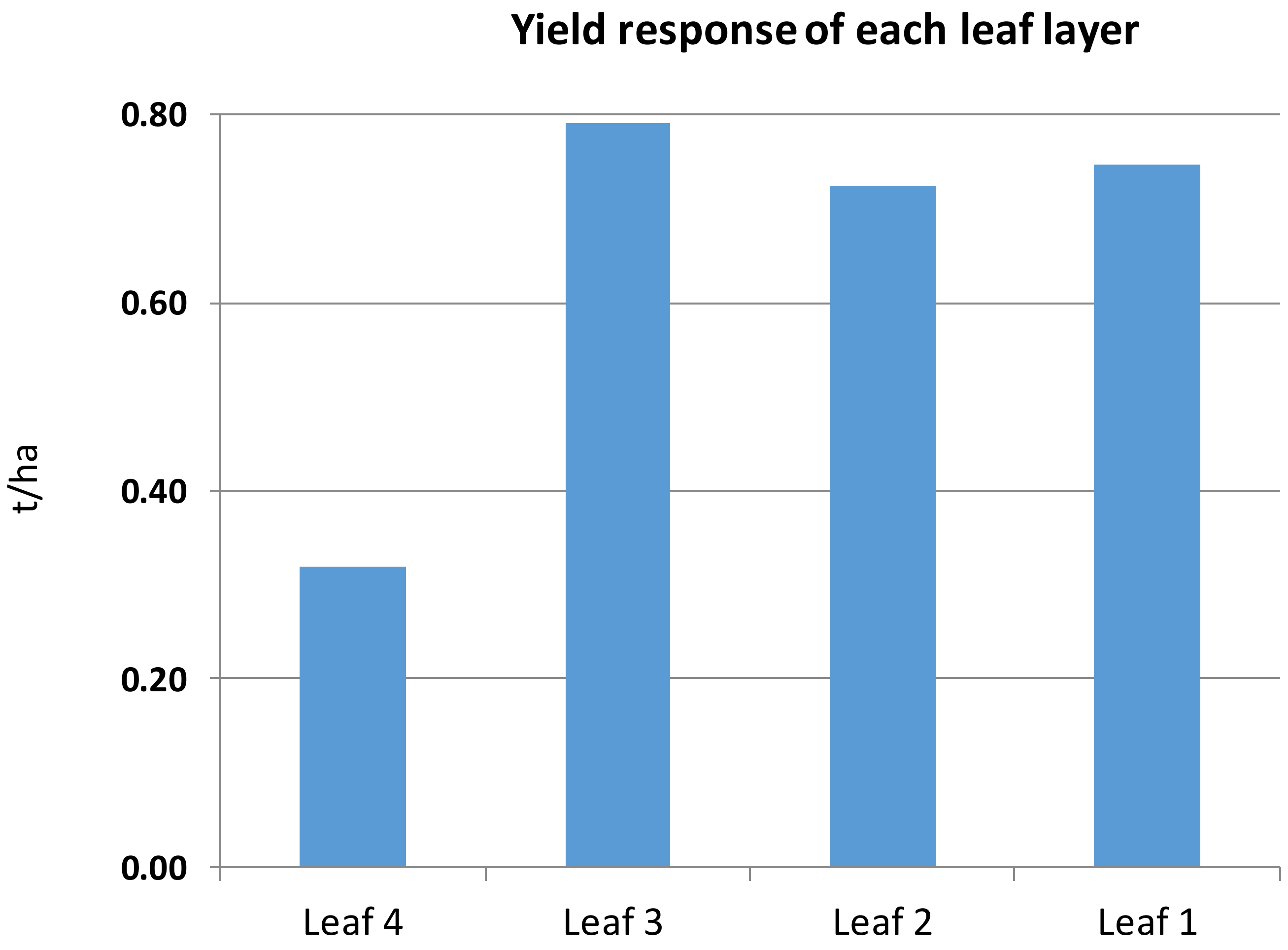
Need to protect those leaves important to yield





Timing	Growth Stage	Leaf Layer
T0	<30	L4 + below
T1	32	½ of L2, L3, L4
T2	**39**	**L1, L2**
T3	65	L1

What should we expect from a fungicide?



- Contribution of L1, 2 & 3 similar when in "programme"
- L4 showed lowest contribution
- Variation between sites due to infection events

LEAF 3 | LEAF 1 **Normal Programme**

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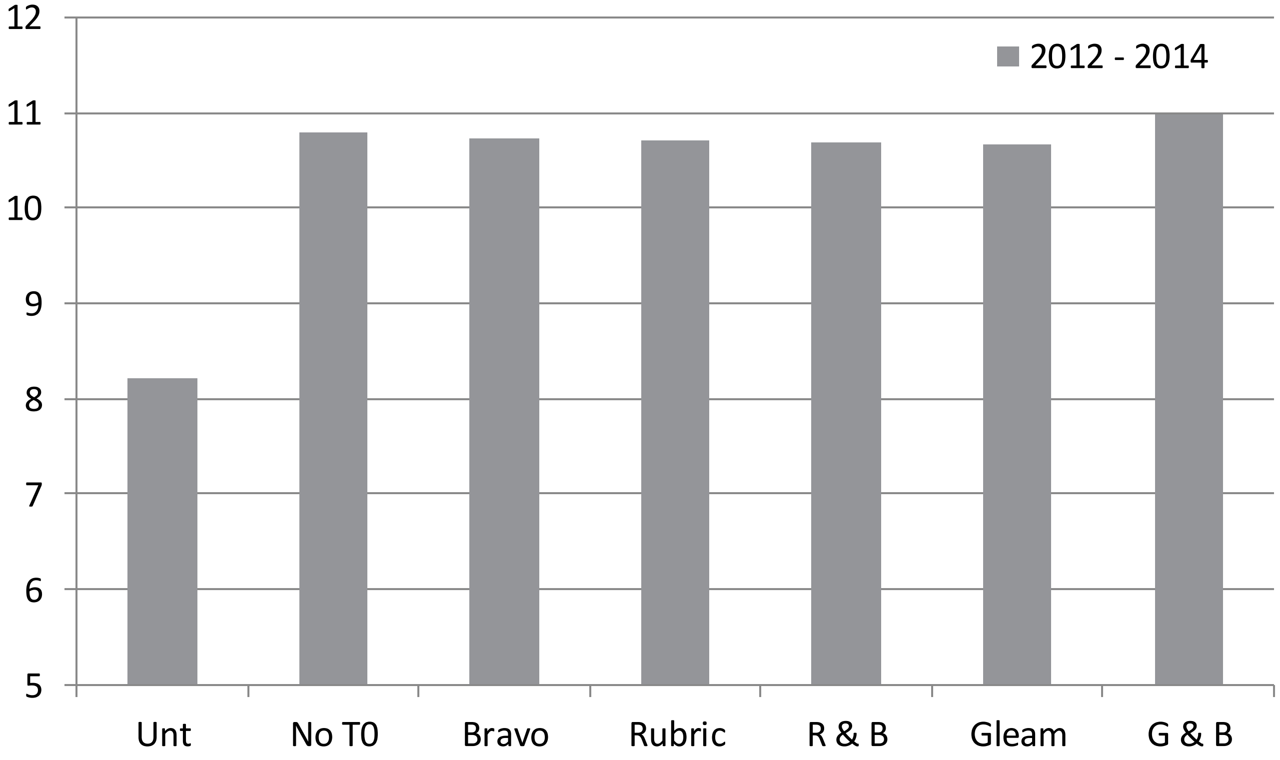
What should we expect from a fungicide?

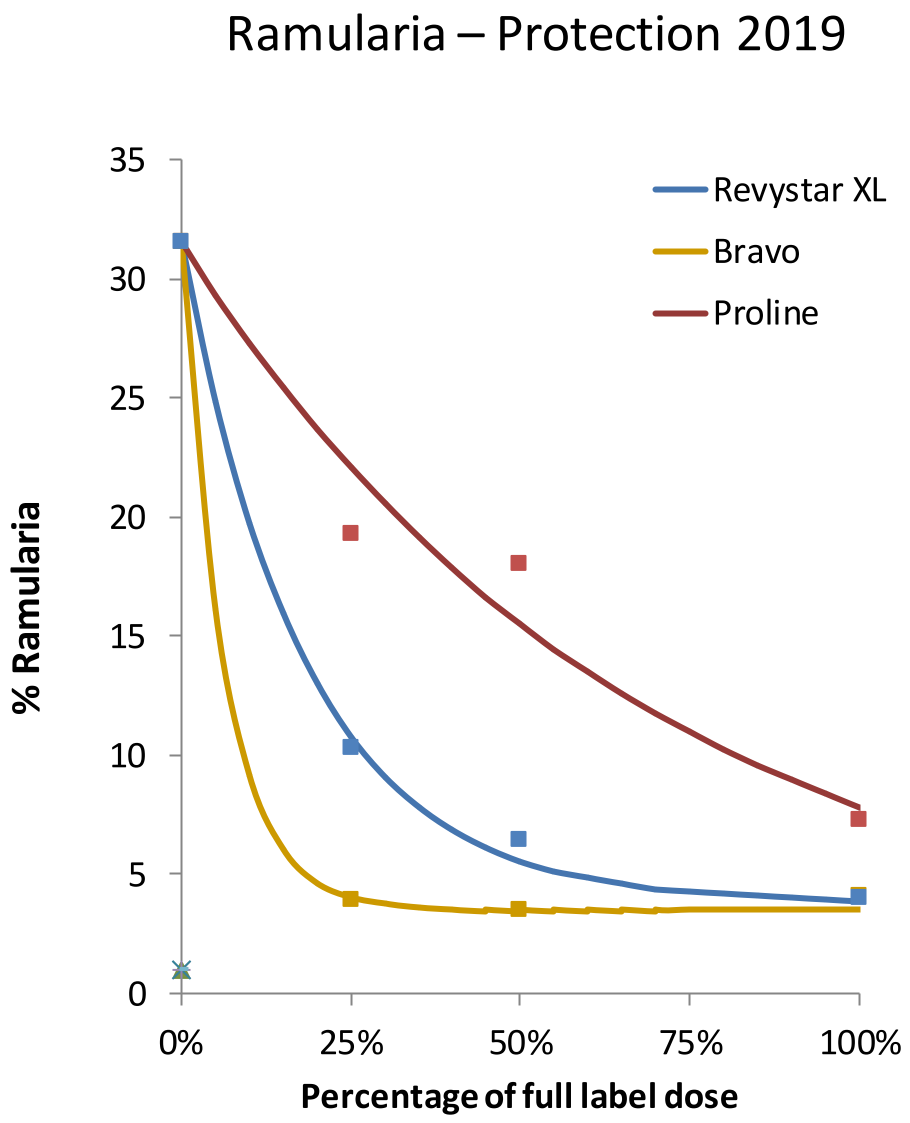
Role of Pre Stem Extension fungicides – Septoria

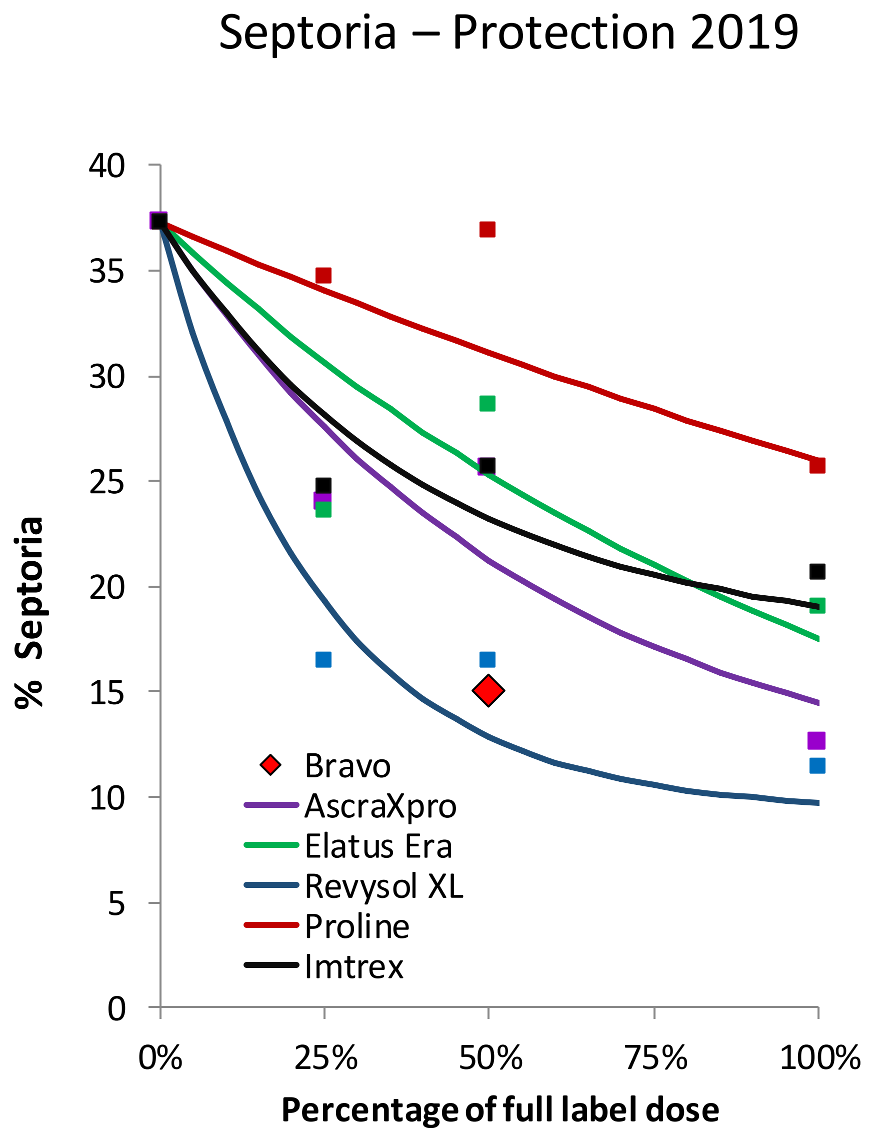
12 Sites
Range of varieties
T1: Proline 1.0L & Bravo 1.0L
T2: Adexar 1.6L & Bravo 1.0L
T3: Prosaro 1.2L (Gleam 2.0L 2012)



No significant yield benefit from PSE (T0)

How does new chemistry fit - Ireland?





Why is RAMULARIA a problem?

- **Varietal Resistance** – if available not in elite varieties
- **Agronomic practises** – don't stress the crop….in the Irish climate??
- **Nutrition** – don't stress the crop!
- **Fungicides** – *R. collo-cygni* has demonstrated quite an ability to become resistant
- CTL has provided a consistent/inexpensive "backup" to all of above

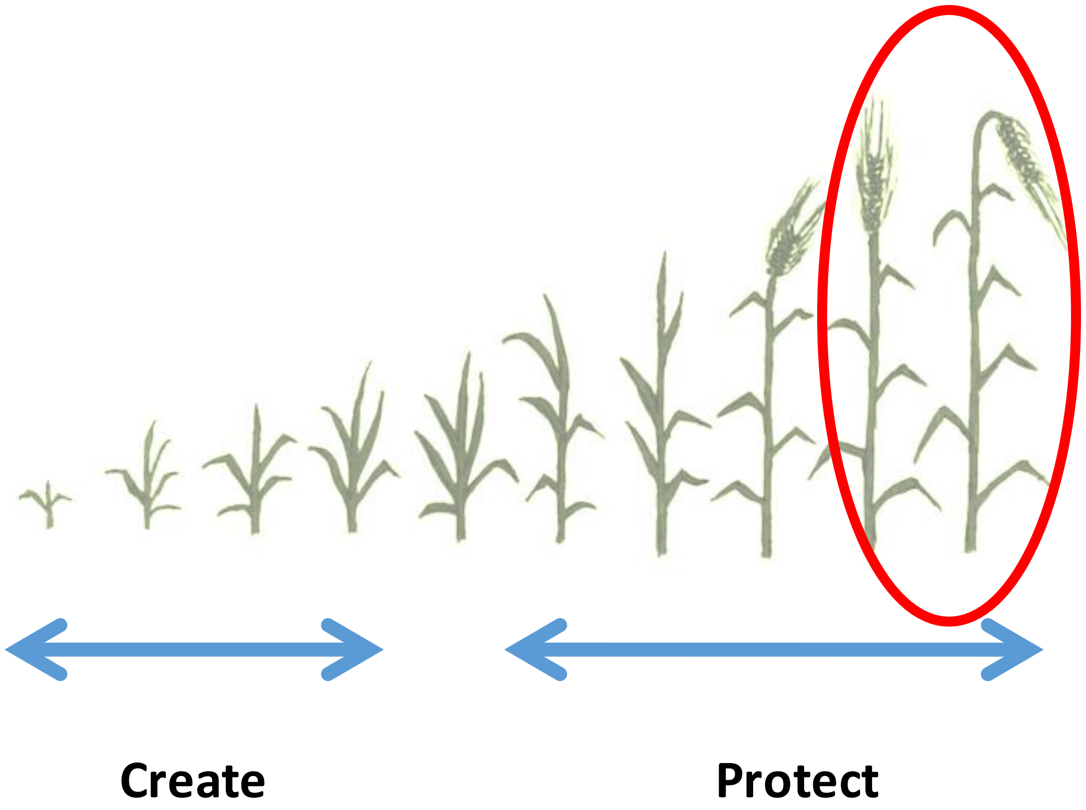
Ramularia – a bit of a spanner?

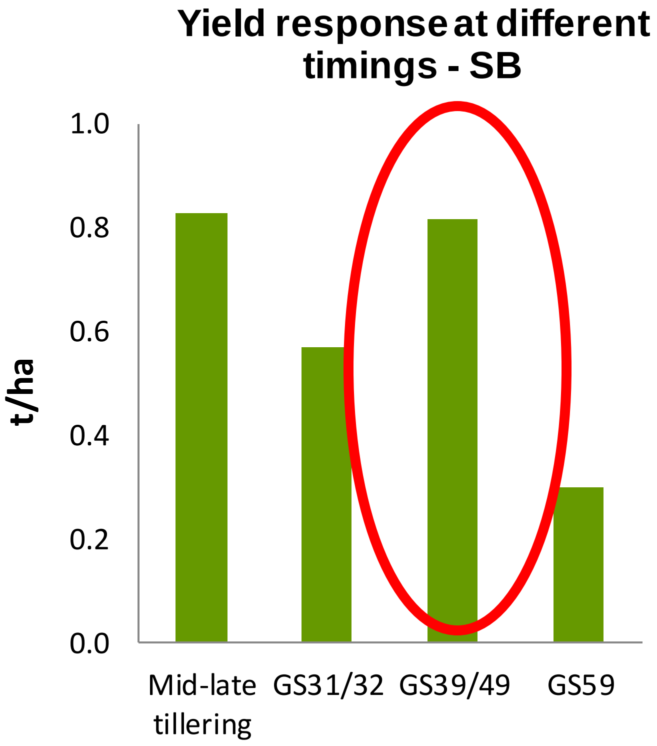
"Don't worry about it, CTL will take care of it"

- Dr.Eugene O'Sullivan (circa 2014)

Maximising barley yields?

Understanding why RLS important to yield





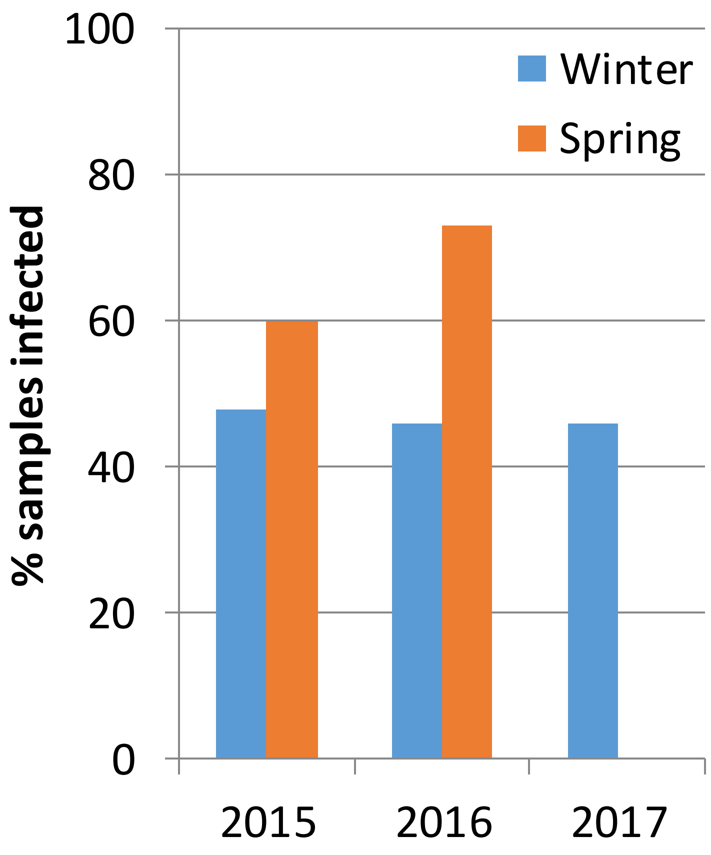
Ramularia - it's bloody complex!

It is in the seed – no surprise

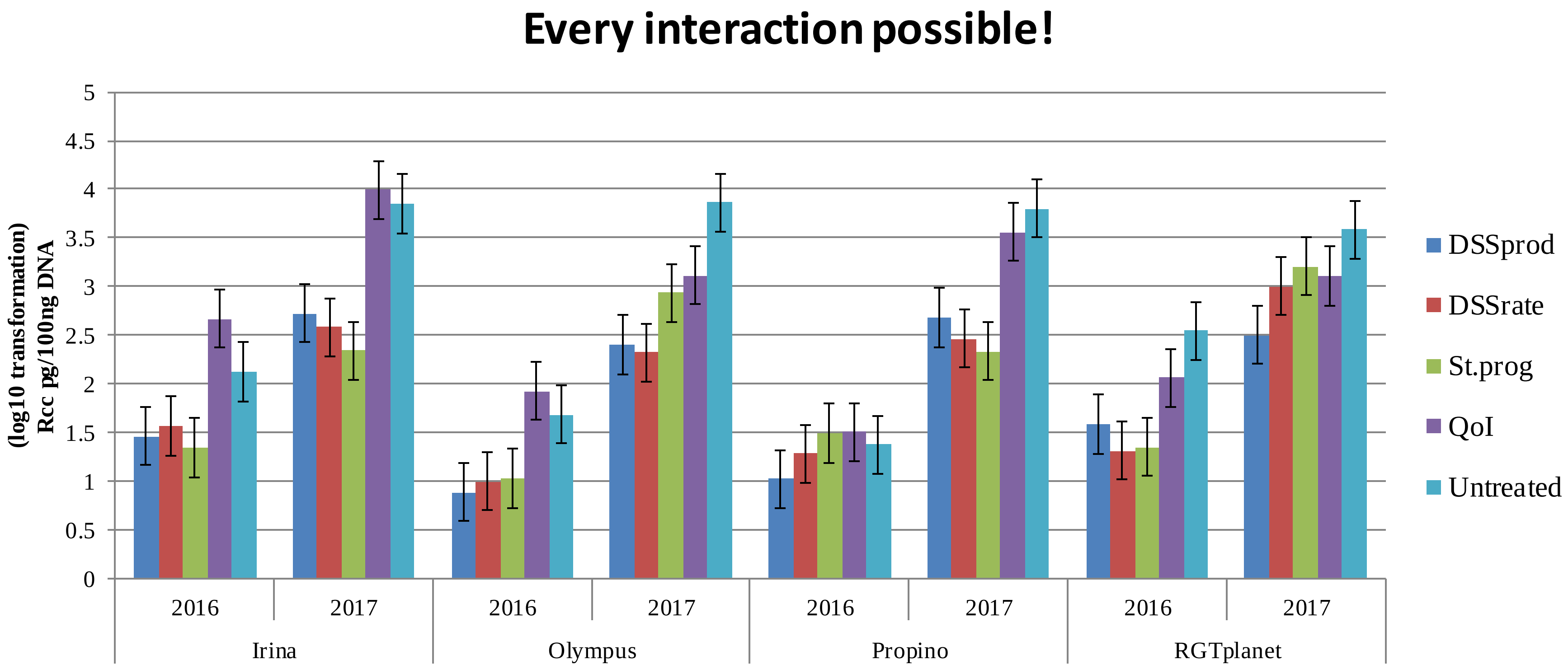
- Screening all seed samples submitted for certification
- qPCR based quantification
- Seed samples 2015-2017 (significant year effect *P* = 0.018)
- No location x variety effect!

Year	Barley	N	Mean	Range*
2015	Winter	150	0.71	0 – 6.19
	Spring	94	0.6	0 – 6.38
2016	Winter	102	4.69	0 – 62.51
	Spring	104	0.64	0 – 3.58
2017	Winter	94	0.67	0 – 0.271

*pg/100ng total DNA



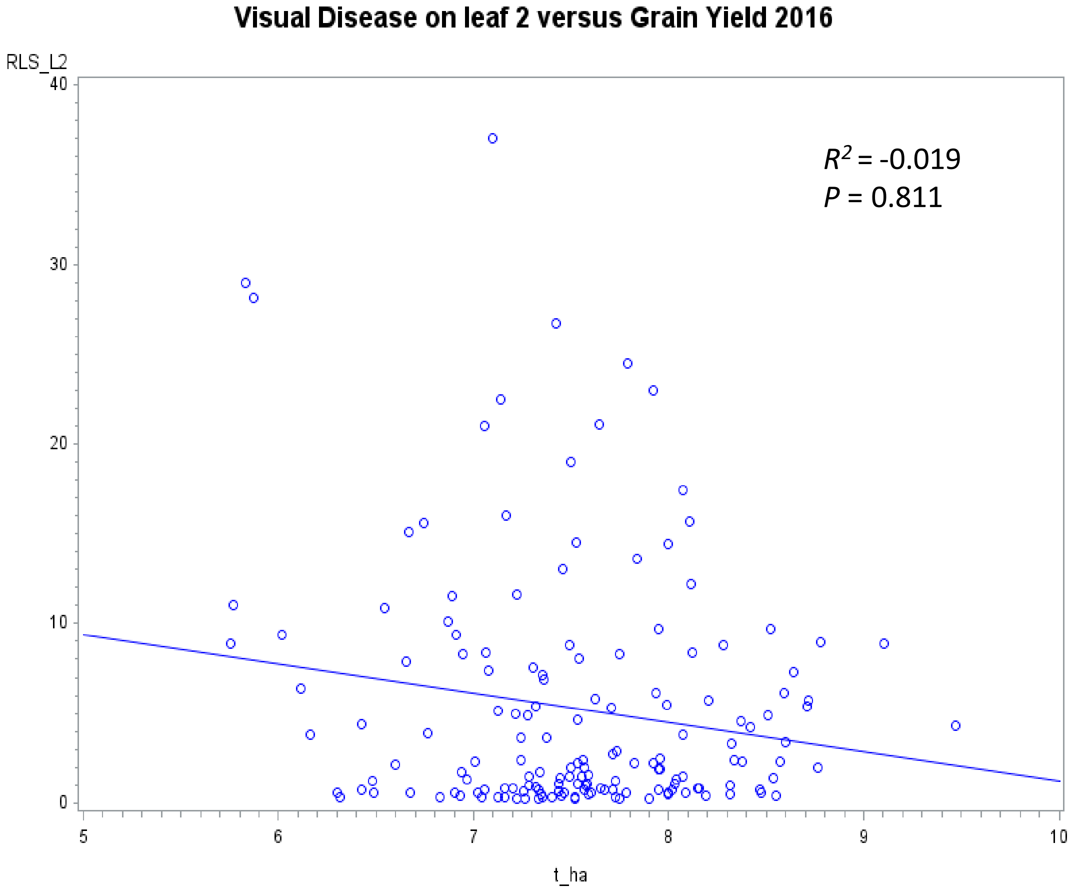
Ramularia - it's bloody complex!

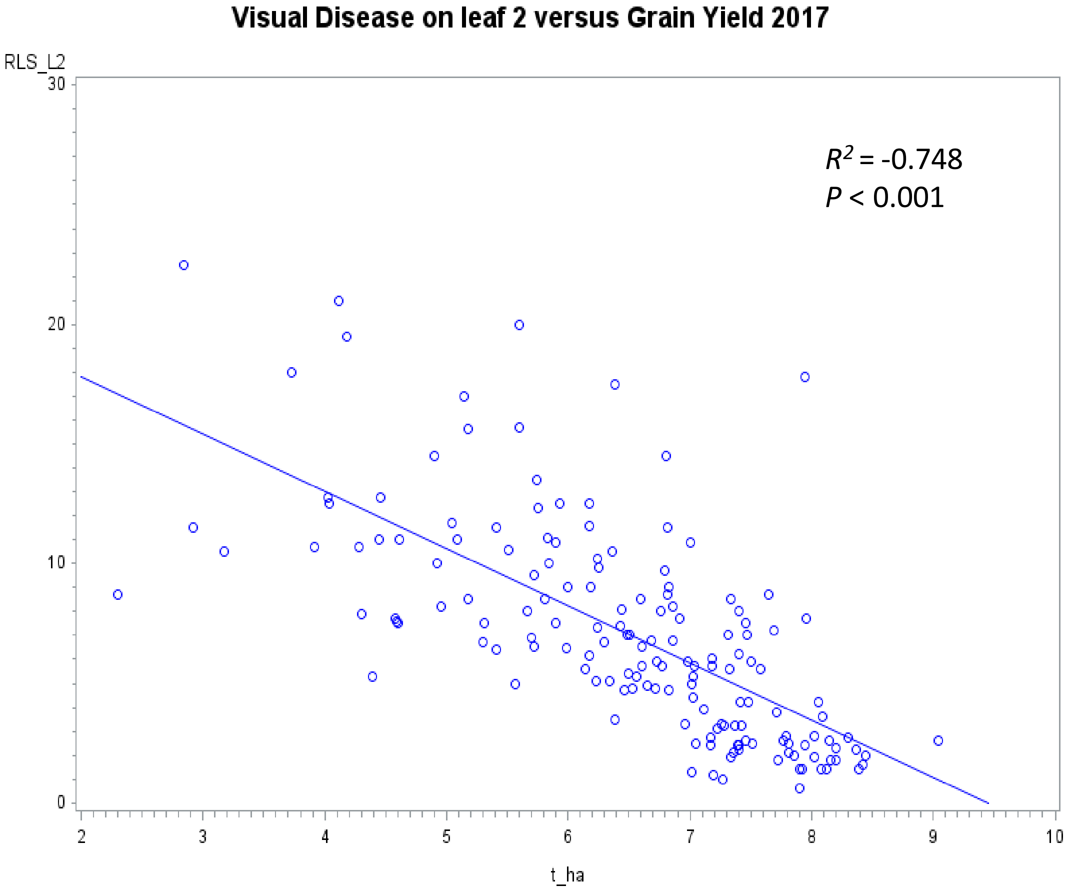


Source of variation	d.f.	(m.v.)	s.s.	m.s.	v.r.	F pr.
Treatment	4		55.701	13.9252	36.88	<.001
Cv	3		8.0296	2.6765	8.44	<.001
Treatment.Cv	12		7.6881	0.6407	2.02	0.045
Site	1		42.1909	42.1909	96.01	<.001
year	1		169.5052	169.5052	385.73	<.001
Treatment.Cv.Site	12		14.9144	1.2429	2.83	0.002
Treatment.Cv.year	12		10.8724	0.906	2.06	0.022
Treatment.Site.year	4		5.0658	1.2664	2.88	0.024

Ramularia - Relationship with Yield

Impact on yield depends on year / PRESSURE





Ramularia - Some answers, more questions!

EPIC IPM

1. **Is Irish barley seed infected with Ramularia?**
   - Yes
2. **What role does seed play in RLS?**
   - We really don't know, very difficult to prevent it from being in seed
3. **What impact has RLS have on yield**
   - Can be quite significant, but not always – <u>barley is not wheat</u>
4. **Does variety make a difference?**
   - Differences apparent, but not clear – visual v DNA v treatment
5. **Can we predict RLS**
   - Even in a relatively small trial lots of interactions exist – we need to know more about the disease!

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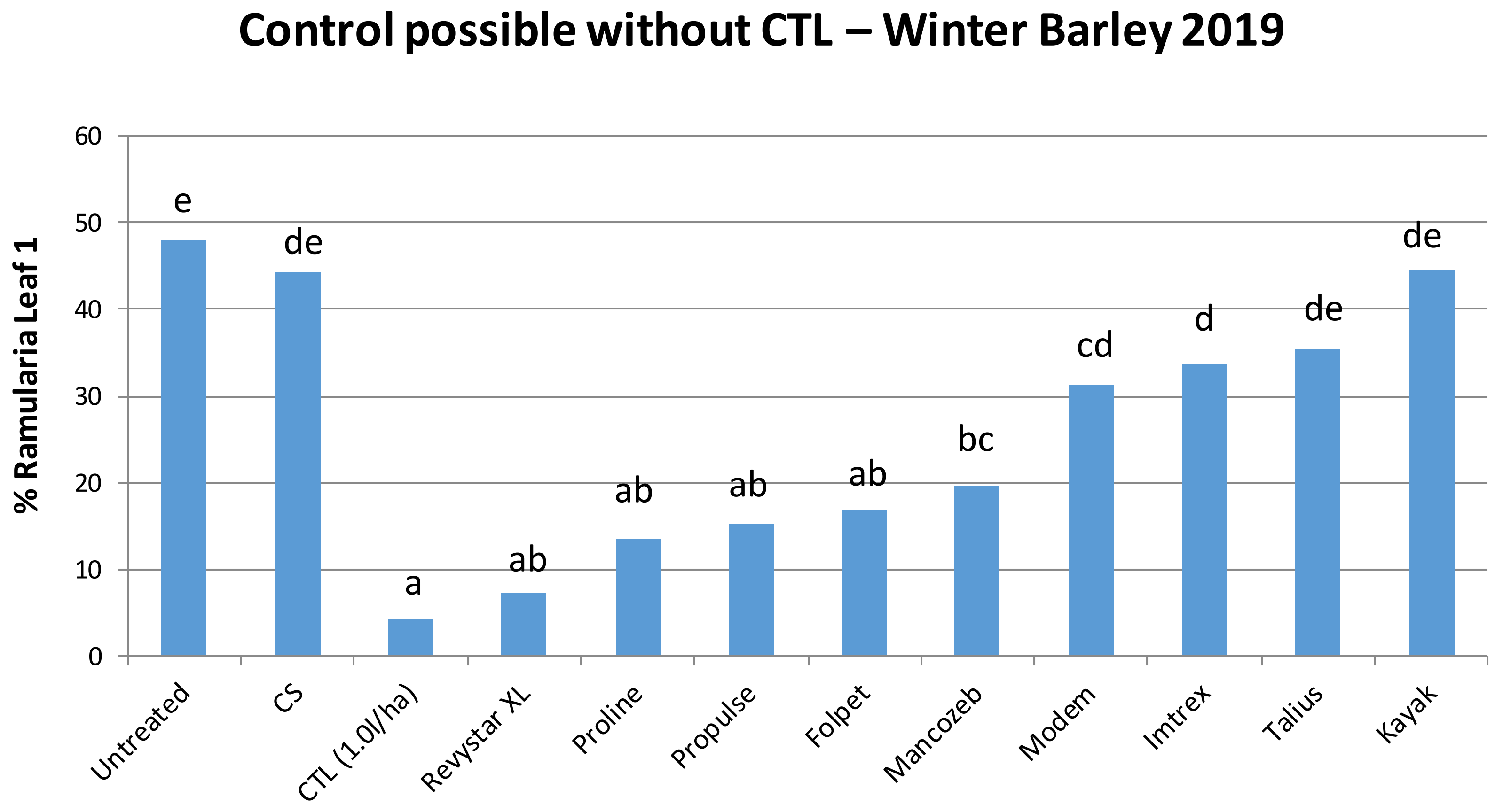
What's working & what's not



Teagasc Ramularia "Alternative" Fungicide Trial 2019

- WB at two sites, cv Pixel
- Cover Spray (CS) Proline (0.4 l/ha) & Modem (0.625 l/ha)
- No site x treatment interactions (P=0.174)
- Significant fungicide effect (P<0.001)

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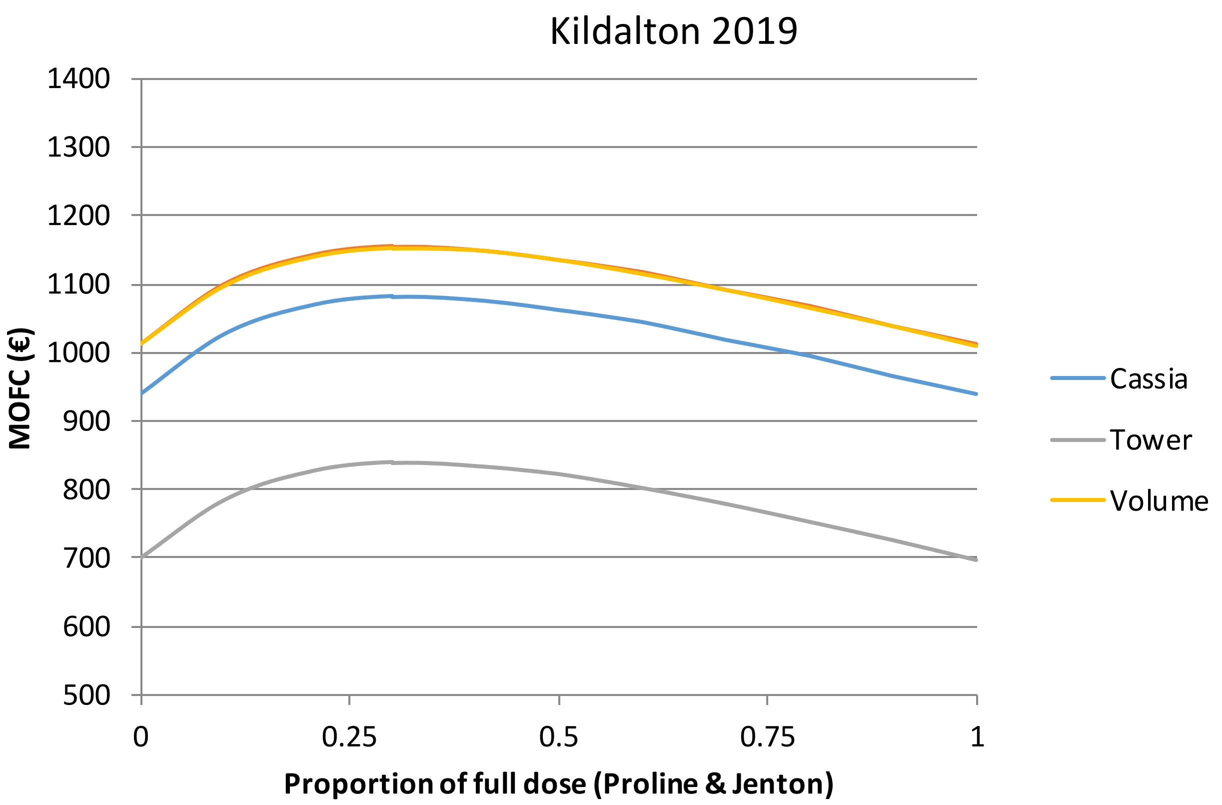
Understanding impact of programme

Optimum Fungicide Programme Dose Response WB 2016-2019



Proportion of full dose required for optimum

Site	KWS Cassia	KWS Tower	SY Volume
OP 2016	0.25	0.30	0.28
KD 2016	0.25	0.27	0.24
OP 2017	0.18	0.27	0.19
KD 2017	0.34	0.34	0.34
OP2019	0.34	0.43	0.18
KD 2019	0.37	0.37	0.37

Teagasc WB Fungicide x Variety DR

- WB at two sites, 4 varieties (Retriever replaced by Kosmos)
- Proline & Jenton x 3 applications
- Significant exponential plus linear fits (*P*<0.001)

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Understanding impact of programme

SY Volume - Kildalton

Proline + Jenton x 3 applications

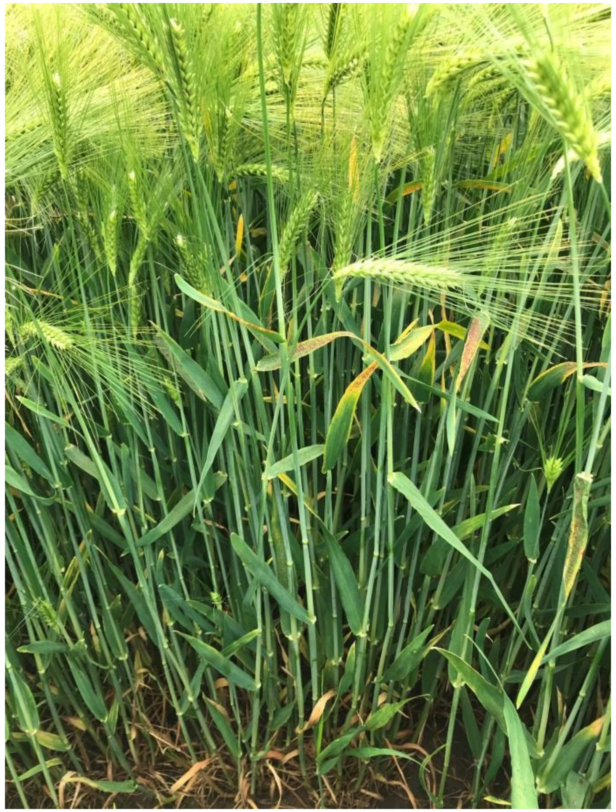
Untreated

X

Optimum Dose

(0.37)

½ Rate



Full Rate

So how will we manage without CTL?

1. **Know your risk**
   - Strengths & weakness of variety?
   - When & where is it being grown?
   - Know strengths & weakness of fungicides

2. **Know your crop**
   - What growth stage – timings critical
   - What is disease pressure?
   - Is it under stress – Ramularia

3. **Know your fungicide**
   - What can I expect from the fungicide, new or old?
   - Alternative multisites <u>do work</u>!

Acknowledgements

Teagasc Crops Research

Deirdre Doyle, Jim Grace, Liam Shepard (Liz Glynn)

Dr. Henry Creissen & Dr. Joe Mulhare (Ramularia work)

Farm staff

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

EPIC IPM

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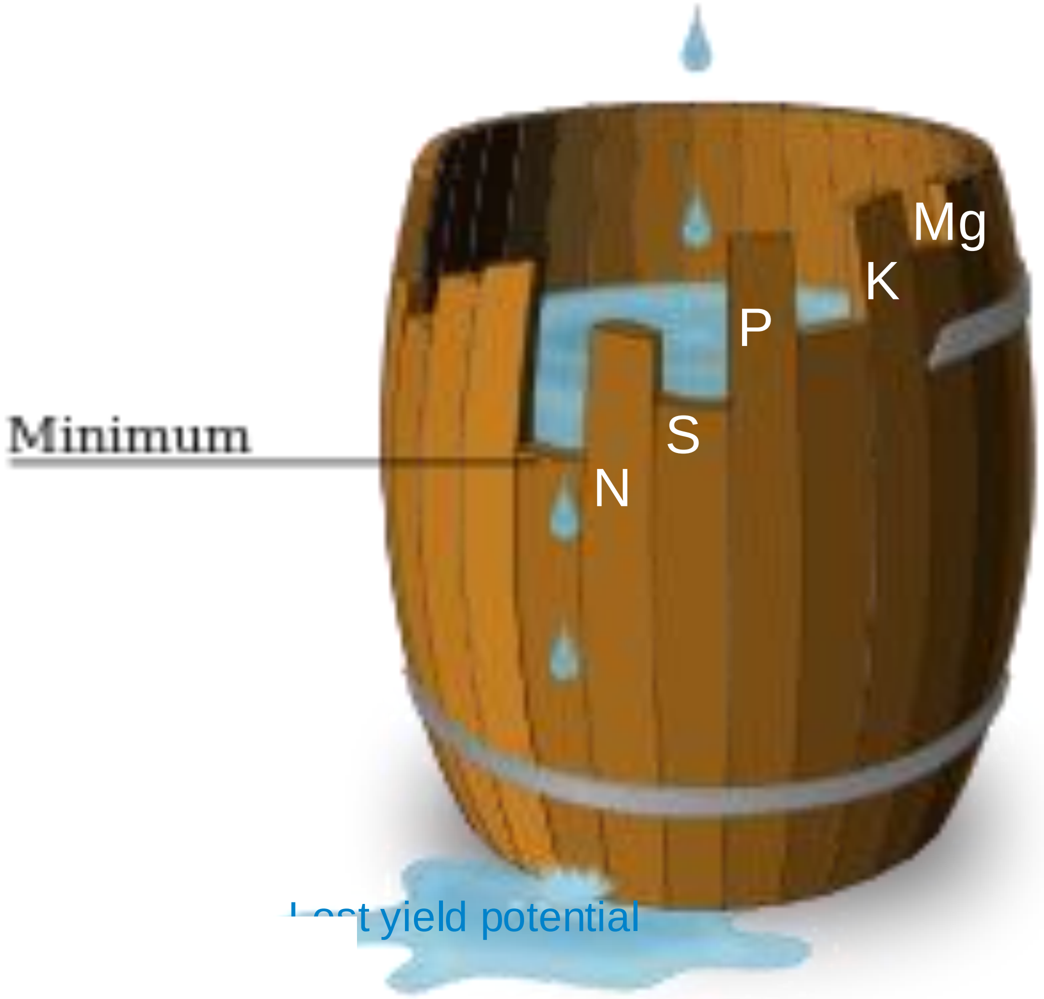
Agronomy West 2020

Improving yield through using micro-nutrients

Steve McGrath

Head of Sustainable Agriculture Sciences, Rothamsted Research

Law of the minimum



Are micronutrients limiting yields of high-yielding crops on at risk soils?

Questions

AHDB project report 518

- Is there any evidence of changing Cu, Mn and Zn status in soils?
- Do high yielding wheat varieties respond more to Cu, Mn and Zn?
- Evidence for reports of up to 3 t/ha yield increases due to micronutrient sprays?
- Does soil, leaf or grain analysis help predict when yield will be affected?

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ROTHAMSTED RESEARCH

1) Changes in soil micronutrient status?

Used standard EDTA extracts for soil analysis

- Sampled 132 arable soils in 2009 - 2010 = “NEW”

- National Soil Inventory sampled 1978 - 1982

1,805 arable soils = “OLD”

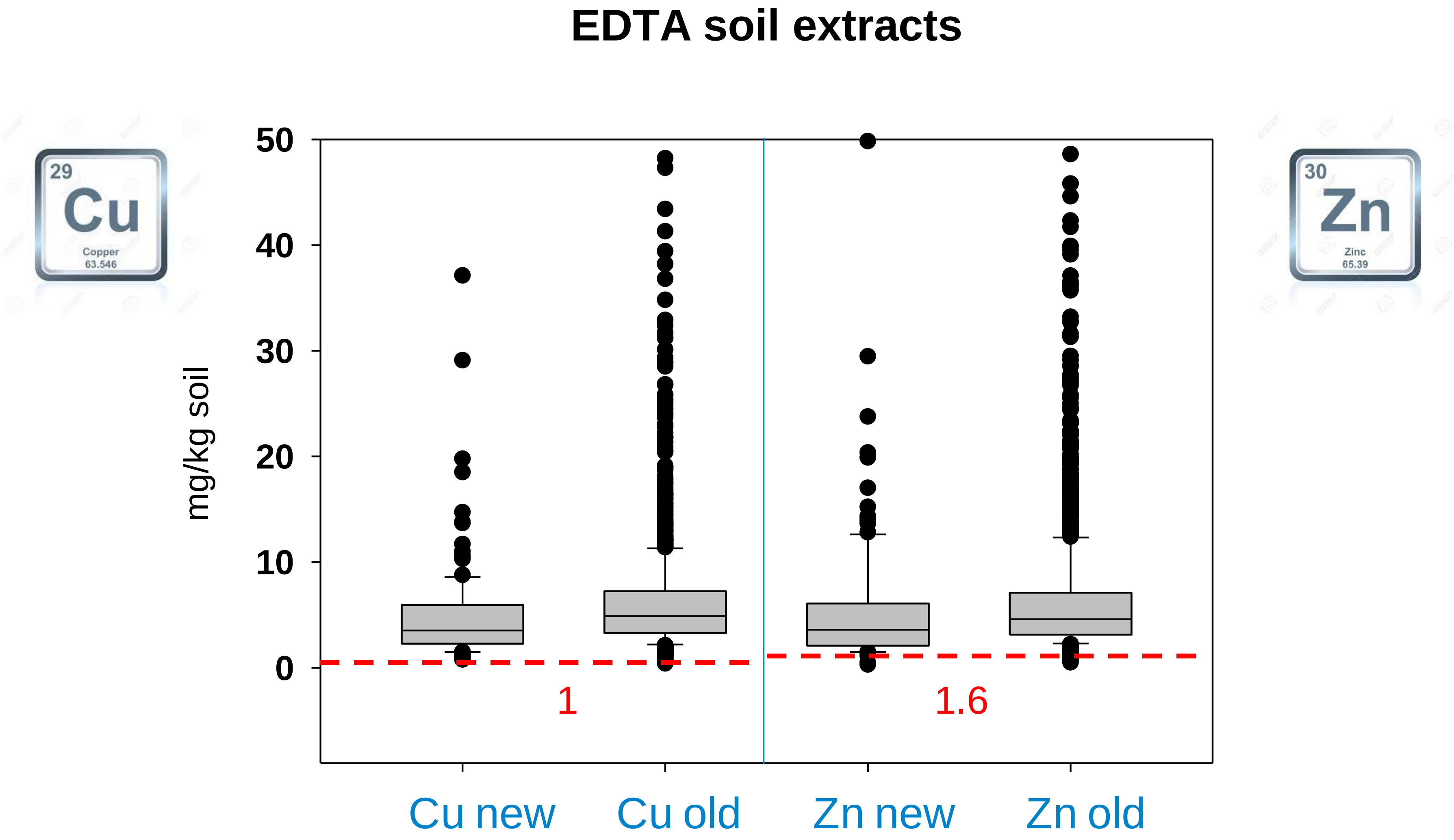
Soil extractable Manganese

n = 132

n = 1,805

Note: no soil threshold value

Soil extractable Copper and Zinc



ROTHAMSTED RESEARCH

2) Field Experiments on the need for micronutrient applications

- 15 site years (5 sites x 3 seasons)
- Type of soil – light (6), organic (6), high pH (3)
  - – all high risk due to low bioavailability of micronutrients in soil
- Visible symptoms
- EDTA extracts of soil
- Leaf tissue analysis in spring
- Grain analysis at harvest

ROTHAMSTED RESEARCH

Visual symptoms

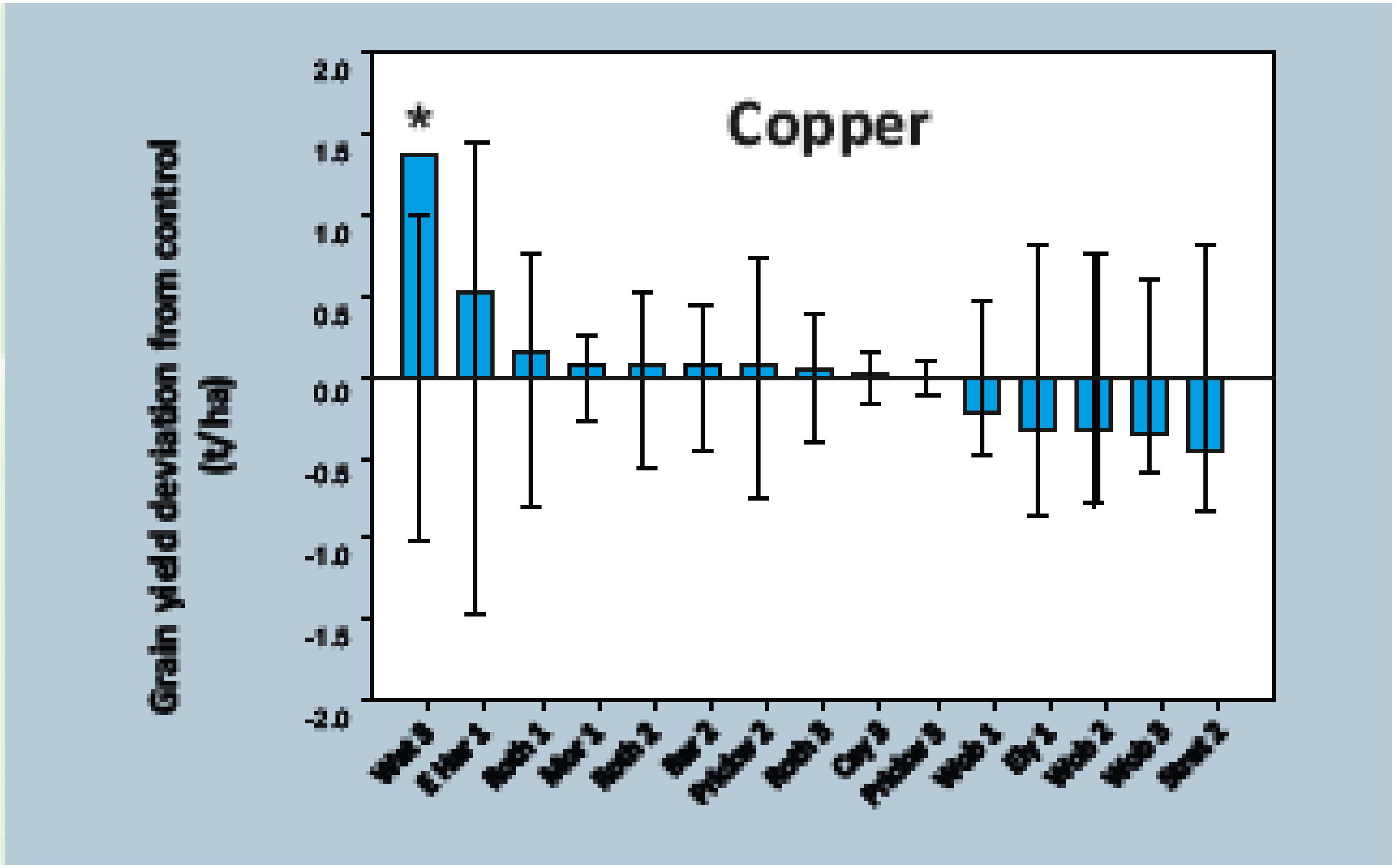
- Assessed leaves at GS 33
- None were observed
- Can be confused with other problems…

Visual symptoms

Easily misinterpreted…

Grain yields as deviation from control (t/ha)

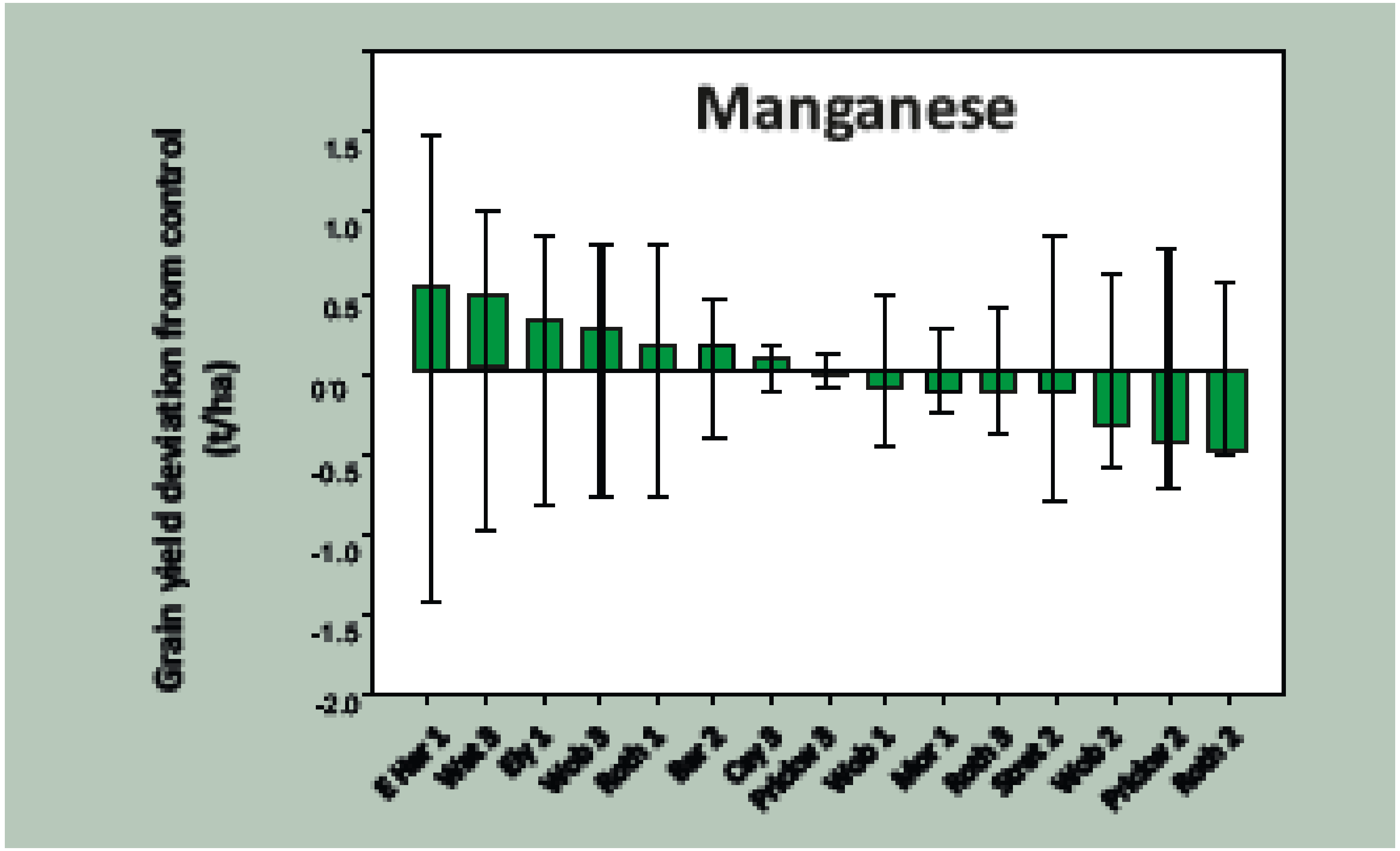
- Copper significantly affected yield in only 1 experiment



ROTHAMSTED RESEARCH

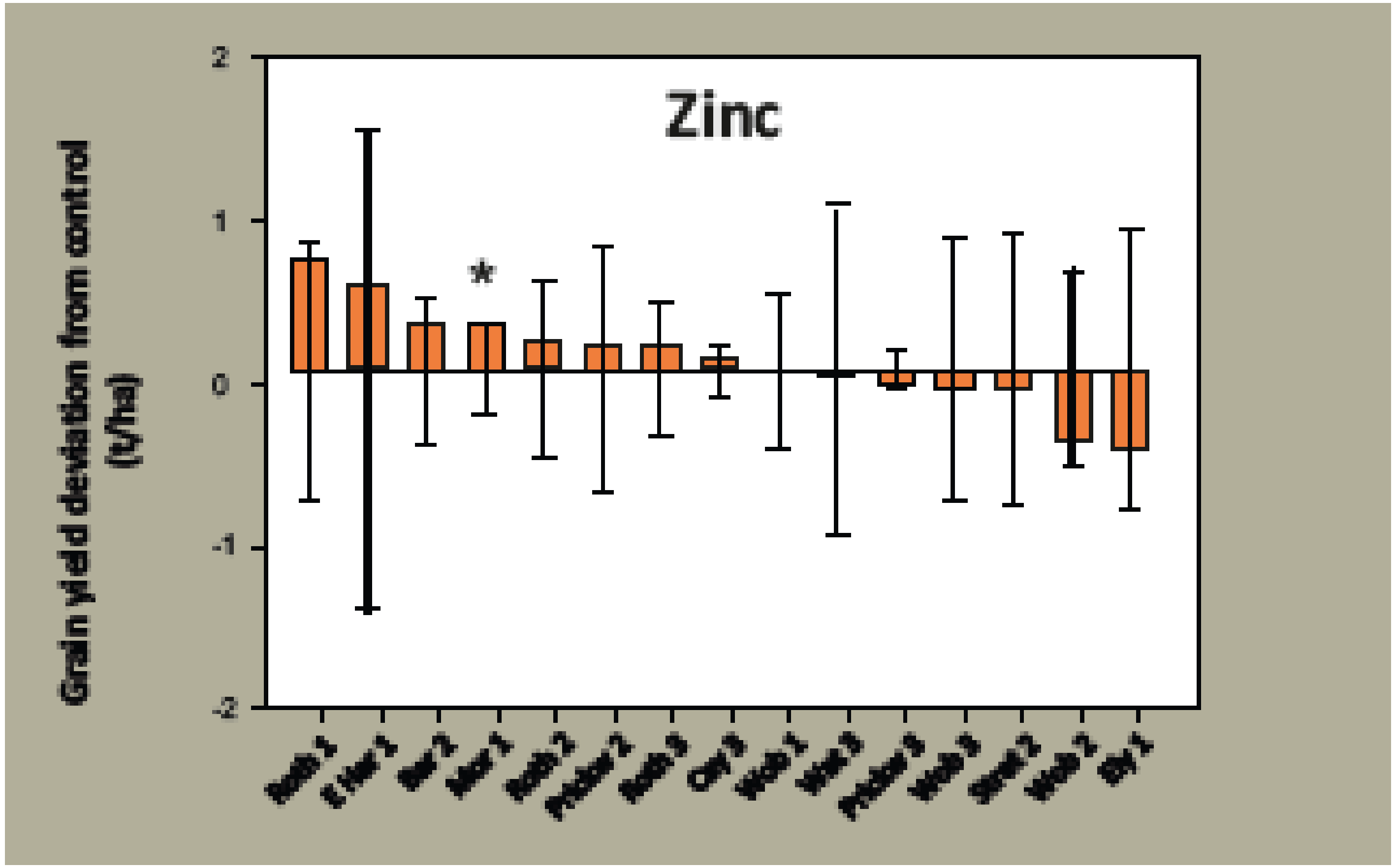
Grain yields as deviation from control (t/ha)

- Manganese significantly affected yield in no experiments



Grain yields as deviation from control (t/ha)

- Zinc significantly affected yield in only 1 experiment



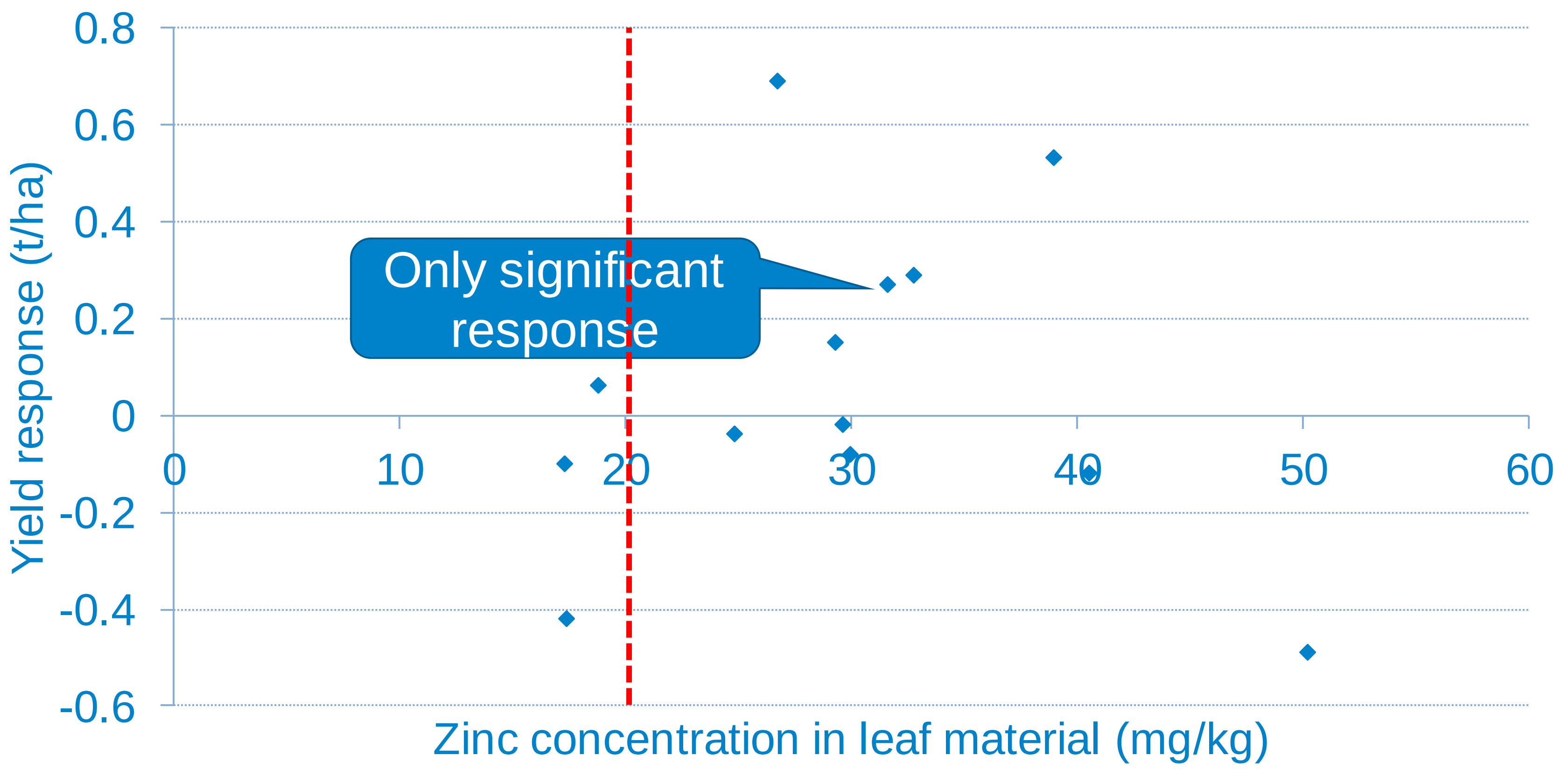
What size increase in grain yield is detectable in these plot experiments?

- Coefficient of variation of each field trial, in terms of t/ha of grain
- Any yield increase compared to control yield would have to be larger than these values to be detected

CV% as t/ha	Yr 1	Yr 2	Yr 3
Range	0.20 – 1.11	0.34 – 0.62	0.08 – 0.76
Mean	0.58	0.48	0.37

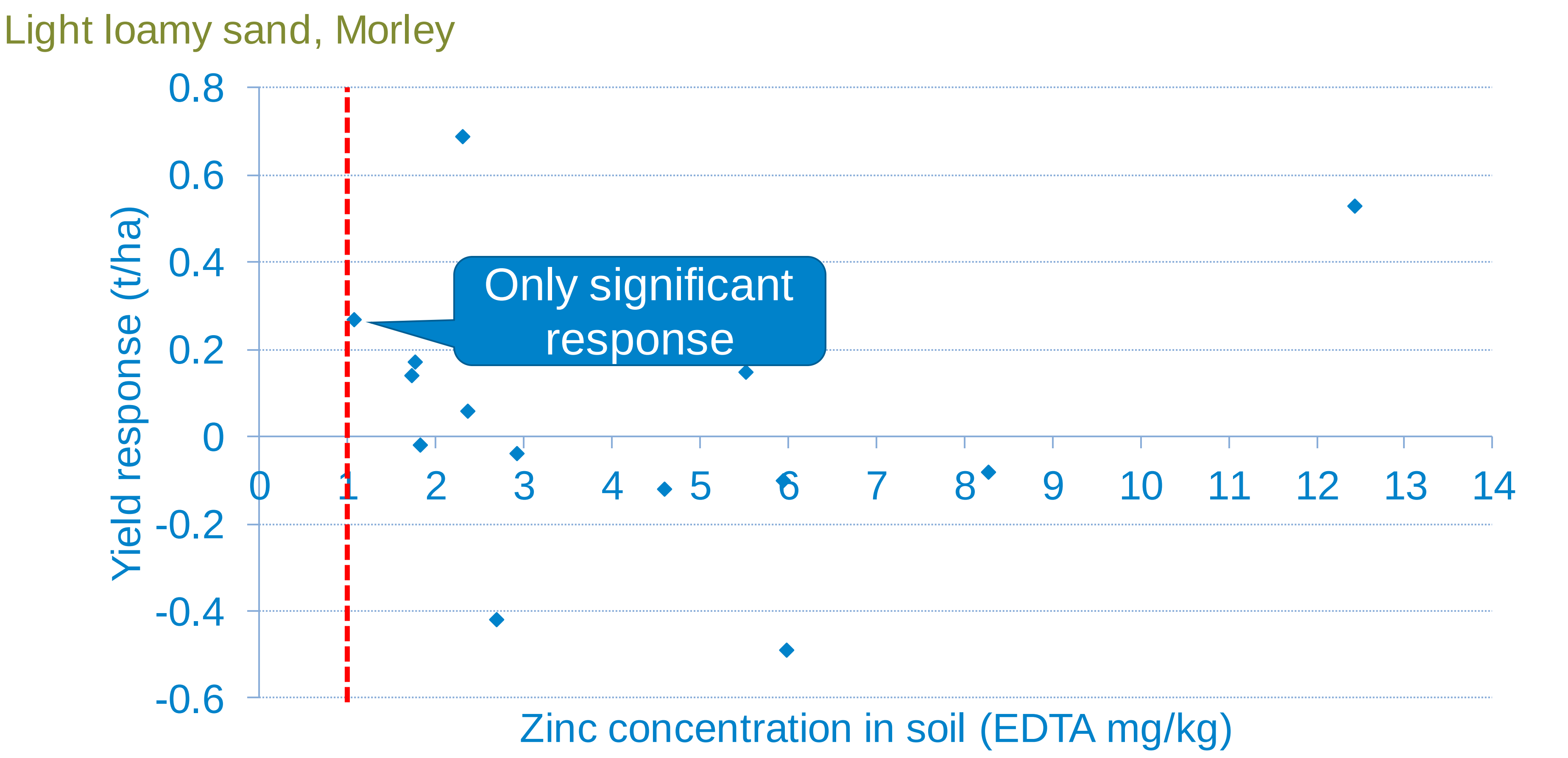
ROTHAMSTED RESEARCH

How diagnostic is leaf tissue testing for zinc?



Threshold: Zn < 20 mg/kg in leaves

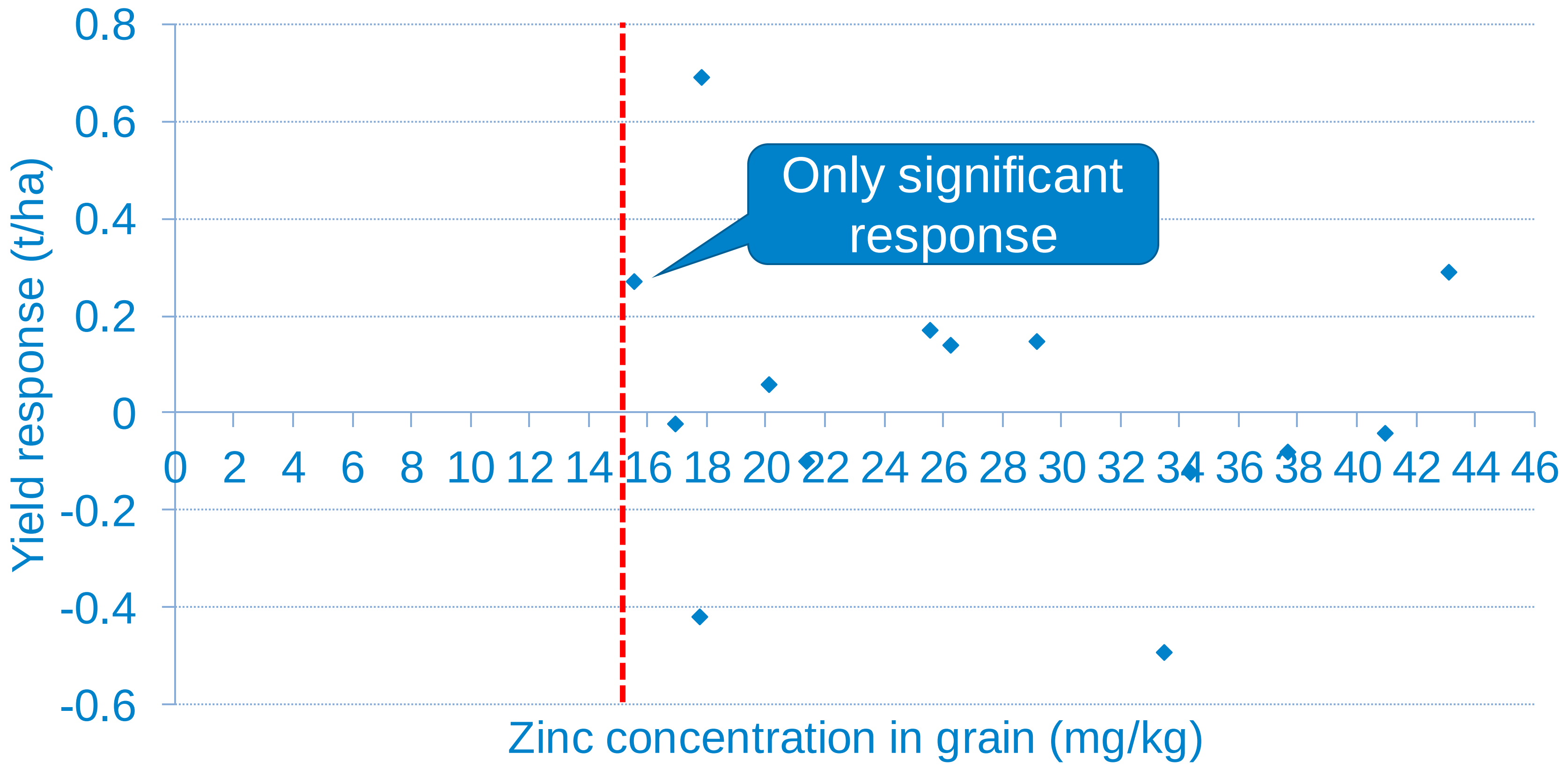
How diagnostic is soil testing for zinc?



Threshold: Zn < 1 mg/kg in soil

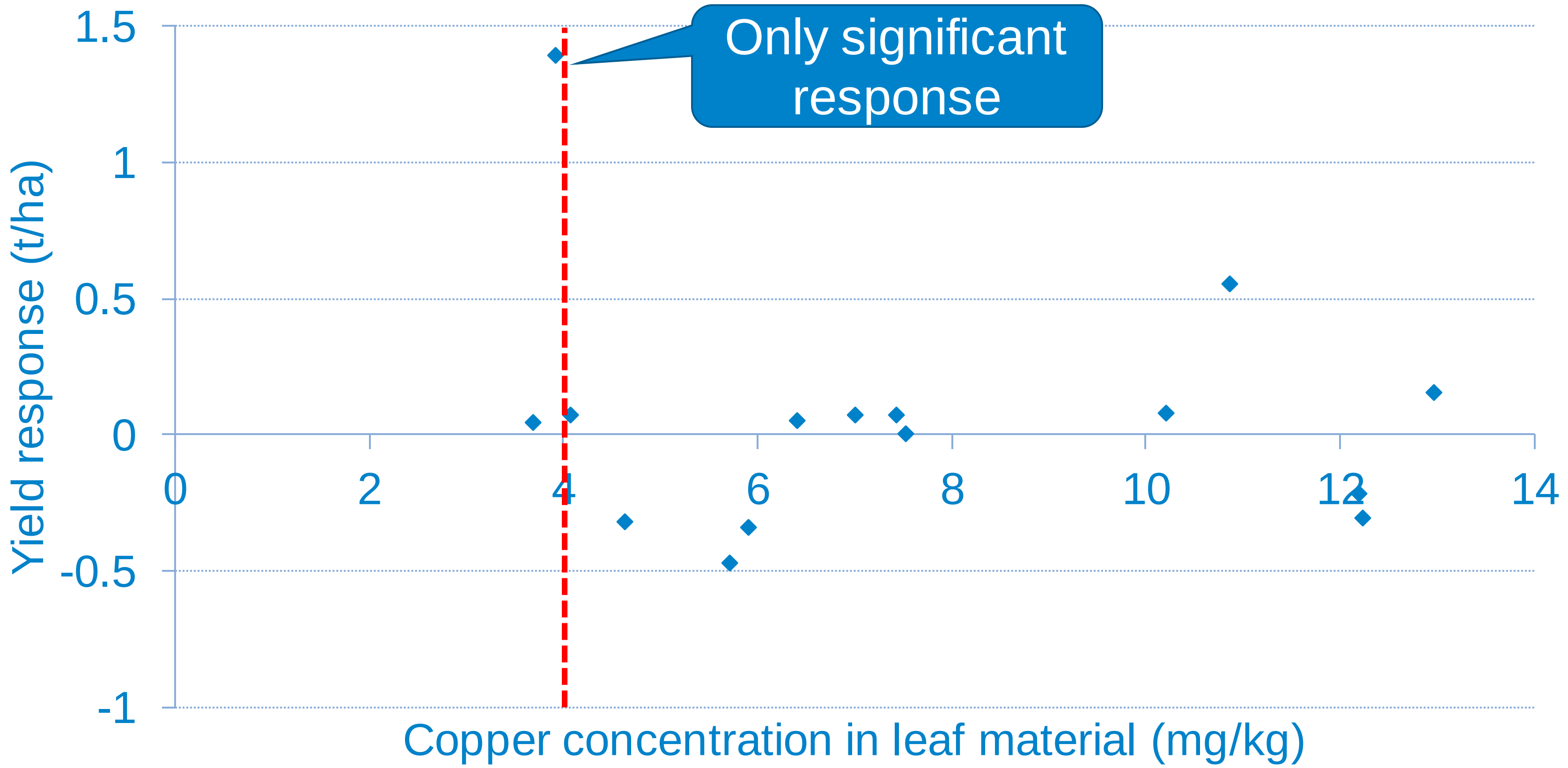
ROTHAMSTED RESEARCH

How diagnostic is grain testing for zinc?



Threshold: Zn < 15 mg/kg in grain

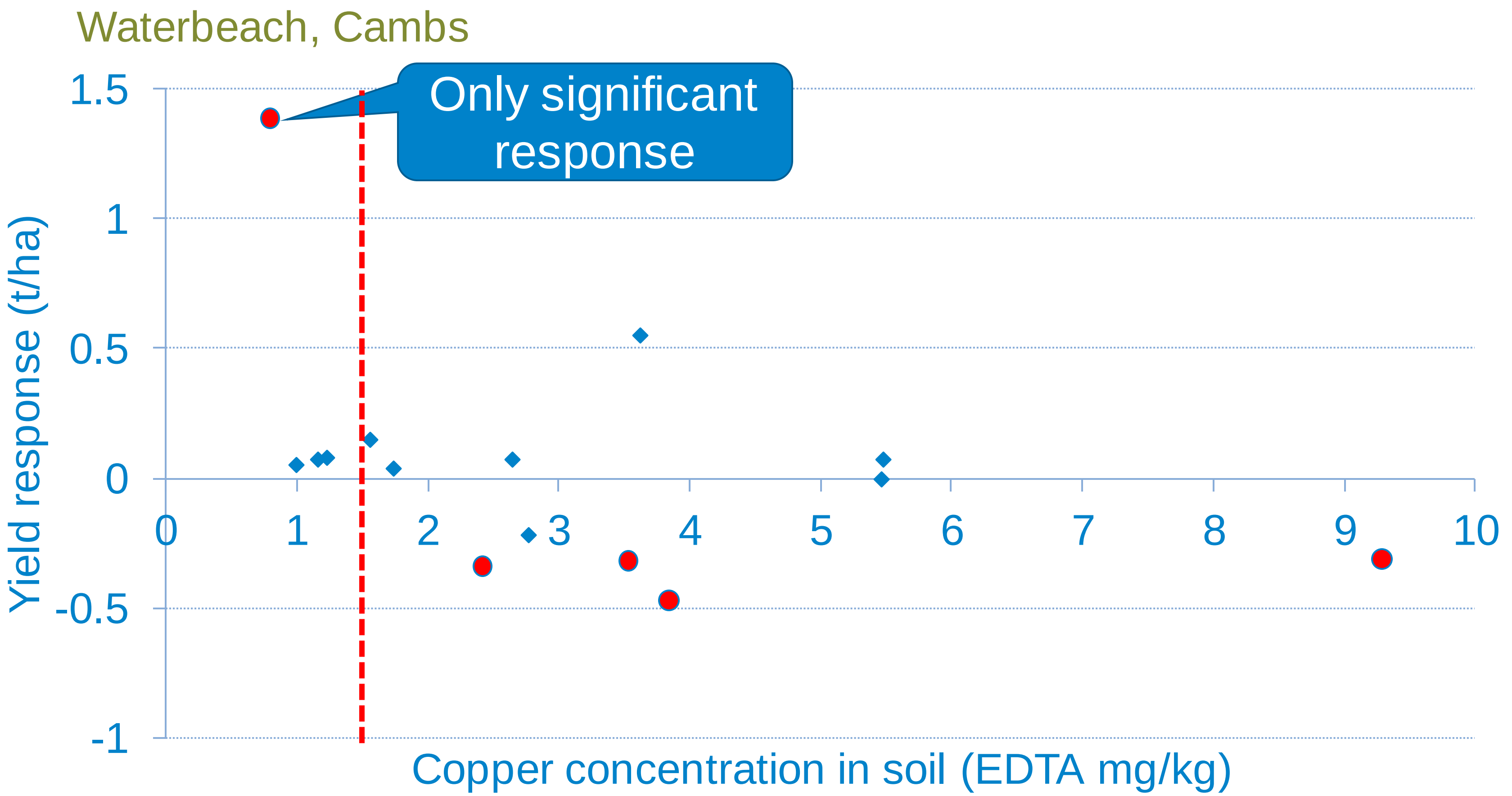
How diagnostic is leaf tissue testing for copper?



Threshold: Cu < 4 mg/kg in leaves

ROTHAMSTED RESEARCH

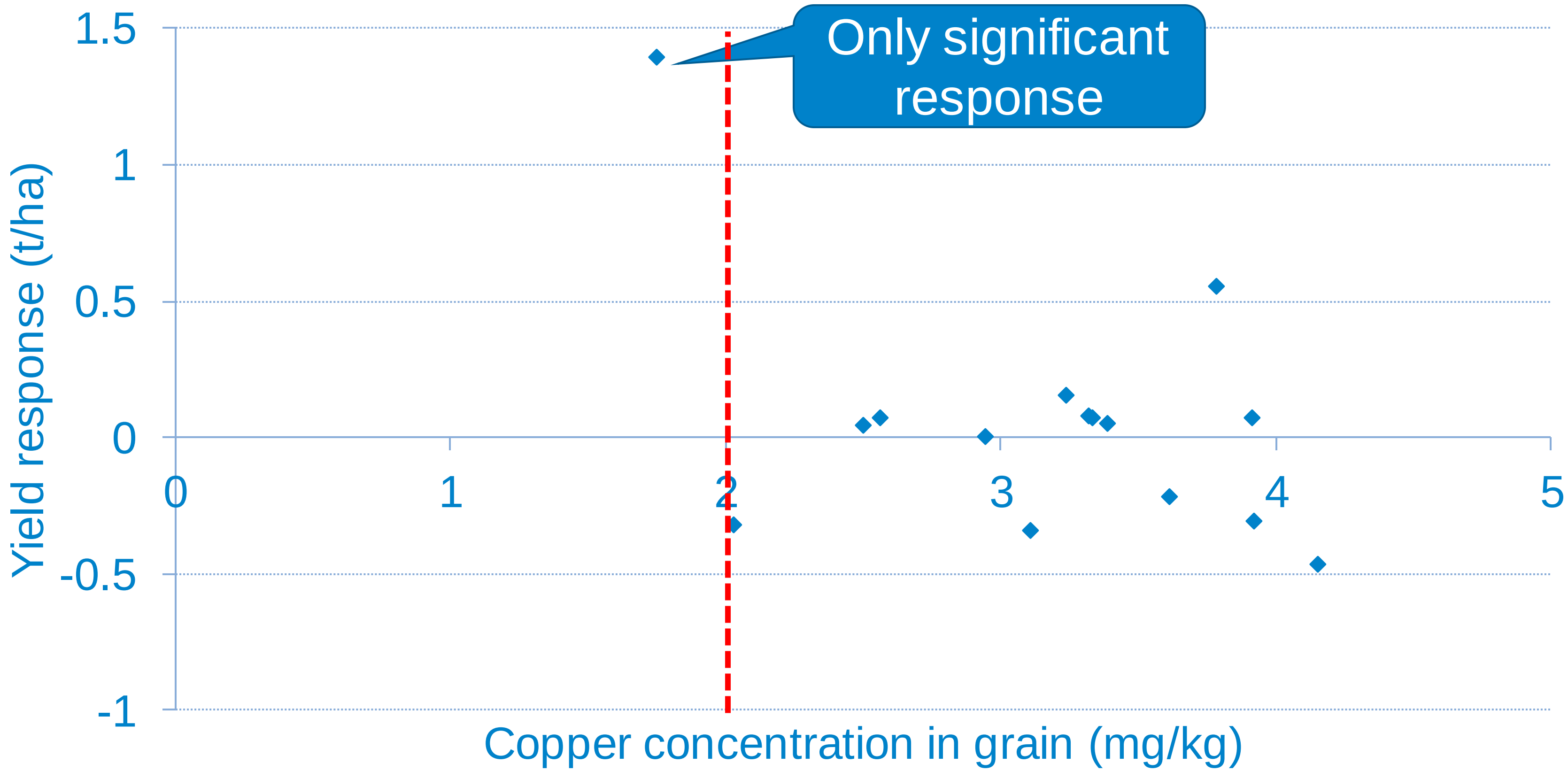
How diagnostic is soil testing for copper?



Threshold: Cu < 1.6 mg/kg (•< 2.5 organic soil)

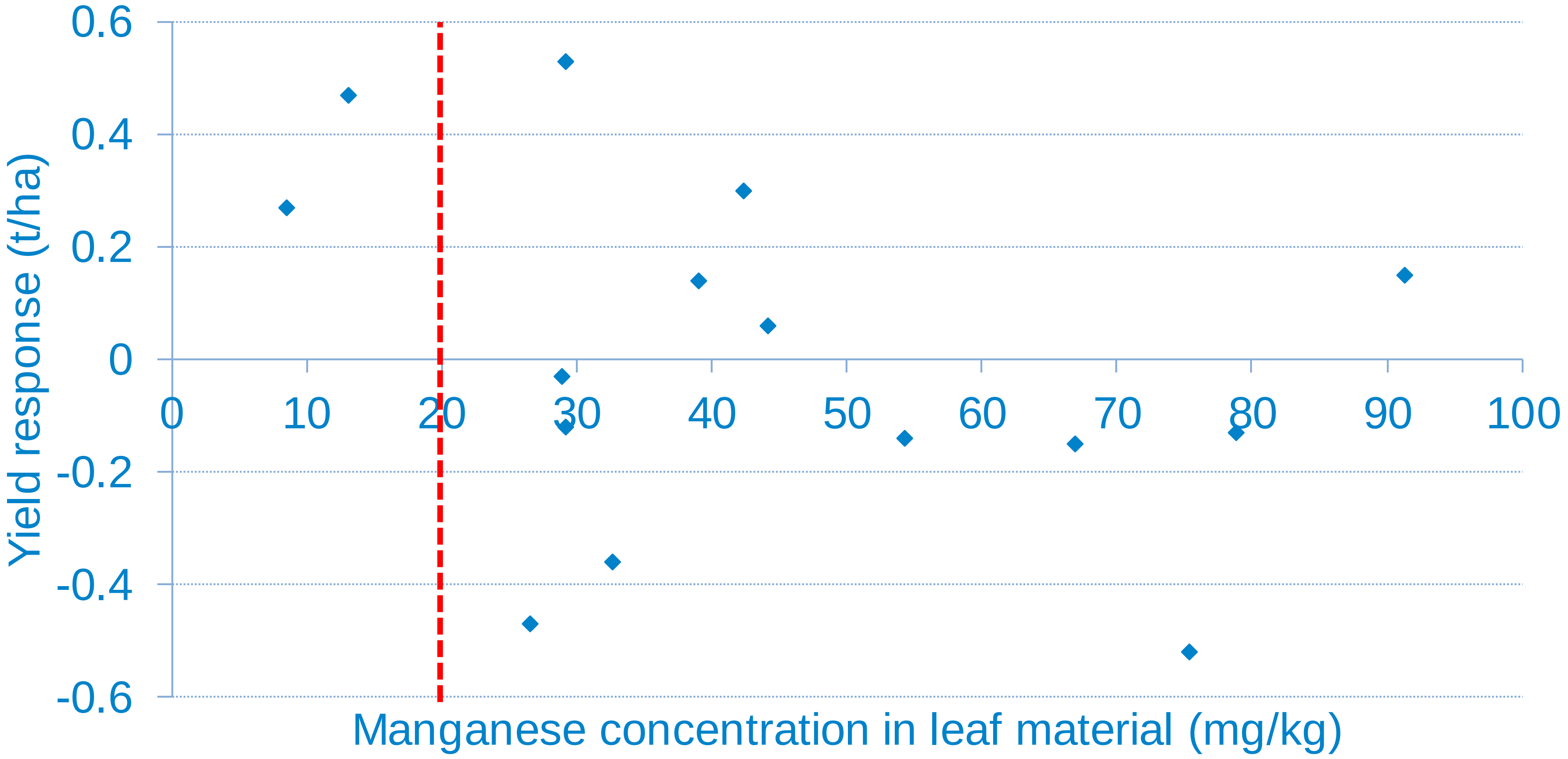
ROTHAMSTED RESEARCH

How diagnostic is grain testing for copper?



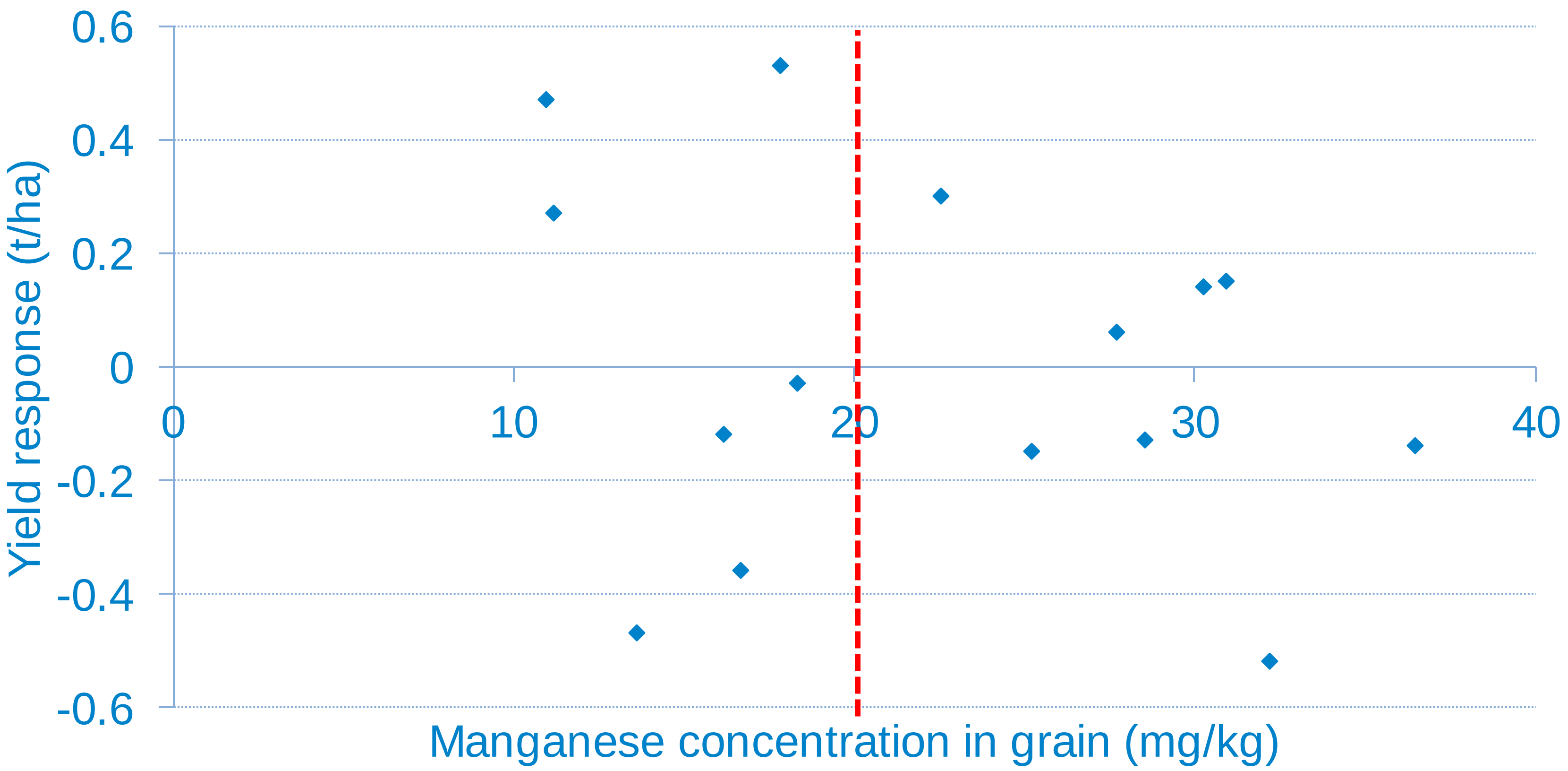
Threshold: Cu < 2 mg/kg in grain

How diagnostic is leaf tissue testing for manganese?



Threshold: Mn < 20 mg/kg in leaves

How diagnostic is grain testing for manganese?



Threshold: Mn < 20 mg/kg in grain

ROTHAMSTED RESEARCH

Comparison of winter wheat yield responses in Research Review No. 78 and PR518

Micronutrient	1st trials	All trials RR78 (resp/total)	Since 2005 RR78 (resp/total)	PR518 (resp/total)
Copper	1952	8/45	1/27	1/15
		18%	4%	7%
Manganese	1976	7/37	2/25	0/15
		19%	8%	0%
Zinc	2005	-	1/29	1/15
		-	3%	7%

Note: RR78 included many countries for Cu and Zn

ROTHAMSTED RESEARCH

Micronutrients in wheat

AHDB project report 518

1. Extractable Mn, Cu & Zn in soils have fallen a tiny amount in the last 30 years but not considered biologically significant
2. Leaf tissue analysis at GS30 resulted in six false recommendations for treatment for either Cu or Zn in 15 trials as well as missing the recommendation for the one Zn response
3. Our limited response data do not suggest that leaf analysis in spring is useful to predict yield responsiveness
4. Soil analysis identified correctly the two responses (one zinc, one copper) in 15 trials, but for 3 sites copper it wrongly recommended treatment
5. Grain analysis appeared to identify the two responses correctly (one zinc, one copper) in 15 trials

6. Cu may have had a fungicidal rather than a nutrient effect
7. Mn – no response, 9 false applications that did not affect yield
8. Grain analysis may be a useful indicator – ongoing discussion

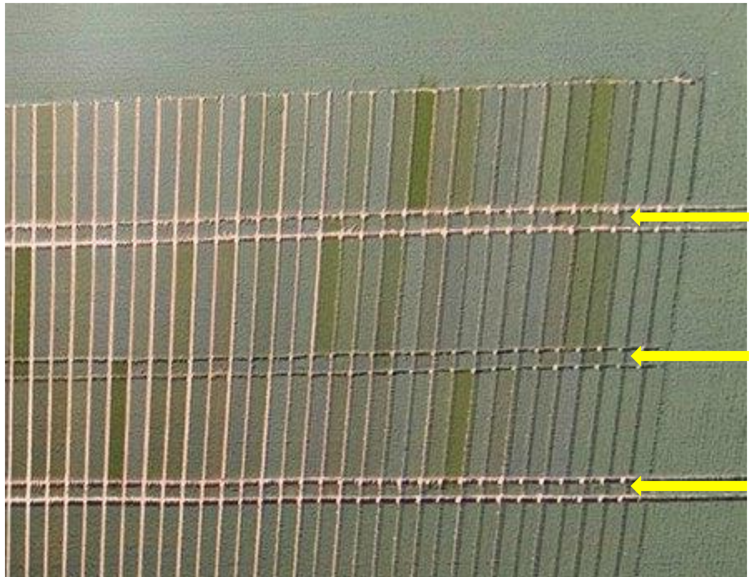
ROTHAMSTED RESEARCH

3) Looking forward – can we do things differently?

- How do we get more data?
- How can we improve threshold values?
- Under development
- Use tissue (leaf, grain) and soil testing
- Use conventional wet chem and new dry spectral methods

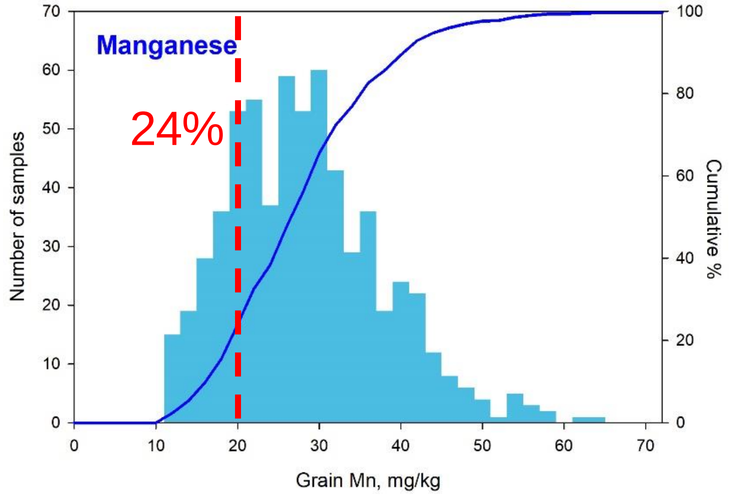
RL trials 2019

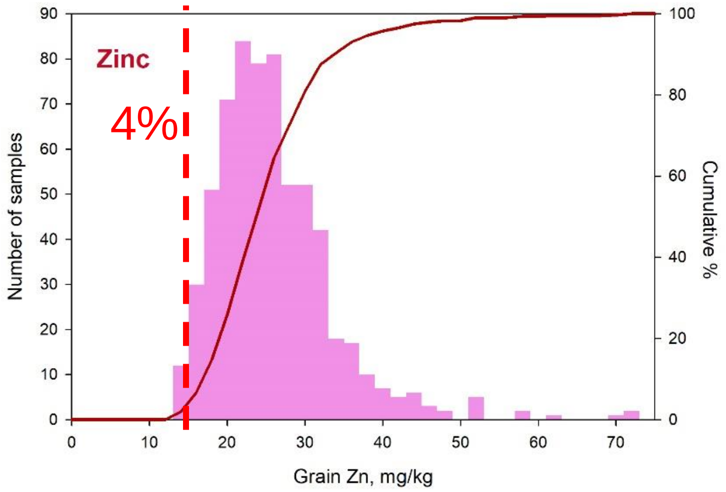
- 5 standard WW varieties
- Soil, leaf, straw and grain samples from 20 sites
- Sites chosen for their range of soils

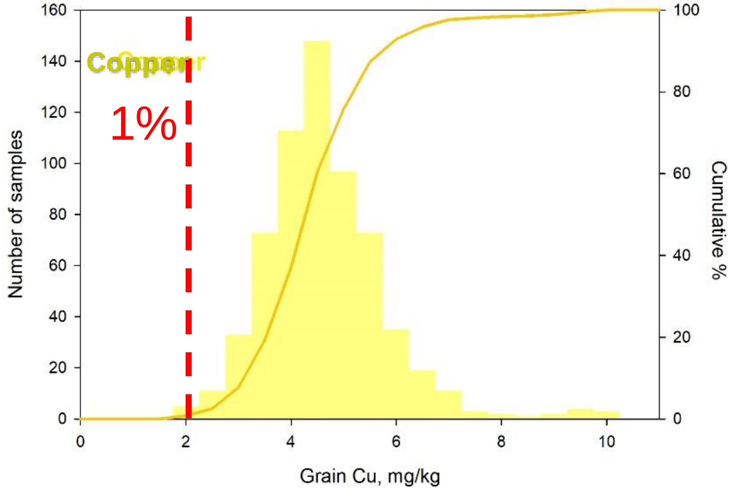


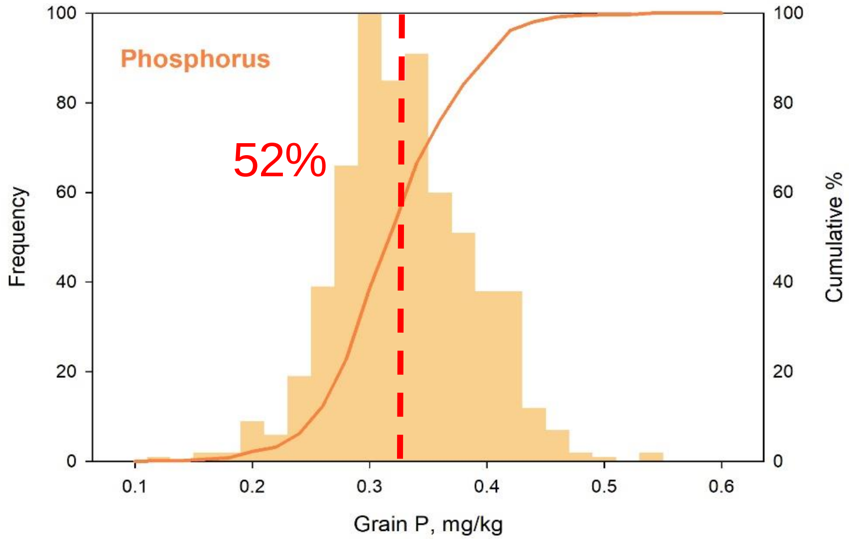
Grain nutrient benchmarking

Analyses of grain samples from 633 YEN^{+} crops after harvests 2016, 2017 & 2018







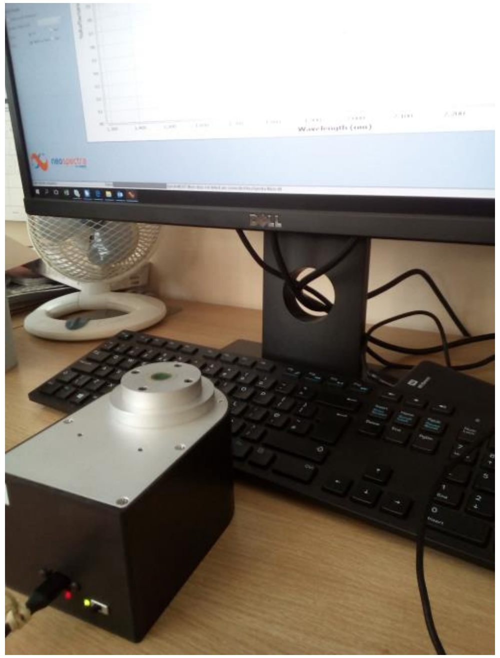


- Red pecked lines = threshold values
- Would crops below thresholds respond to fertiliser?
- Grain quality is another consideration – biofortification (Zn, Fe)

AHDB

Can we do things differently in future?

- Predicting those situations that will respond in yield to nutrient additions
- Benchmarking
- Diagnosis is usually done by wet chemistry
- Direct spectral signals from soils and plant tissues



ROTHAMSTED RESEARCH

Acknowledgements

- AHDB for funding, BBSRC for facilities
- [Ron Stobart], Jim Orson and colleagues, NIAB/TAG
- Mechteld Blake-Kalff, Hill Court Farm
- Roger Sylvester-Bradley and colleagues in ADAS

References

AHDB Report PR518. Current status of soils and responsiveness of wheat to micronutrient applications
AHDB Report PR570. Cost-effective phosphorus management on UK arable farms (Sustainable-P)
AHDB Research Review 78. A review of the non-NPKS nutrient requirements of UK cereals and oilseed rape
Fan et al., 2008. Journal of Trace Elements in Medicine and Biology, 22, 315–324.

A farmer’s journey

Steve Klenk, Garnstone Farms

CEREALS & OILSEEDS

WHO AM I??
WHY AM I HERE??

PLAN OF

THE GARNSTONE ESTATE

IN THE PARISHES OF

Weobley, Dilwyn, King's Pyon, Canon Pyon, Norton Canon,
Yazor, Sarnesfield & Wormsley,

HEREFORDSHIRE.

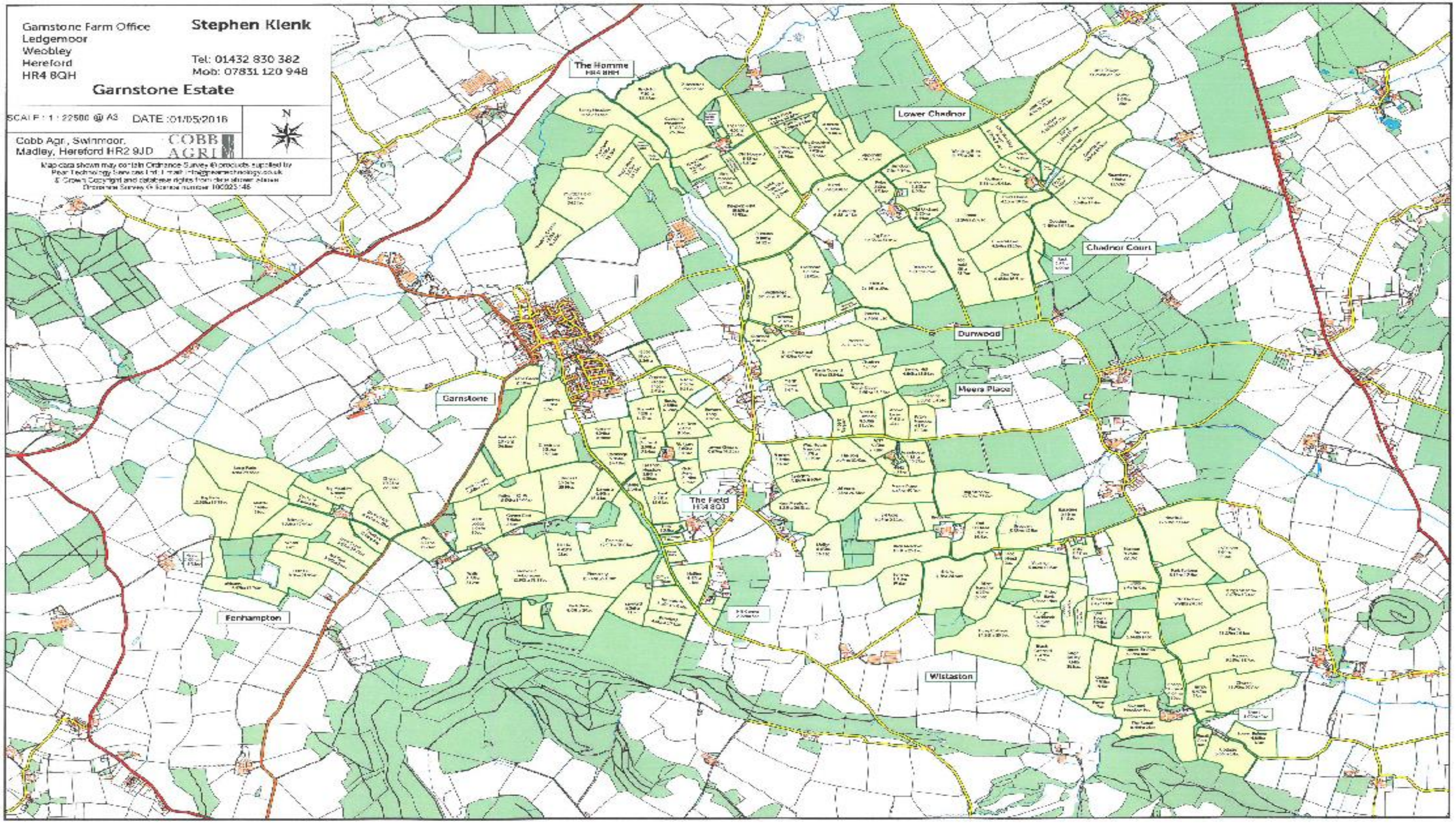
FOR SALE BY AUCTION BY

MESSRS. WALTON & LEE.

1887.

Garnstone Estate

- 2754 acres in hand
- 192 fields average size 14 acres
- Largest arable field 36 acres
- Smallest arable field 6 acres
- 500 acres woodland
- Approx 2100 acres in 8 long term tenancies
- Let houses and cottages



Garnstone Farm Office
Ledgemoor
Weobley
Hereford
HR4 8QH
Stephen Klenk
Tel: 01432 830 382
Mob: 07831 120 948
Garnstone Estate
SCALE : 1 : 22500 @ A3
DATE :01/05/2016
N
Cobb Agri, Swinmoor,
Madley, Hereford HR2 9JD
COBB AGRI
The Homme
HR4 8RH
Lower Chadnor
Chadnor Court
Dunwood
Meers Place
Garnstone
The Field
HR4 8QJ
Fenhampton
Wistaston

Cropping in hand land 2019 Harvest (acres)

Winter wheat 812

- OSR 320
- Maize 412
- Herbage seeds 260
- Whole crop cereals 140
- Clover for seed 25
- Fodder Beet 20
- Grass we graze 250
- Grass we let 250
- Orchard 80
- Traditional Orchard 25
- Stewardship areas 81
- Headland margins 45
- Let for currants 34
- Cover crops 352

Livestock

- Up to 700 beef cattle - Pedigree Herefords
- Single suckler Hereford X
- Bought in weaned calves mostly continental X

- Chicken Unit producing fertile eggs

- Anaerobic digester needing 35 to 45 tonnes per day of feed

Labour

- <u>Arable and general</u>
- 1 Sprayer operator
- 1 Drill man
- 1 tractor /combine driver
- Seasonal harvest
- 1 manager
- Average age 52

- <u>Livestock</u>
- 3 full time on cattle
- 4 – 5 on chickens

Machinery

"The answers to your soil problems are beneath your feet, not in the machinery shed."
The kit in the shed probably causes the problems.


NEW HOLLAND

Crop establishment

- Cereals – direct drilling
- OSR and herbage seed– scratch till, drill, roll x2
- Cover crops – broadcast seed, scratch till, roll if needed
- Maize – Low disturbance subsoiler, scratch till, precision drill

How and why did we get here?

How and why did we get here?

By Accident!!

A bit at a time!!


SN08
HBZ

“The soil is our past, our present and our future”


YX12 BLK
MASSEY FERGUSON
VÄDERSTAD
Carrier 500


DTS


WEAVING
WEAVING

Aims

- To produce healthy high yielding crops
- To reduce cost of production
- To improve work rates
- To improve sustainability of the business
- To improve soils resilience
- To lessen the reliance on “out of the bottle” solutions
- To reduce artificial inputs (by 50%) in five years
- (To create a better work life balance)

“The soil is our past, our present and our future”

- Where is the best soil on the farm?

- Middle of the field?
- Headland?
- Under the hedge?

What happens in a hedge?

- Soil never moved
- Always something growing
- Crop residue returned
- Variety of species
- Less or no fertilizer and ag chems
- Therefore
- Better friablity
- Better biology
- Better OM

Regen Ag Principles

- Limit Tillage
- Plants or crop residue on the soil surface
- Living roots in the soil
- Diverse crop rotations
- Multi species cover crops
- Integrate livestock

How to try to replicate a hedge in the middle of your field?

- Agro forestry
- Reduce cultivations
- Direct drilling
- Companion cropping
- Cover cropping
- Reduce ag chems and fertilizers
- Increase biology
- Return crop residue
- Add organic matter

Crimson clover in OSR

Crimson clover in OSR

Triticale and Oats

Spring Barley and Peas

Different varieties

Other options

- Maize with ryegrass
- Maize with Clover
- Wheat with Clover
- OSR with Vetch, Buckwheat, Lucerne, Beans
- OSR and Peas (Peola)

- Many others

Cover cropping Tillage radish

Our typical cover crop mixes

- Homegrown spring oats / spring barley 90kg
- Homegrown Peas 10kg
- Buckwheat 5kg
- Vetch 2.5kg
- Berseem clover 2.5kg
- Phacelia 3kg
- Crimson clover 2.5kg
- Linseed 5kg
- Seed £54.73 per Ha
- Establishment £39.53 per ha
- Total £94.26

Dry Matter Report

Customer: Stephen Klenk Garnstone Farm
Date: 27/09/2019
Field: Maize Cover Crop

	Results	Weight/ha
Nitrogen (N)	40.50	Kg
Sulphur (S)	5.79	Kg
Phosphorous (P)	9.35	Kg
Potassium (K)	76.33	Kg
Calcium (Ca)	38.72	Kg
Magnesium (Mg)	4.45	Kg
Sodium (Na)	0.00	Kg
Iron (Fe)	0.88	Kg
Manganese (Mn)	149.54	g
Copper (Cu)	13.13	g
Zinc (Zn)	70.76	g
Boron (B)	47.40	g
Molybdenum (Mo)	1.71	g

Total dry mass/ha (Kg):	2225

Edaphos Ltd
Old Farm Offices
Manor Farm
Ginge
Oxon. OX12 8QS

Tel: 01235 834997
Fax: 01235 833390
www.edaphos.co.uk

Value

- Nitrogen)
- Phosphorus)
- Potassium) 50 % of analysis £73.82
- Sulphur)
- Magnesium)

- Trace elements 50 % of analysis £12

- Grazing rent Based on 6 sheep per acre for 1 week £2.25

- TOTAL £88.07

Biological Improvements

- Higher worm counts, up to 35 per cubic foot =9.45 million per ha
- Greater water permeability
- Increasing Organic Matter
- Increased rooting depth - can cause issues
- Increased microbial activity
- Increased Fungal activity
- Quicker breakdown of crop residue
- Healthy crops
- Increased wildlife numbers and diversity

Potential savings

• Direct drilling v plough based	• Saves £83.32
• Home saved seed mixed varieties	• Saves £21
• No dressing applied to seed	• Saves £12.25
• No insecticide applications	• Saves £4.10
• Reduced Growth regulators	• Saves £12.50
• Reduced lime application	• Saves £12
• Reduced P and K	• Saves £85
• Reduced N	• Saves £38
• Reduced fungicide application	• Saves £69.67
• Increase in Trace Elements, Humic, Fulvic Mollasses and Biologicals	• Costs £55
• Balance	• £282.84

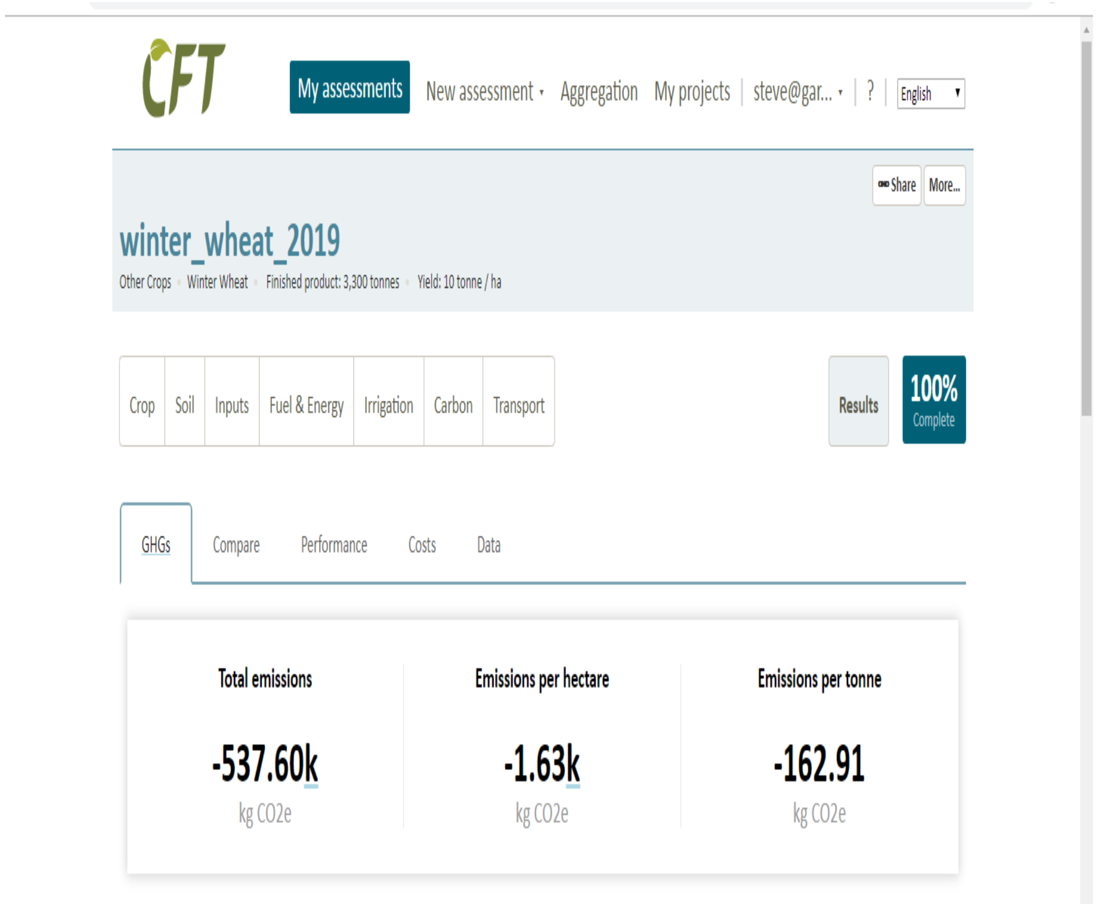
Issues

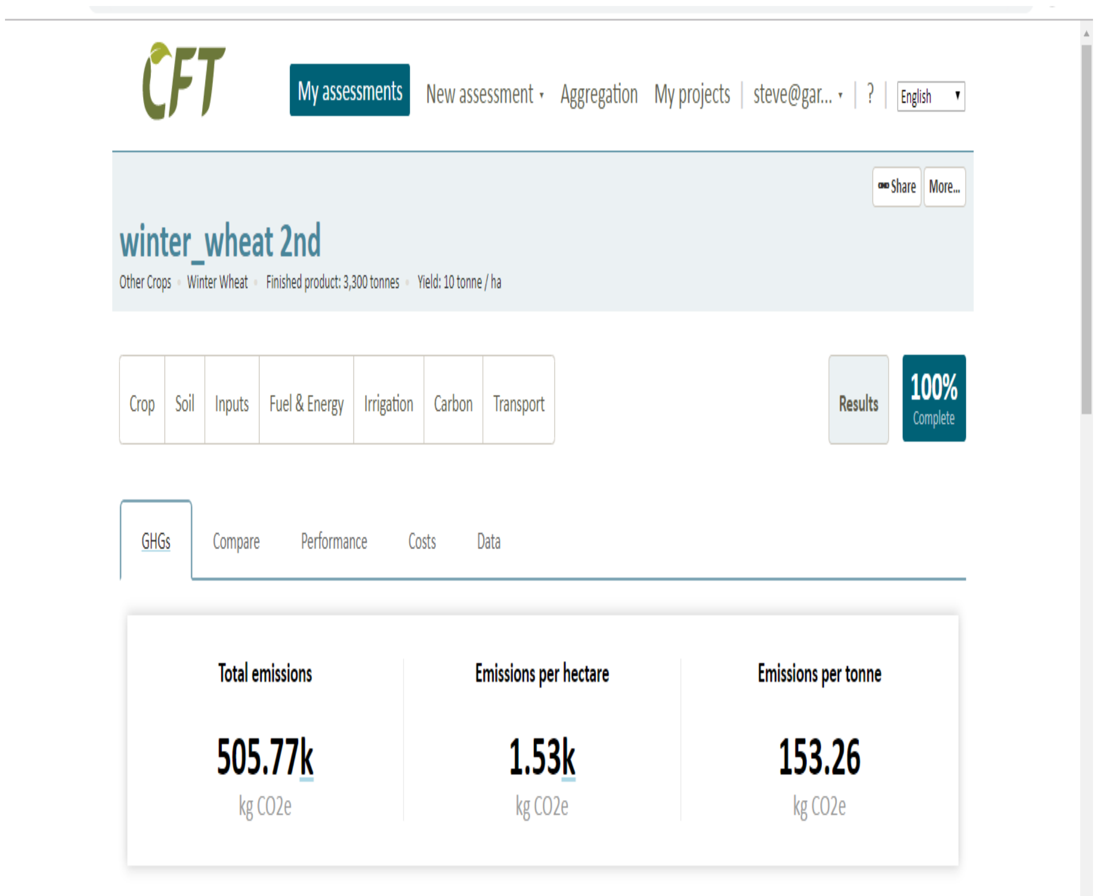
- Management
- Drains
- Trees
- Justifying labour
- Having patience

Opportunities

- Public good - ELMS
- Points system for reduced inputs?
- Points system for increased soil health?
- Carbon

CARBON


My assessments
New assessment
Aggregation
My projects
steve@gar...
?
English
Share
More...
winter_wheat_2019
Other Crops
Winter Wheat
Finished product: 3,300 tonnes
Yield: 10 tonne / ha
Crop
Soil
Inputs
Fuel & Energy
Irrigation
Carbon
Transport
Results
100%
Complete
GHGs
Compare
Performance
Costs
Data
Total emissions
-537.60k
kg CO2e
Emissions per hectare
-1.63k
kg CO2e
Emissions per tonne
-162.91
kg CO2e


My assessments
New assessment
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My projects
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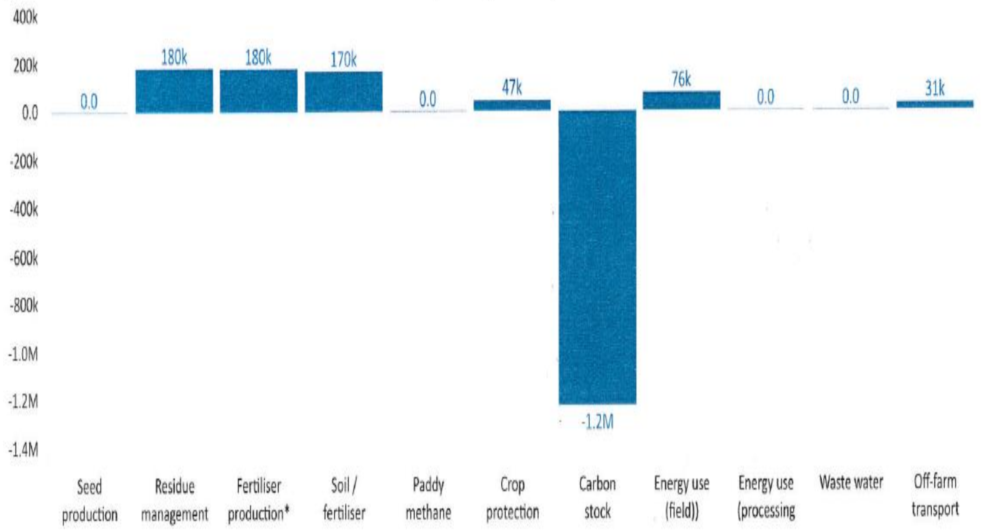
More...
winter_wheat 2nd
Other Crops
Winter Wheat
Finished product: 3,300 tonnes
Yield: 10 tonne / ha
Crop
Soil
Inputs
Fuel & Energy
Irrigation
Carbon
Transport
Results
100%
Complete
GHGs
Compare
Performance
Costs
Data
Total emissions
505.77k
kg CO2e
Emissions per hectare
1.53k
kg CO2e
Emissions per tonne
153.26
kg CO2e

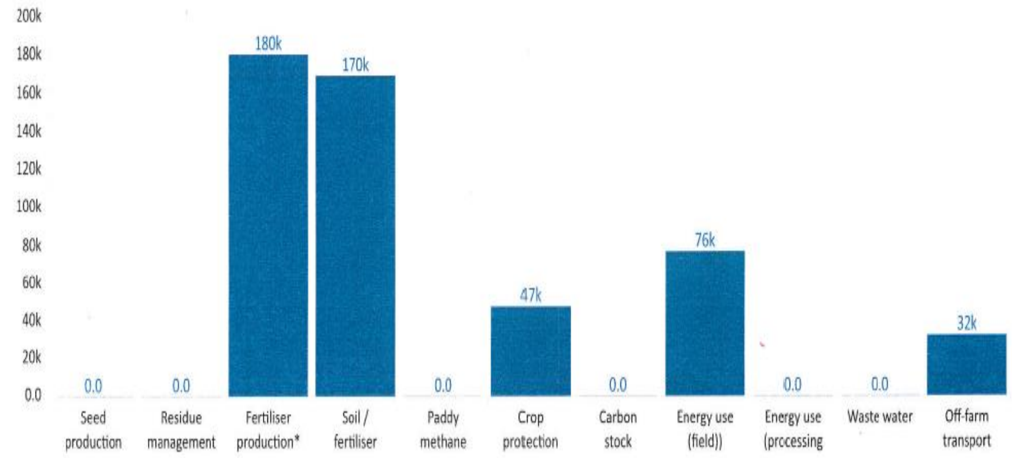


Detailed data (all values in kg)

Hide data

Sources	CO_2	N_2O	CH_4	Total CO_2 eq	Per ha	Per tonne
Seed production	0	0	0	0	0	0
Residue management	0	616.43	0	183.70k	556.66	55.67
Fertiliser production*	180.59k	0	0	180.59k	547.25	54.72
Soil / fertiliser	0	568.08	0	169.29k	512.99	51.30
Paddy methane	0	0	0	0	0	0
Crop protection	47.35k	0	0	47.35k	143.50	14.35
Carbon stock changes	-1.23M	0	0	-1.23M	-3.71k	-371.36
Energy use (field))	76.43k	0	0	76.43k	231.59	23.16
Energy use (processing))	0	0	0	0	0	0
Waste water	0	0	0	0	0	0
Off-farm transport	30.53k	0	0	30.53k	92.53	9.25

6/26/2019 Crop Product (GHG results) - Cool Farm Tool



Detailed data (all values in kg)

Hide data

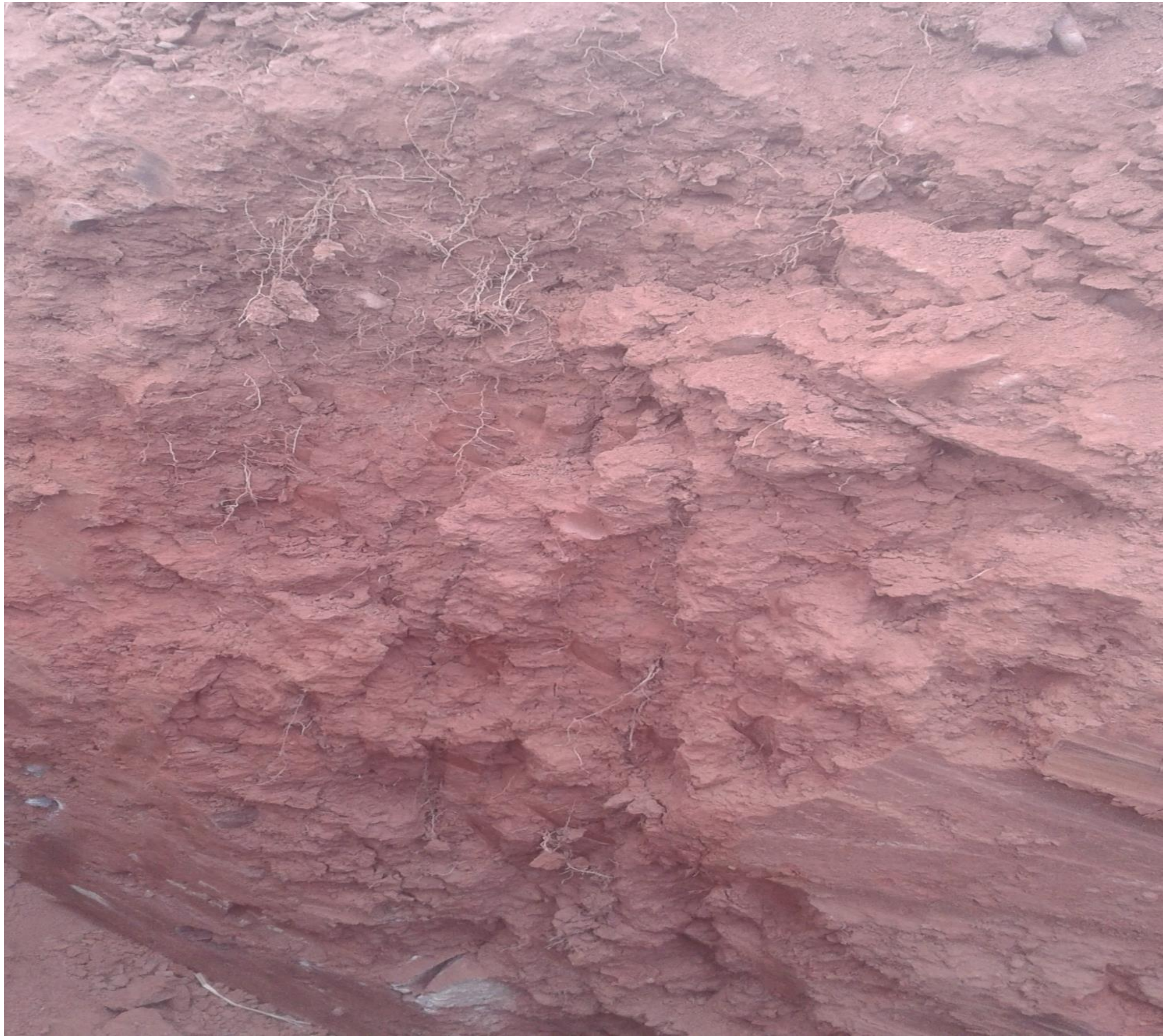
Sources	CO_2	N_2O	CH_4	Total CO_2 eq	Per ha	Per tonne
Seed production	0	0	0	0	0	0
Residue management	0	0	0	0	0	0
Fertiliser production*	180.59k	0	0	180.59k	547.25	54.72
Soil / fertiliser	0	568.08	0	169.29k	512.99	51.30
Paddy methane	0	0	0	0	0	0
Crop protection	47.35k	0	0	47.35k	143.50	14.35
Carbon stock changes	0	0	0	0	0	0
Energy use (field))	76.43k	0	0	76.43k	231.59	23.16
Energy use (processing))	0	0	0	0	0	0
Waste water	0	0	0	0	0	0
Off-farm transport	32.11k	0	0	32.11k	97.29	9.73

** Calculated with validated default values for fertiliser production.*

Assume 0.1% increase in organic matter on a standard bulk density soil.

That equals 8.39 tonnes per Ha of Co2 sequestered.

At todays euro carbon trading price that would be between £63.76 and £100.68 per ha.



Thank you

POTATOES

Refreshment break

Potential for biopesticides / bioprotectants in field crops

Dave Chandler, Warwick Crop Centre

POTATOES

Potential for biopesticides / bioprotectants in field crops

Dave Chandler

Warwick Crop Centre

AMBER team

University of Warwick.

ADAS Boxworth

Silsoe Spray Applications Unit

Rationale Biopesticides Strategists

Rob Jacobson Consultancy

Radical change needed to global agriculture.

- Global agriculture: homogenous & highly connected.
- A major producer of greenhouse gases. Vulnerable to climate heating.
- Loss of natural habitats to monocultures.
- Loss of ecosystem services, replaced by artificial inputs.
- Shift in power & agency from farmers to corporations.

Not UK btw!

Nystrom et al., *Nature* (575), 7 November 2019;
Bahadur et al. (2018), PLOS ONE 0205683

A new farming revolution?

The EAT Lancet strategies

- **From quantity to quality.**
- **Sustainable intensification**:
  - Reduce yield gaps, fertilizer & water use efficiency, enhance biodiversity in ag. systems.
  - Make agriculture a net carbon sink.
  - **Halve food losses and waste**.

Sustainability: agriculture is the solution, not the problem

Where does crop protection fit in?

- Pests (invertebrates, pathogens, weeds): a major constraint on quality production.
- Climate heating will make things more challenging.
- Over-reliance on synthetic chemical pesticides.
- Need a more sustainable system.

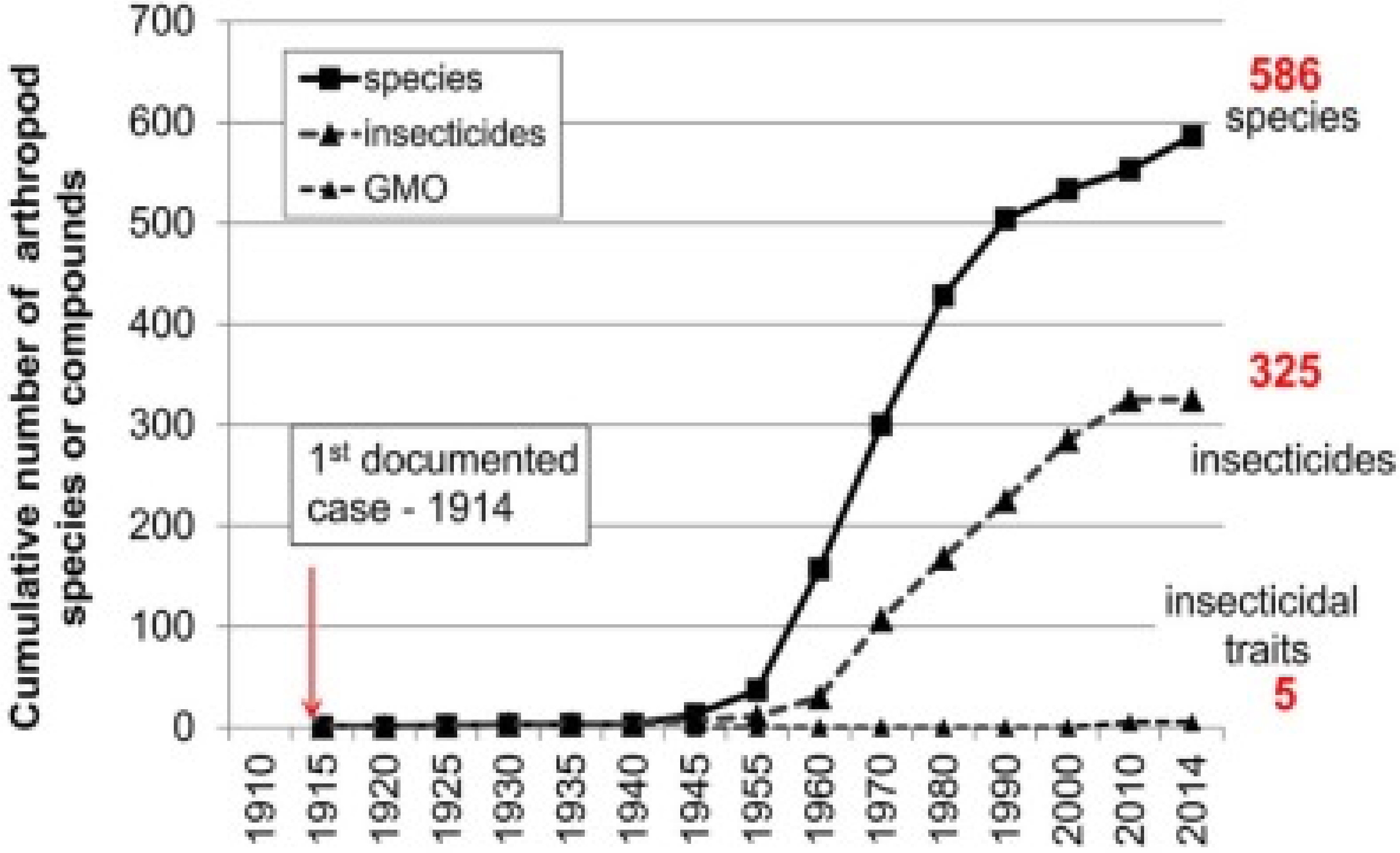


Unsustainable use of synthetic chemical pesticides

The 1960s Green Revolution:
'Top down' use of synthetic
chemical pesticides – industrialised farming

- Evolution of resistance
- Environmental damage
- Health concerns

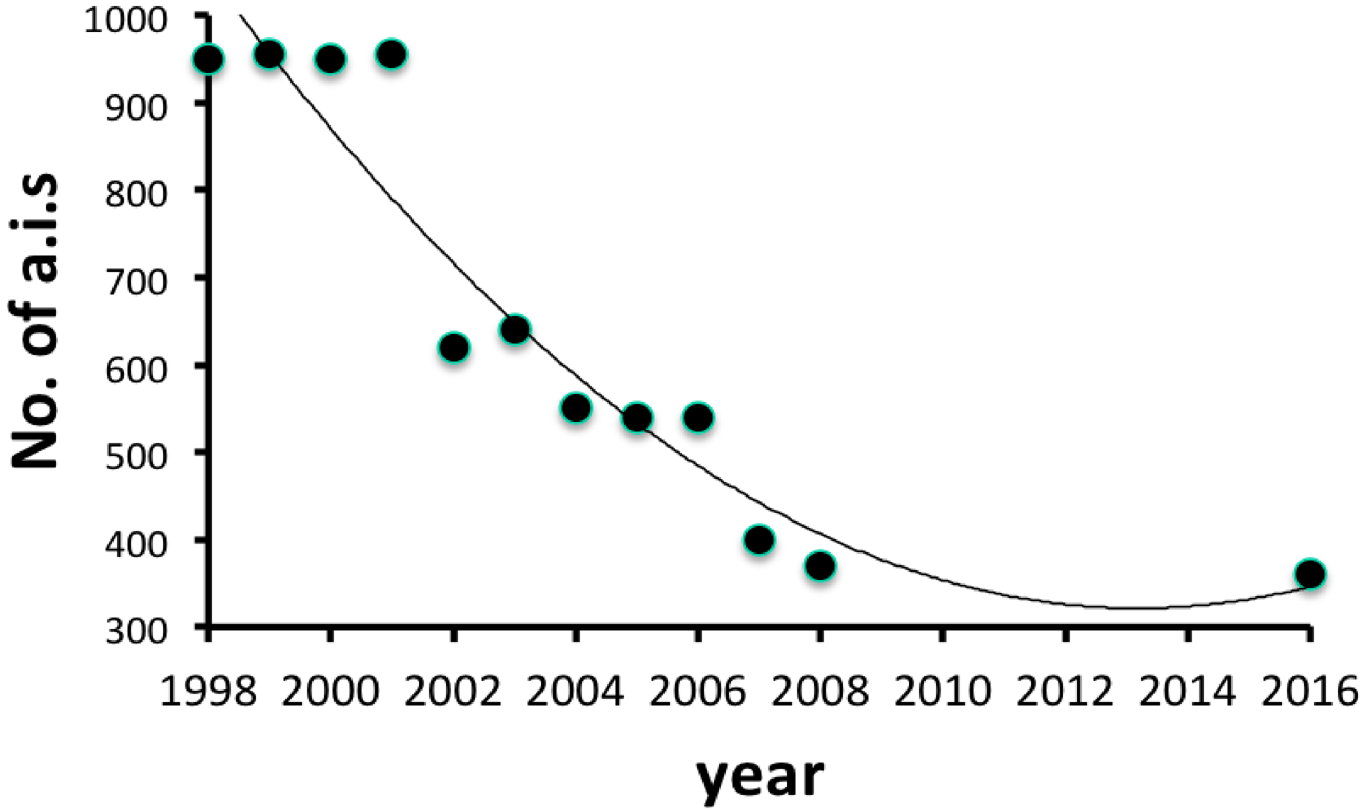
Reduction in availability:
- Products stop working.
- Government restrictions.
- Retailer restrictions.
- Pesticides – precious resource.



Cumulative increase in (a) the number of species resistant to one or more insecticides, (b) number of insecticides for which one or more species has shown resistance, and (c) number of GMO traits for which resistance has been reported.

Sparks & Nauen (2015). IRAC: Mode of action classification and insecticide resistance management. Pesticide Biochemistry and Physiology, 121, 122-128.

The number of synthetic chemical pesticides available is declining.



Conventional pesticides approved in EU

- Costs c. £200M & 10 years to develop a new conventional pesticide. Few new actives in the pipeline.
- European Parliament calls for mandatory reduction targets for the revised Pesticides Directive (resolution passed 18.12.19).

Field crops: P&D becoming 'more challenging'

aphids

weeds

slugs

flea beetle

septoria

powdery mildew

moth pests

Soil borne pathogens

Netherlands ‘2030 plant protection vision’ strategy document

We need
this too!

Integrated Pest Management (IPM): the way forward for all growers

- Integrated Pest Management (IPM) is an ecosystem approach to crop production and protection that combines different management strategies and practices to grow healthy crops and minimize the use of pesticides (UN FAO).

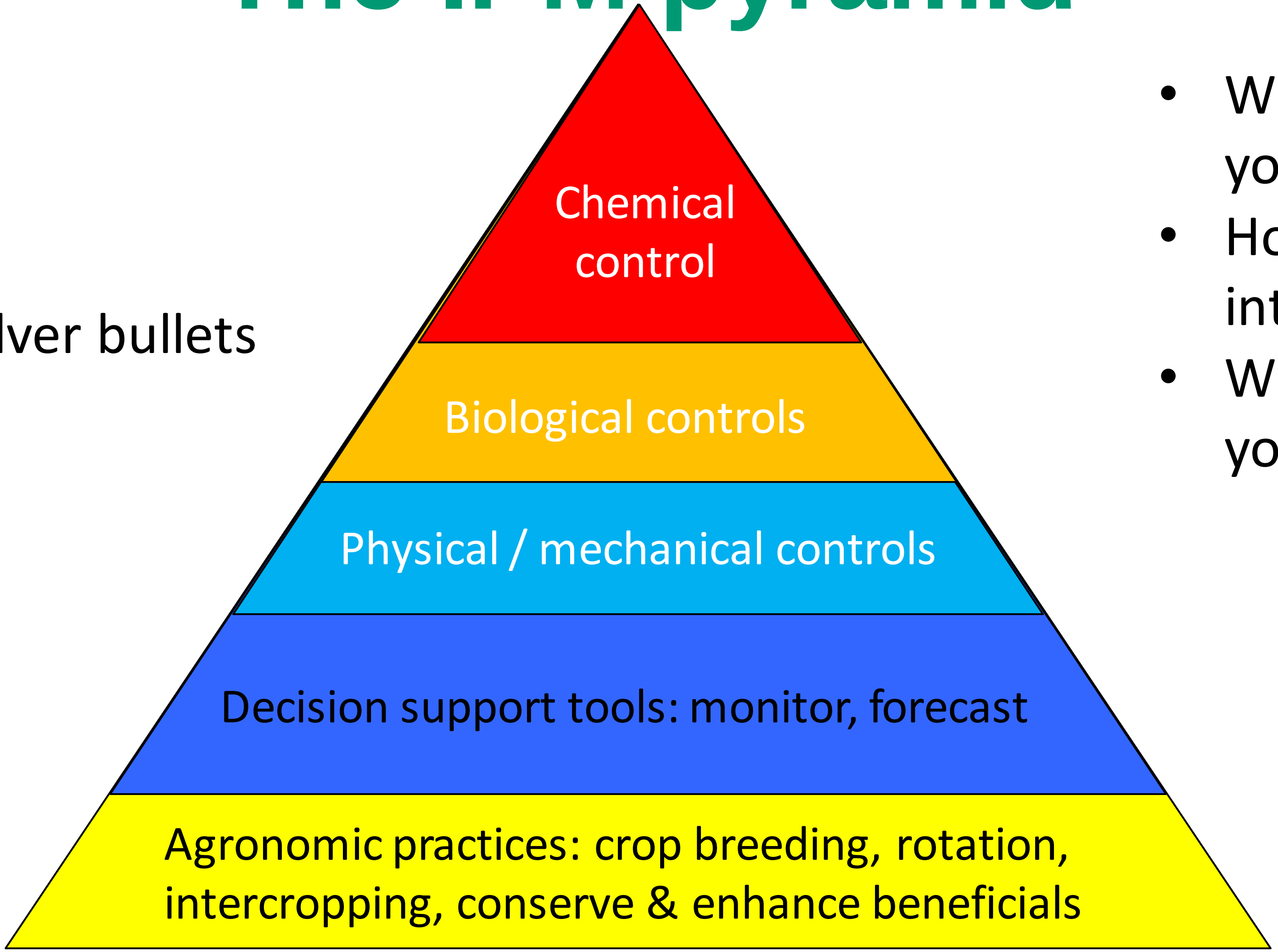
IPM – the Sustainable Use Directive

- IPM is mandatory under EU law
- Growers should adhere to core principles set out in the Directive (prevention, monitoring, treatment, checking effectiveness).
- Each country has a National Action Plan.

The SUD: sustainable pest management

- Sustainable **biological, physical and other non-chemical methods** must be preferred to chemical methods if they provide satisfactory pest control.
- Pesticides applied shall be as **specific as possible** … and shall have the least side effects on human health, non-target organisms and the environment.
- Where the risk of resistance against a plant protection measure is known … **anti-resistance strategies** should be applied to maintain the effectiveness of the products.

The IPM pyramid



Few silver bullets

- Which of these are you already using?
- How well are they integrated?
- What new tools do you need?

Biopesticides / Bioprotectants

- Biological plant protection tools to help manage pests*.
- Living microbes, semiochemicals, plant extracts & other natural products.
- Originate from nature, or are nature-identical when synthesized. Formulated & packaged.
- Low impact on human health & environment.
- Varied modes of action.
  - Some may not directly kill the target (e.g. preventative biofungicides).
  - Hence term "**bioprotectant**" is now preferred by EU, IBMA.

New substances coming on stream

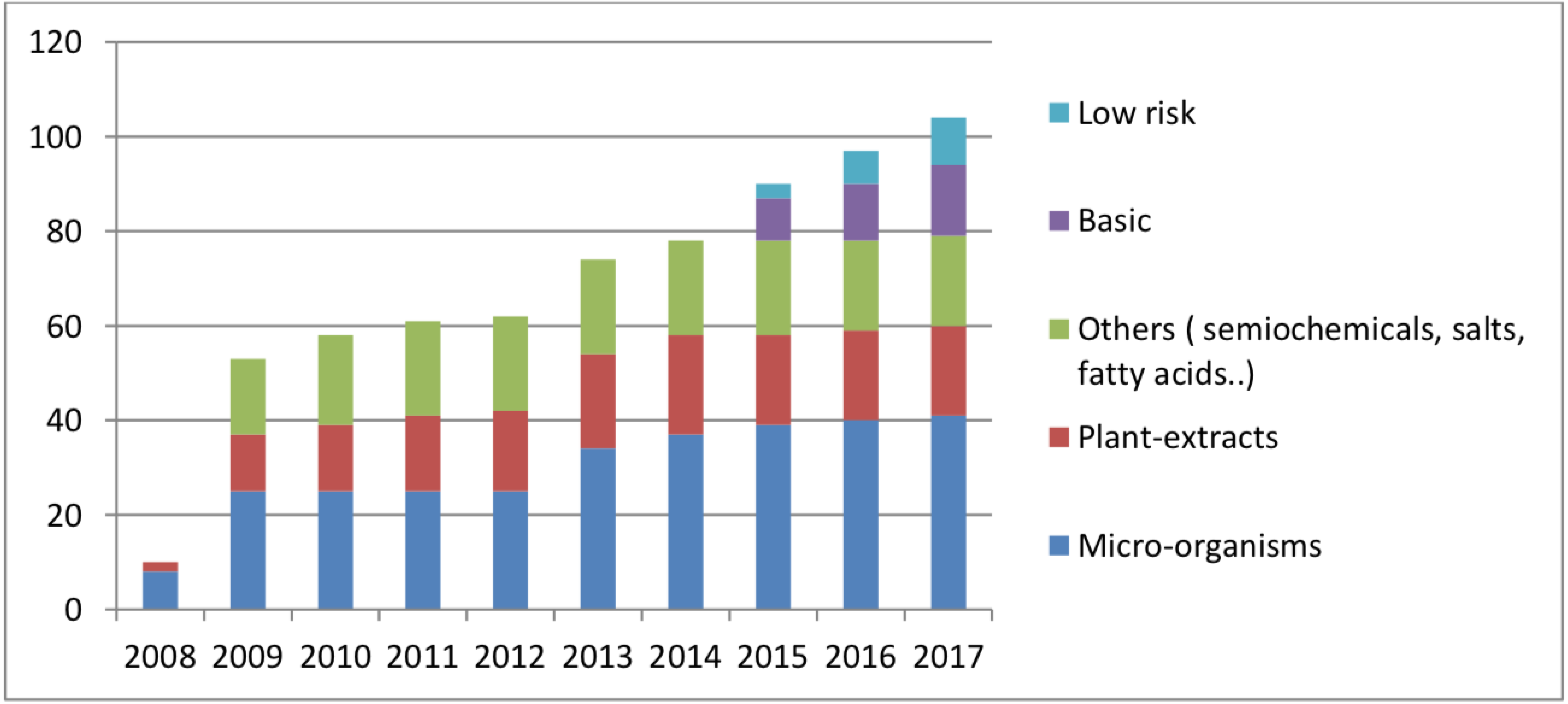
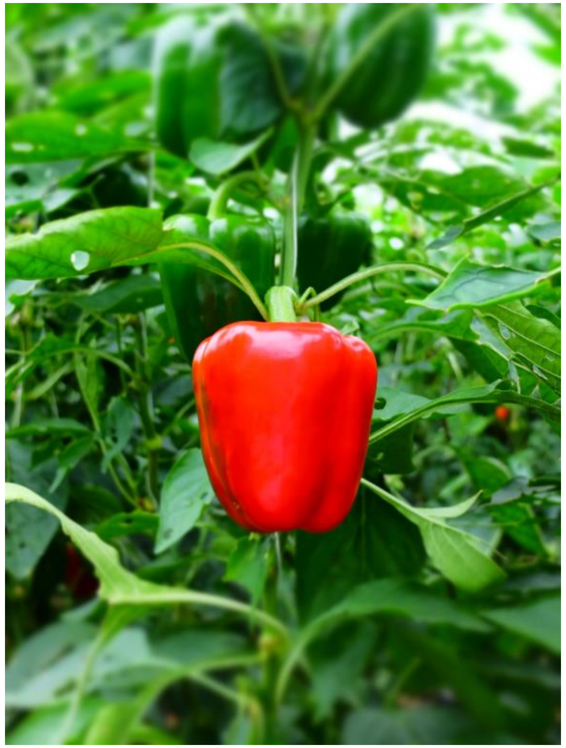


Figure 2: Increase in numbers of alternative substances approved by the EU

European Commission 2017

Protected crops & orchards



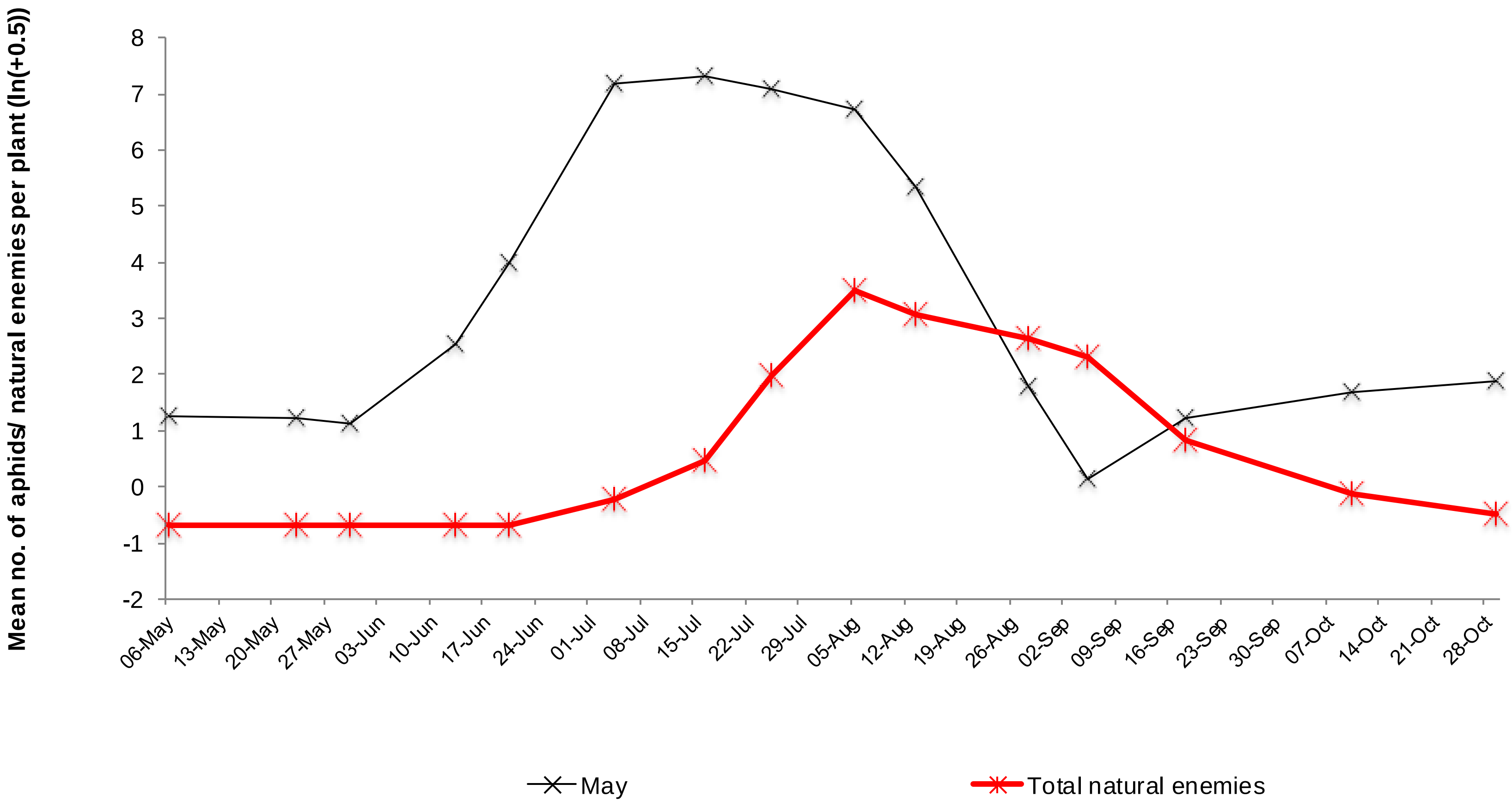
Why should we be considering them for field crops?

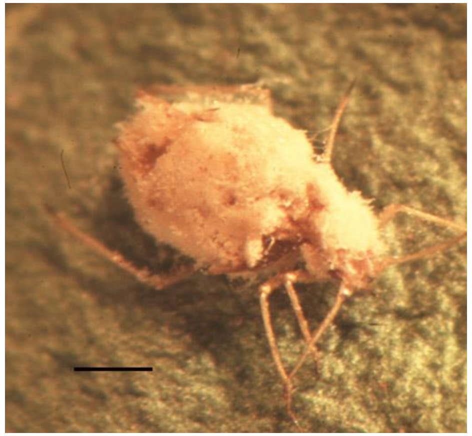
- Number of products increasing while conventional pesticides decreasing.
- They are not silver bullets but they have attractive properties for IPM, human safety & the environment.
- An opportunity: how can we get the best out of it?

IPM in field crops: challenges & opportunities

- Outdoor environment (weather, climate).
- Not enough new plant protection products.
- Integration can be complex.
- Cost of bio-based protectants.
- Improve biodiversity & soils.
- Exploit beneficials.
- Cultural control options at different scales.
- Manage pesticide resistance.

Bioprotectants give natural control – they are already out there!



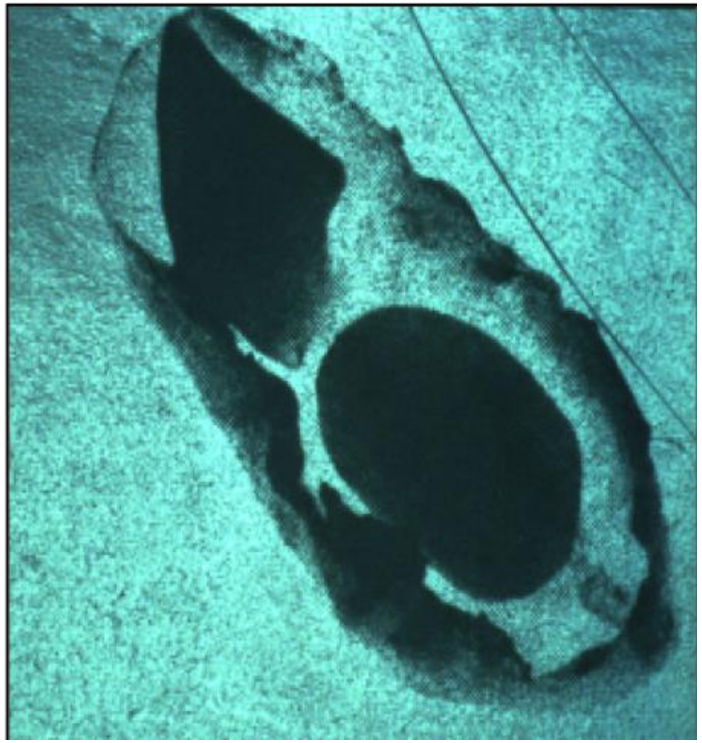


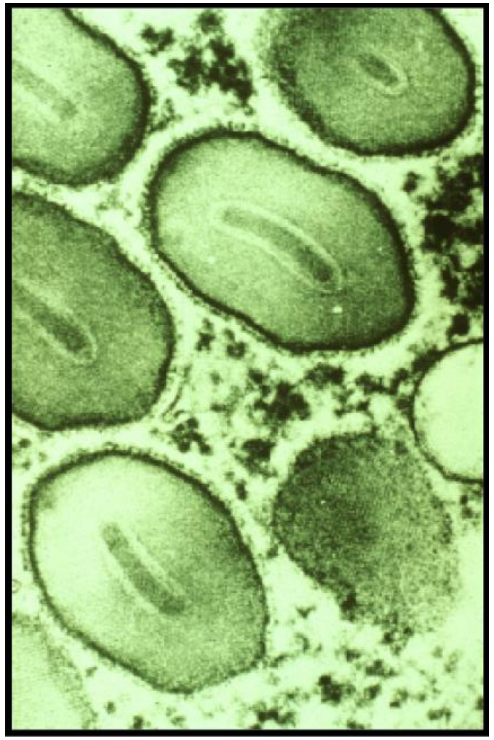
Aphid population dynamics on sequentially planted Brussels sprouts and associated guild of natural enemies

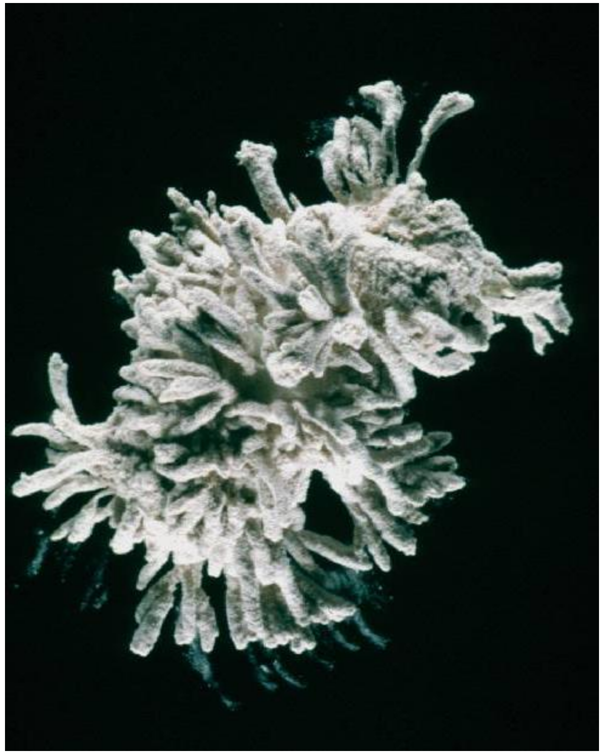
Let’s look at 3 types of bioprotectant

- Microbial control agents of insect pests (insect pathogens).
- Microbial control agents of plant pathogens.
- Semiochemicals – insect pheromones.

Insect pathogenic microbes







Biofungicides – preventative vs curative

Preventatives for Botrytis (but note MoA).

- *Bacillus amyloliquefaciens* QST 713 (Serenade): extracellular lipopeptides
- *Gliocladium catenulatum* J1446 (Prestop): colonizes plant surfaces, hyperparasite.

Curative for powdery mildew

- *Ampelomyces quisqualis AQ10* - mycoparasite

Lallemand plant care

BASF Mating behaviour disruption pheromone against codling moth and leafrollers (RAK 3+4)

Other products & manufacturers are available!

- one ampoule contains codling pheromone, the other contains tortrix pheromone. Gives 90 – 99% control depending on target species.

Increasing range of pheromones available

- Russell IPM – Europe's biggest producer.
- Pheromones for > 40 insect pest species.
- Leek moth, turnip moth, cutworm, diamondback moth

Russell IPM
INTEGRATED PEST MANAGEMENT

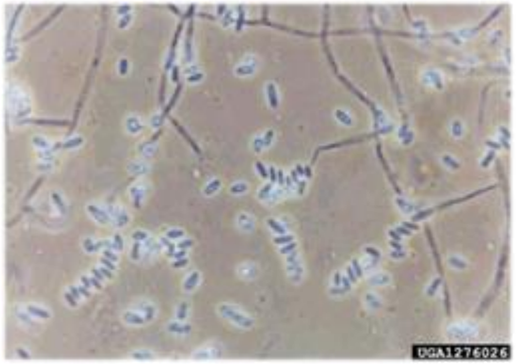
- Human & environmental safety.
- EU approval inc. efficacy.
- Compatible with the IPM pyramid.
- Not silver bullets. Lower potency, some are slow acting.
- Many are contact acting.
- Less forgiving:
  - Good knowledge. Attention to detail.
  - Environmental conditions.

The challenge: capture their benefits & mitigate for their downsides.

Can they work in the field?

Proof of potential

- Lab & field experiments with Botanigard (*Beauveria bassiana*).
- Reduced cabbage aphid by 70%.
- Lettuce aphid by 80%.
- No effect on peach potato aphid.



insects

MDPI

Article

Susceptibility of *Myzus persicae*, *Brevicoryne brassicae* and *Nasonovia ribisnigri* to Fungal Biopesticides in Laboratory and Field Experiments

Gill Prince and Dave Chandler *

Warwick Crop Centre, School of Life Sciences, University of Warwick, Wellesbourne, Warwick CV35 9EF, UK; g.prince@warwick.ac.uk

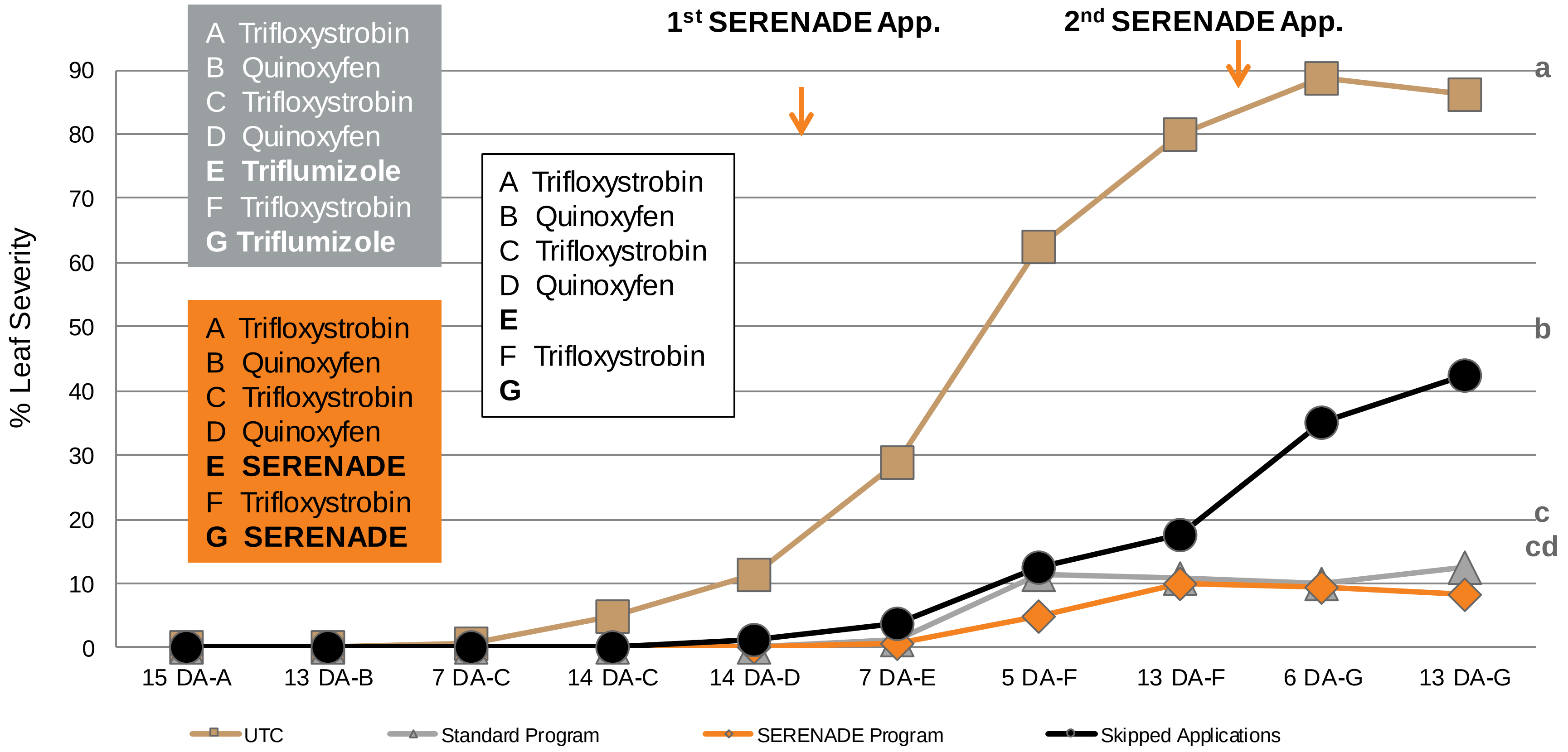
* Correspondence: dave.chandler@warwick.ac.uk; Tel.: +44-2476-575-2041

Received: 30 December 2019; Accepted: 15 January 2020; Published: 17 January 2020

check for updates

Grapes: Integrated powdery mildew control using *Bacillus amyloliquefaciens*(Serenade)

Disease control in grapes comparing an integrated program to a chemical program



Fischer, Columbia Ag Research, Hood River, OR – 2010..

Combining microbials can improve pest control: fungus (*Beauveria bassiana*) and microbial Bt against Colorado potato beetle

Fungus infectious in lab.

Inadequate in field

Bt = some control in field.

Expensive.

FIELD EXPERIMENTS

Fungus: c. 0%

Bt: c. 50%

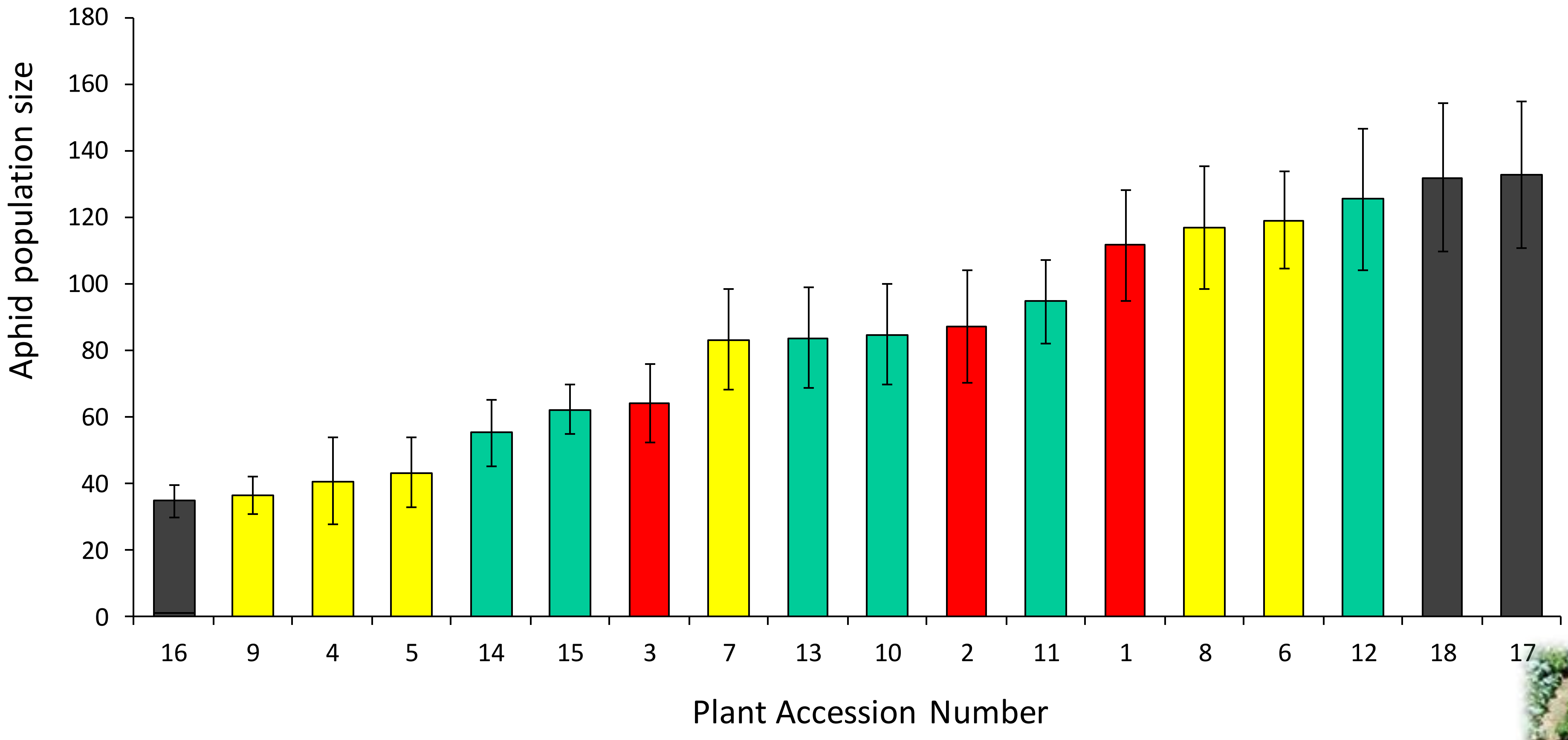
Combined:85%

- Bt prolongs inter-moult period?

- Bt causes starvation?

Wraight & Ramos (2005). J. Invert. Path., 90, 139 – 150.

Integrated control: An IPM system for aphids on Brassica: combining durable crop resistance with biocontrol



BBSRC SARIC: Warwick, Keele, Harper Adams, Durham, ADAS

Bioprotectant strategies must combine: understanding, utility, attention to detail

The AMBER project

- **A**pplication & **M**anagement of **B**iopesticides for **E**fficacy and **R**eliability.
- PE, PO & HNS crops.
- Identify the reasons why biopesticides can be inconsistent.
- Develop management tools and practices that can improve performance.

AHDB
AGRICULTURE & HORTICULTURE DEVELOPMENT BOARD

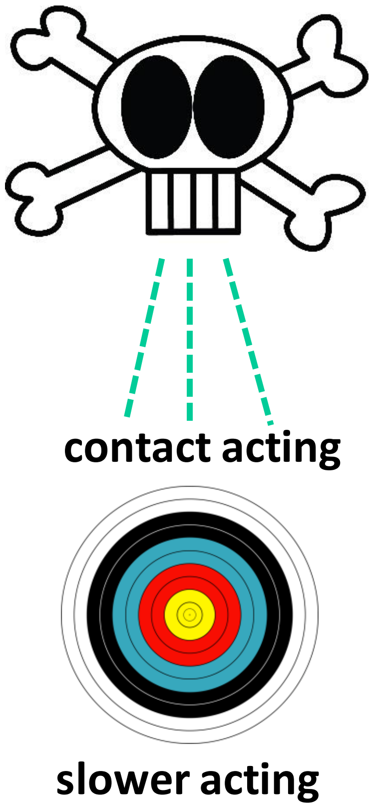
Working in 4 areas

- Making spray application more efficient: relationship between water volume and % of spray retained on crop.
- Biofungicide performance: biofungicide persistence to improve timing of application. Integration with decision support system.
- Bioinsecticide performance: how pest population growth rates influence biopesticide application strategy.
- Knowledge exchange.

Biopesticides: Good application is critical

Effective dose

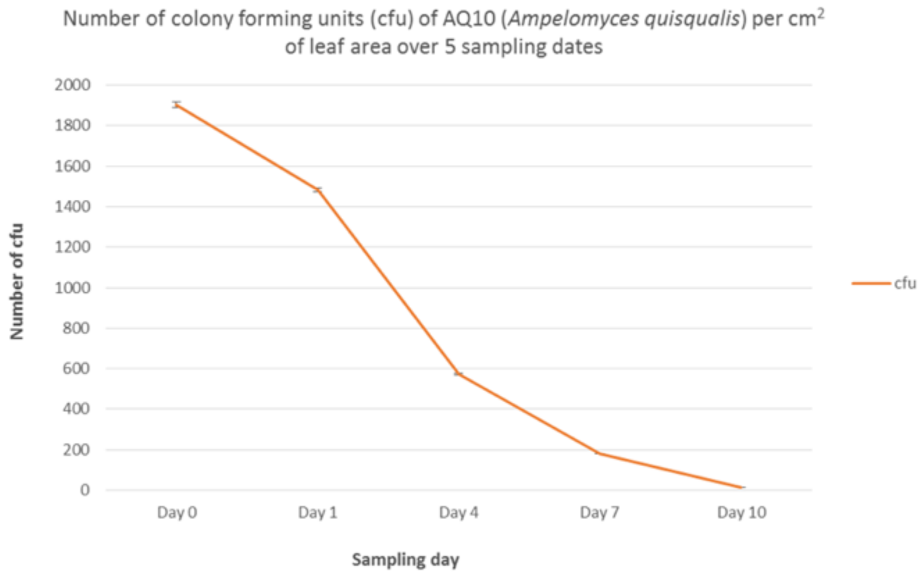
Right place & time



Avoid waste

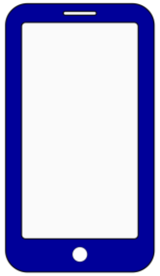
Biology of pest / disease: informs use strategy in IPM

Environment; other IPM tools



Powdery mildew control: Persistence of biofungicide AQ10 on foliage

Apply AQ10

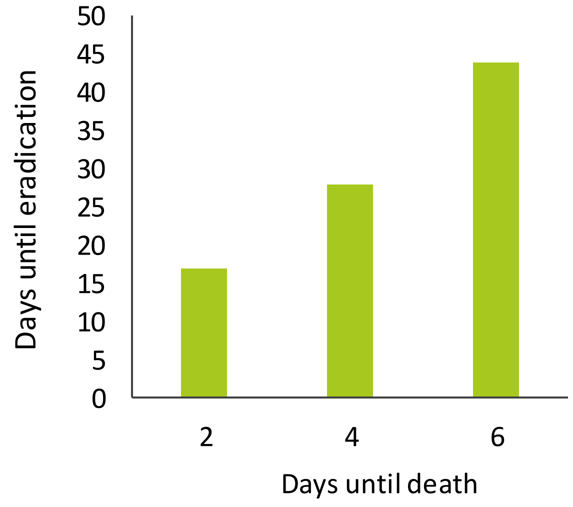


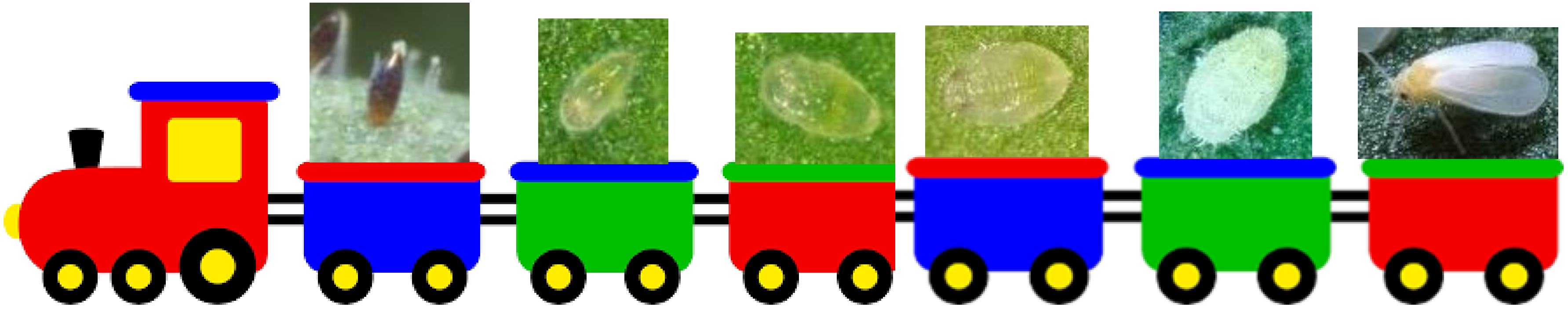
Temp. ‘spikes’.

On line sensor (30 MHz, Fargro)

Boxcar model of pest development: informs biopesticide use strategy in IPM

- Tracks maturation of individuals.
- Simulates applications of biopesticides and control efficacy – important for when kill is not instantaneous (persistence, mortality, speed of kill, frequency).

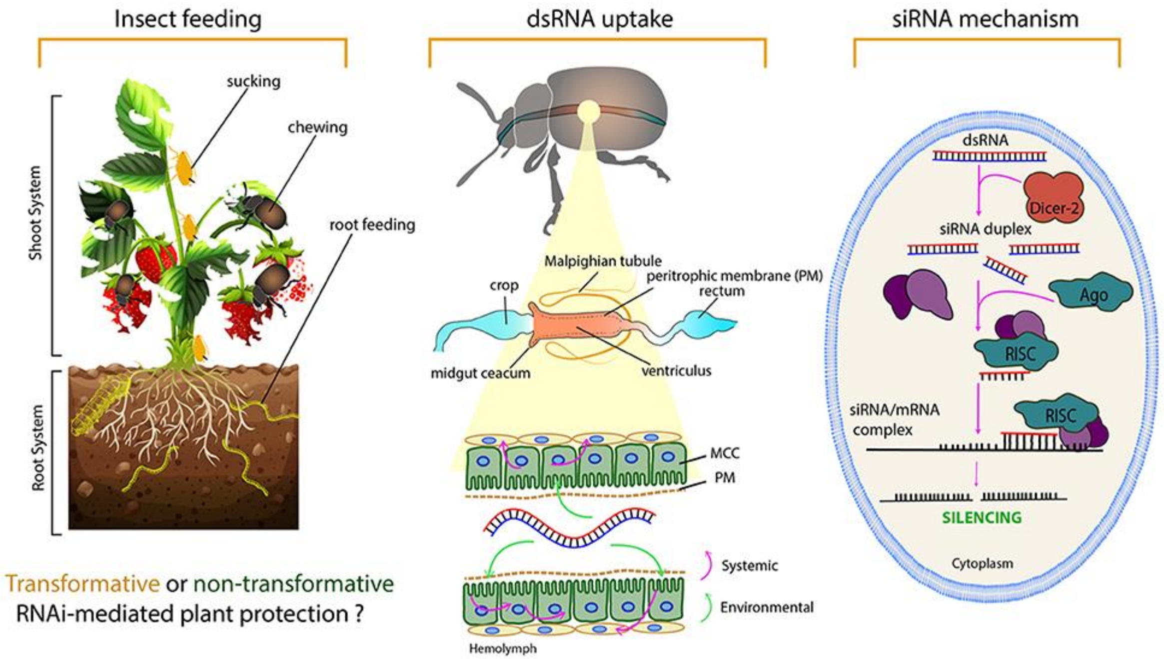




The future: new biologically based products

- Microbes + metabolites:
  - Grandevo (Marrone): *Chromobacterium subtsugae* – whitefly, mites, caterpillars.
  - Requiem (Bayer) - terpenes

- RNAi mediated silencing of gene expression:
  - Exogenous dsRNA



Frontiers in Physiology, 7, 553

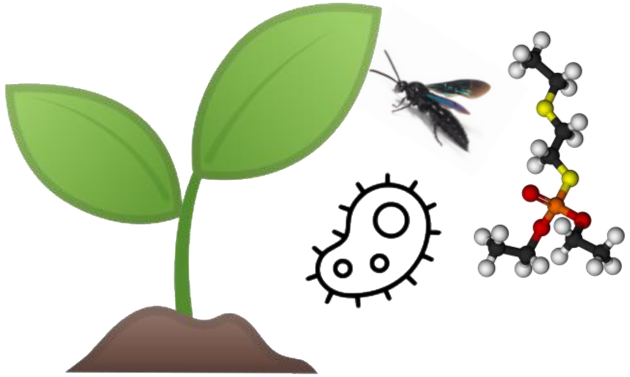
Naio technologies

Hummingbird Tech

30MHz

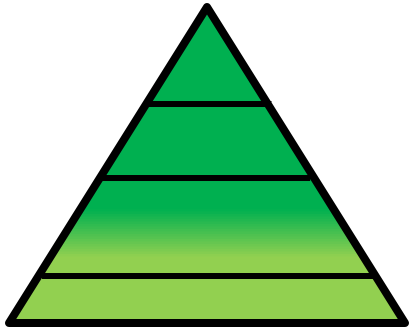
Innok robotics

Future IPM: new technology & understanding



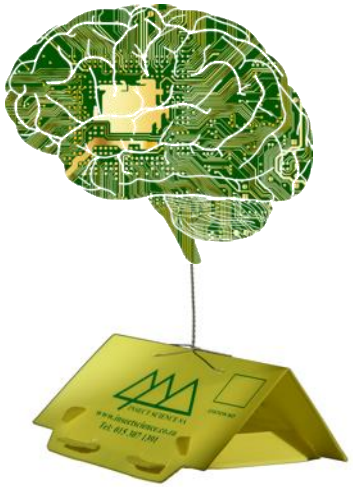
'Bio'-crop protection

Precision farming
(sensing; spraying)



IPM pyramid

Decision
support



Moving forward

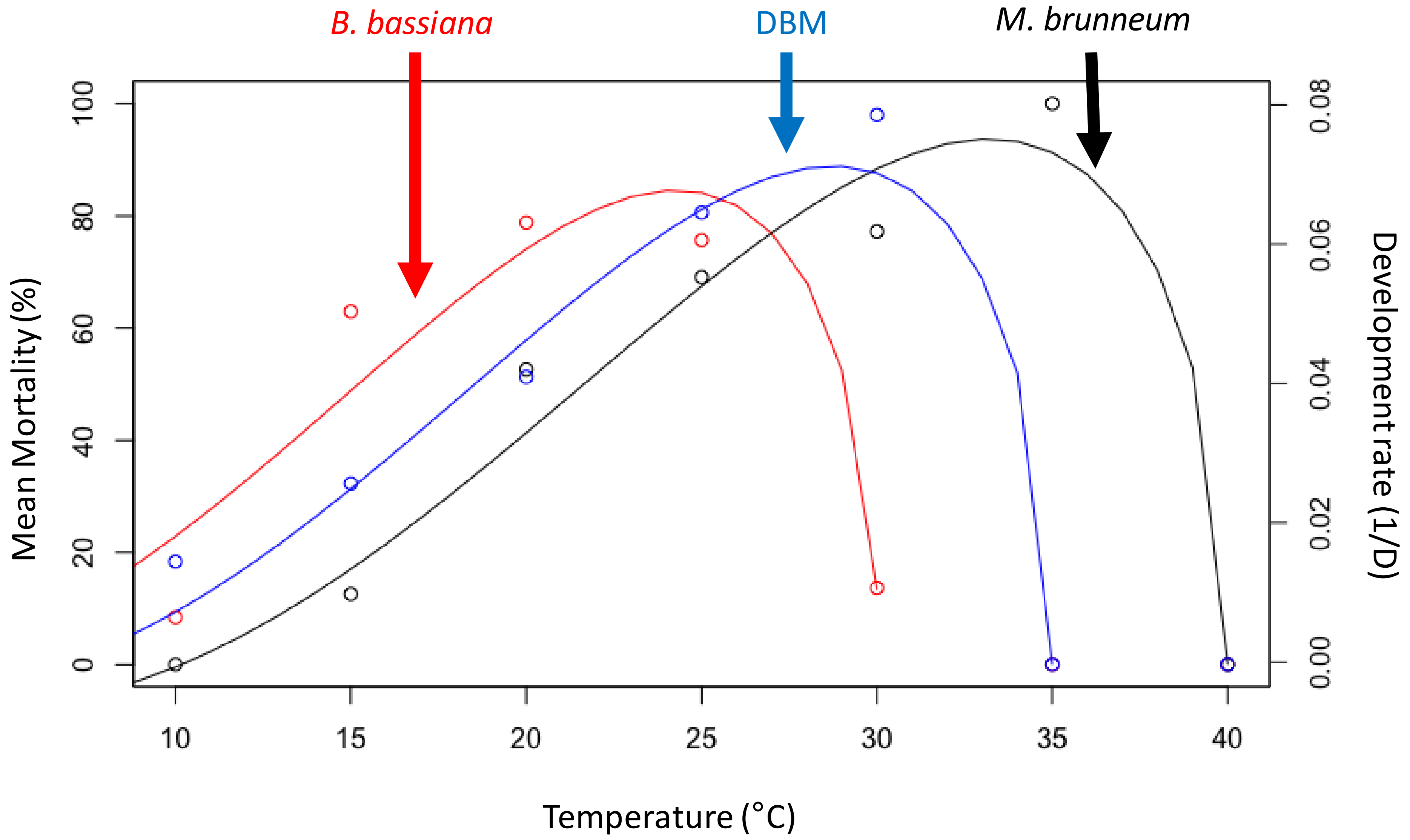
- Transition to full IPM: more biopesticides will be used.
- We need a crop protection 'road map' based around IPM.
- Growers, industry, research, government working together.
- Start of the journey – but business as usual is not an option.


AMBER
Thankyou
Google ‘amber biopesticides’
AHDB
AGRICULTURE & HORTICULTURE DEVELOPMENT BOARD

Commercial bioprotectants for field vegetables

Invertebrate pests	Plant diseases	Weeds
Microbial control agents: Bt Fungi (*Beauveria*, *Metarhizium*) Baculovirus (e.g. diamondback moth)	Microbial control agents Bacteria (*Bacillus* spp.) Fungi (*Trichoderma*, *Gliocladium*, *Ampelomyces*).	
Pheromones		
Botanicals Neem Terpenes (coming soon)	Botanicals Garlic extract Laminarin	Botanicals Pelargonic acid
Microbial metabolites (next 5 years)		
RNAi (10 years)	RNAi (10 years)	

Modelling thermal biology of dungal biopesticide & DBM



Leads to a thermal time forecast of control agent performance

How AHDB research can help

- A road map for IPM.
- Trial biopesticides
  - Where are they successful and why?
  - Where don’t they work and why not?
  - How to make best use in IPM?

Improving soil health: systematic approaches to soil management

Professor Jane Rickson, Cranfield University

CEREALS & OILSEEDS

Improving soil health: systematic approaches to soil management

1. The local / global challenges ahead
2. The importance of soil and soil health
3. Soil management practices for sustainable agriculture
4. Take home messages

1.The local and global challenges ahead: the need for sustainable intensification

How to achieve food security, given:

a) Increasing demands for safe, nutritious and affordable food

b) Finite amount of land

b) Competition with other land uses

biofuels, urban development, infrastructure

c) ‘Yield plateau’ – poor yield response to higher fertiliser use

d) Soil degradation (£1.2 billion per annum in England and Wales alone)

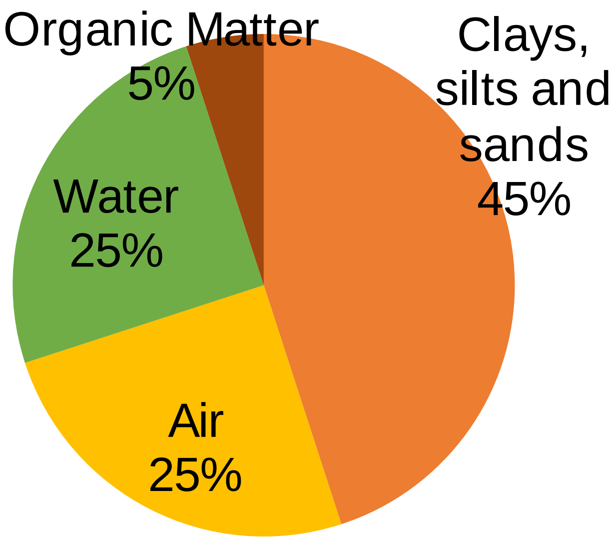
e) Climate change, extreme events and weather variability (and impacts on water management, crop production and land degradation)

…MAYBE THE ANSWER IS IN THE SOIL???

2. The importance of soil and soil health

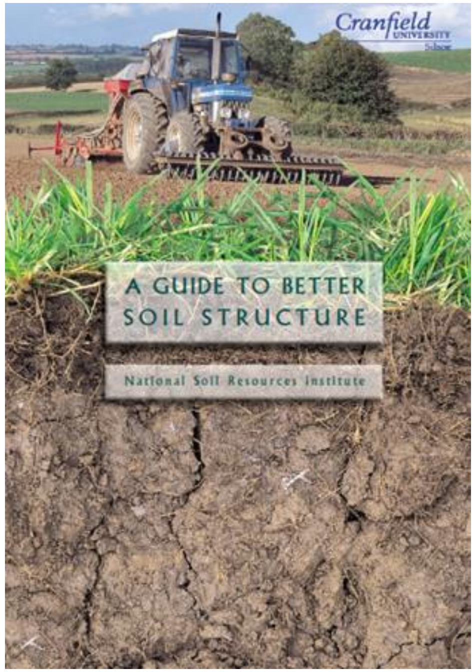
What is soil?

- Mineral content (texture: clays, silts and sands) ≈ 45%
  - Chemical composition (bonds between particles)
- Air ≈ 25%
- Water ≈ 25%
- Organic matter content ≈ 5%
  - Soil flora: roots and leaves
  - Soil fauna
    - macro-organisms e.g. earthworms
    - micro-organisms "microbes"
      - bacteria
      - fungi
      - viruses



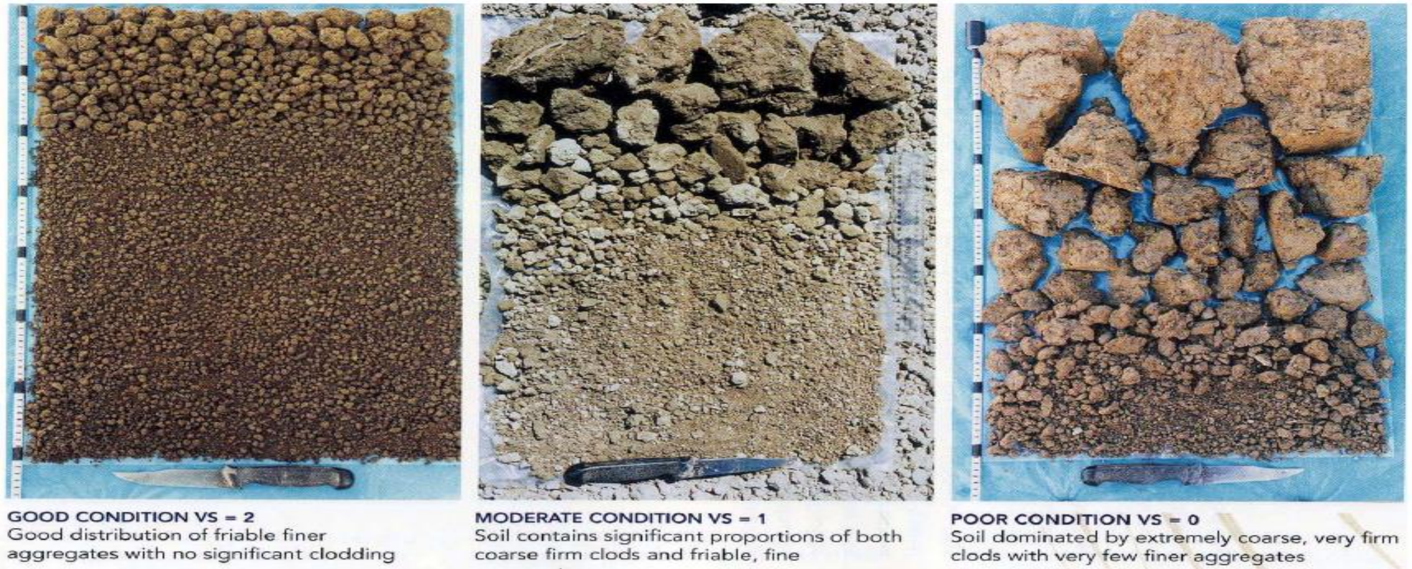
- The physical arrangement of soil particles, air space, water content and organic matter = soil structure
  - Allows roots to grow
  - Allows movement of air, water and soil organisms
  - Affects soil strength / loading capacity (resist compaction)

2. The importance of soil and soil health



What is soil structure?

- Soil aggregate size distribution
- Pore size distribution
  - Macropores (easy drainage – a good or bad thing?; poor seed bed; lodging)
  - Mesopores (water storage / holding capacity (floods and droughts), water availability to crops)
  - Micropores (water unavailable to crops; less air and water movement)
- The 3 ‘Rs’: Well structured soils can **r**eceive, **r**etain and **r**elease water



Visual soil assessment / evaluation http://www.landcareresearch.co.nz/publications/books/visual-soil-assessment-field-guide

2. The importance of soil and soil health: The soils of England and Wales

Soils properties vary

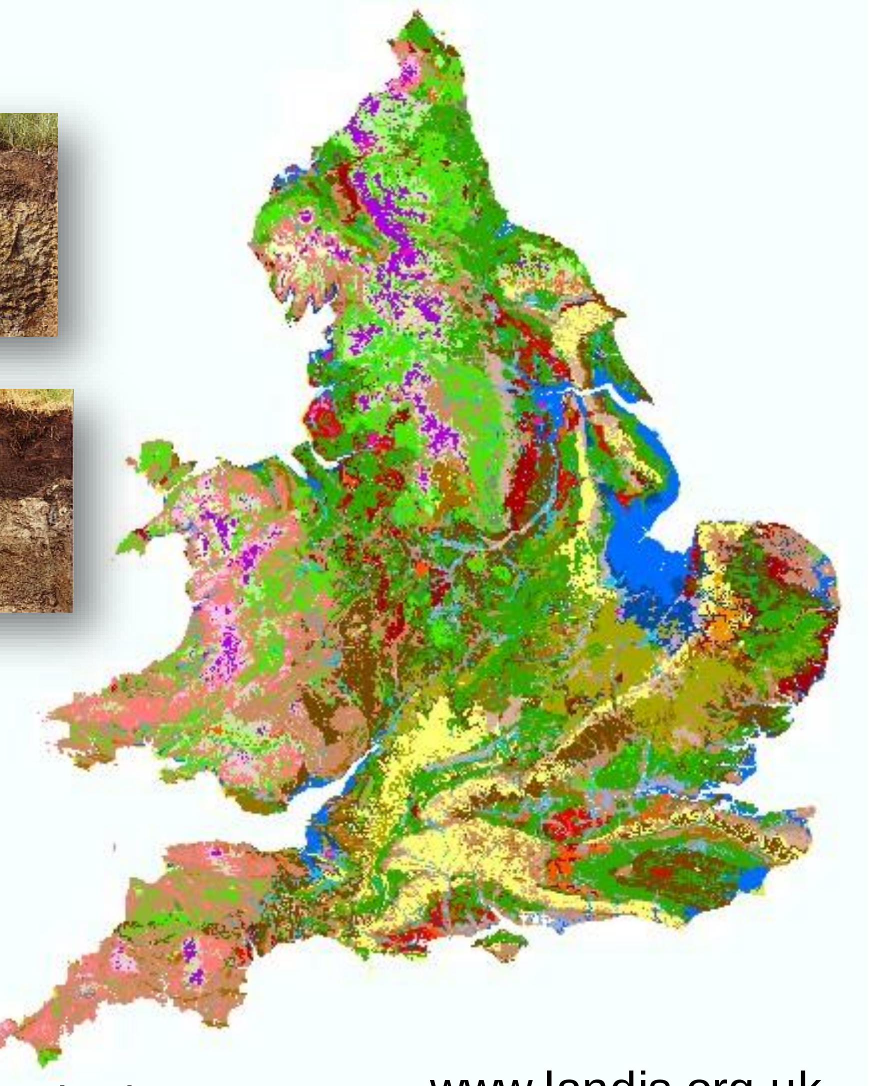
- Texture
- Stoniness
- Organic content
- Depth to rock
- Mineralogy
- Permeability
- Natural drainage
- Consolidation
- Acidity

Denbigh (B.Adams)

Cegin (B.Adams)

Hiraethog (B.Adams)

Wilcocks

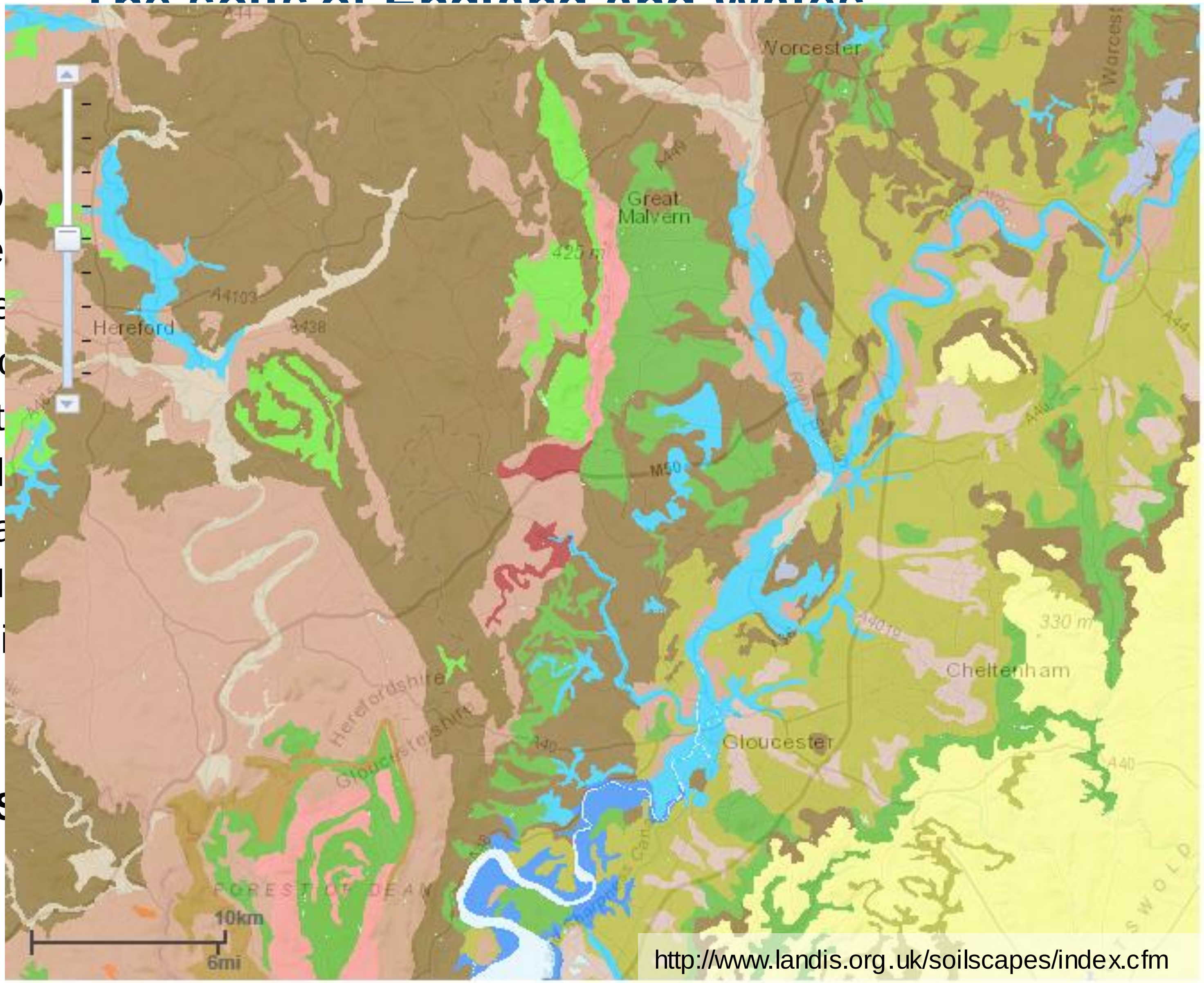


National Soil Map

- Product of 200+ years of field work
- 747 Soil Series (soil types)
- 306 Soil Associations (soil types occurring together)

www.landis.org.uk

2. The importance of soil and soil health: The soils of England and Wales



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- 306 Soil Associations (soil types occurring together)

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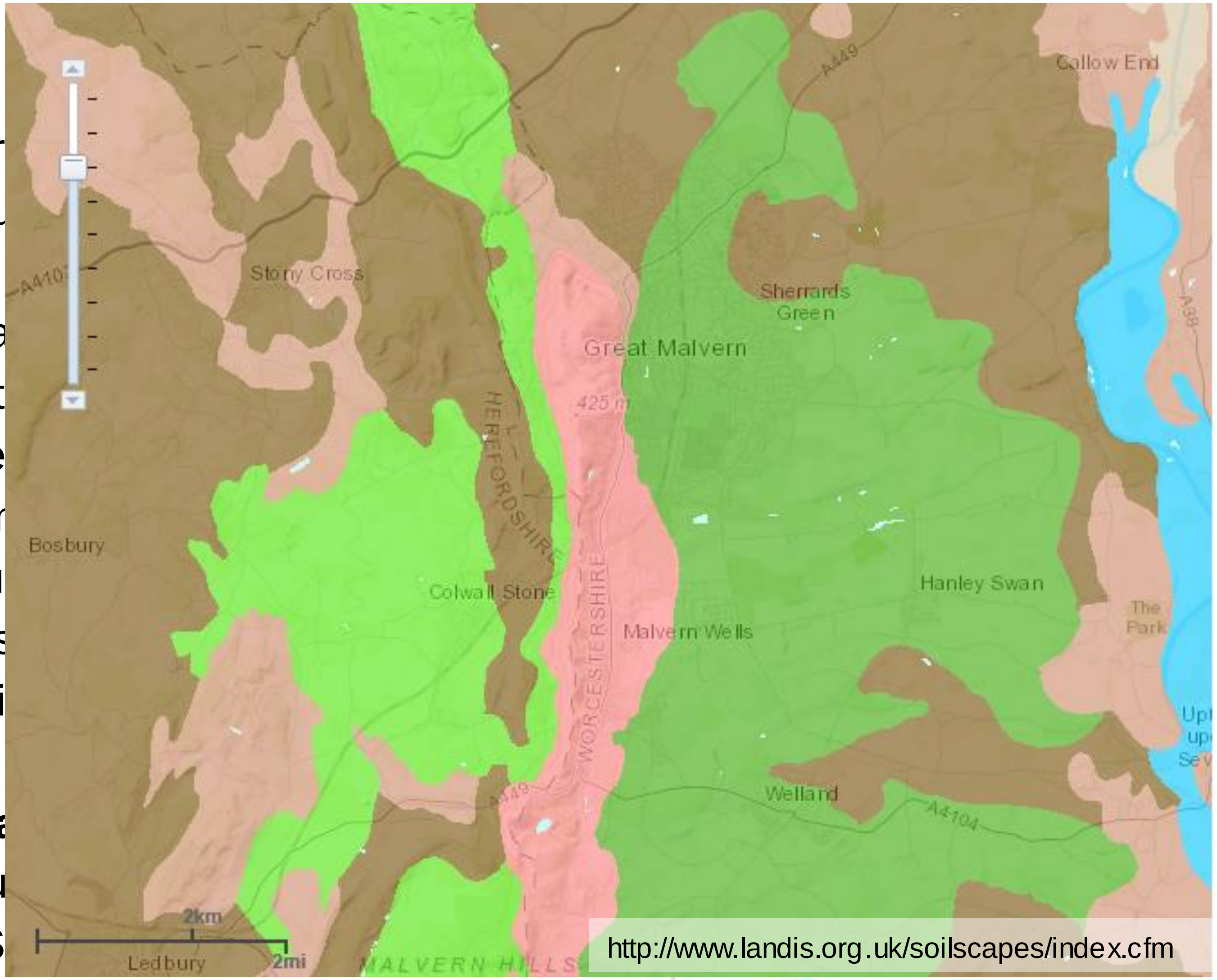

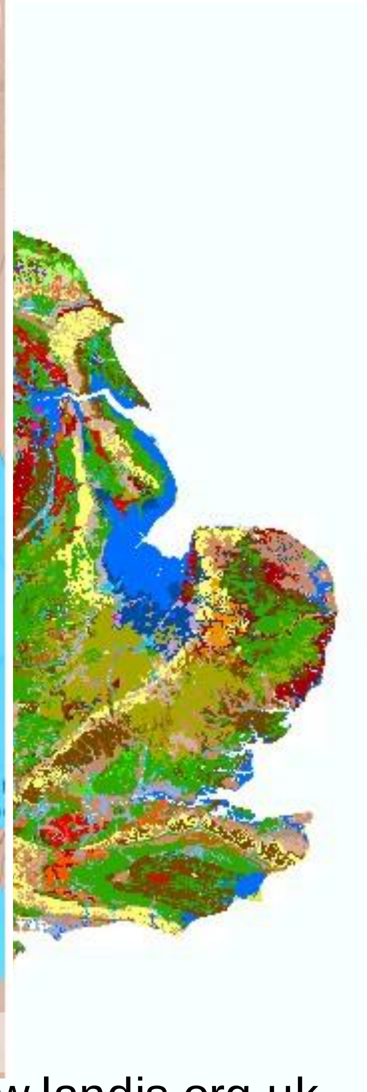

www.landis.org.uk

2. The importance of soil and soil health: The soils of England and Wales

http://www.landis.org.uk/soilscapes/index.cfm

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Descriptions of the full range of soilscapes are available below. For a full soils guide, including detailed descriptions of soil types and associations, please visit the LandIS Soils Guide.

ID	Description
1	Saltmarsh soils
2	Shallow very acid peaty soils over rock
3	Shallow lime-rich soils over chalk or limestone
4	Sand dune soils
5	Freely draining lime-rich loamy soils
6	Freely draining slightly acid loamy soils
7	Freely draining slightly acid but base-rich soils
8	Slightly acid loamy and clayey soils with impeded drainage
9	Lime-rich loamy and clayey soils with impeded drainage
10	Freely draining slightly acid sandy soils
11	Freely draining sandy Breckland soils
12	Freely draining floodplain soils
13	Freely draining acid loamy soils over rock
14	Freely draining very acid sandy and loamy soils
15	Naturally wet very acid sandy and loamy soils
16	Very acid loamy upland soils with a wet peaty surface
17	Slowly permeable seasonally wet acid loamy and clayey soils
18	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils
19	Slowly permeable wet very acid upland soils with a peaty surface
20	Loamy and clayey floodplain soils with naturally high groundwater
21	Loamy and clayey soils of coastal flats with naturally high groundwater
22	Loamy soils with naturally high groundwater
23	Loamy and sandy soils with naturally high groundwater and a peaty surface
24	Restored soils mostly from quarry and opencast spoil
25	Blanket bog peat soils
26	Raised bog peat soils
27	Fen peat soils

Soilscape description:
Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils

Texture:
Loamy and clayey

Coverage:
England: 19.9% Wales: 2.4% England &Wales: 17.5%

Drainage:
Impeded drainage

Fertility:
Moderate

Habitats:
Seasonally wet pastures and woodlands

Landcover:
Grassland and arable some woodland

Carbon:
Low

Drains to:
Stream network

Water protection:
Main risks are associated with overland flow from compacted or poached fields. Organic slurry, dirty water, fertiliser, pathogens and fine sediment can all move in suspension or solution with overland flow or drain water

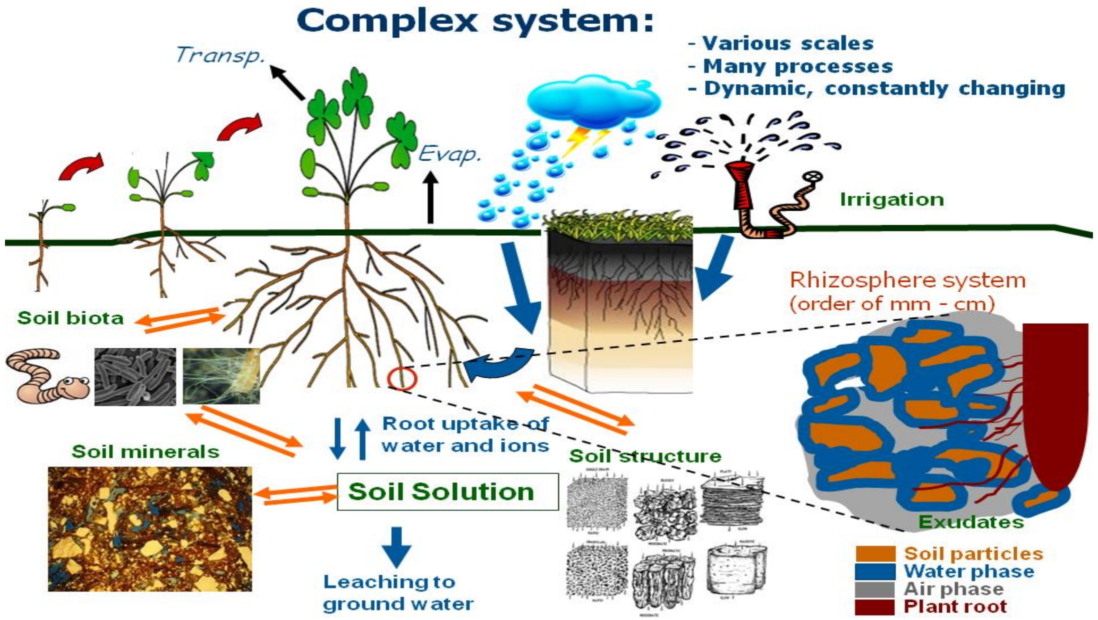
General cropping:
Mostly suited to grass production for dairying or beef; some cereal production often for feed. Timeliness of stocking and fieldwork is important, and wet ground conditions should be avoided at the beginning and end of the growing season to avoid damage to soil structure. Land is tile drained and periodic moling or subsoiling will assist drainage

What is soil health?

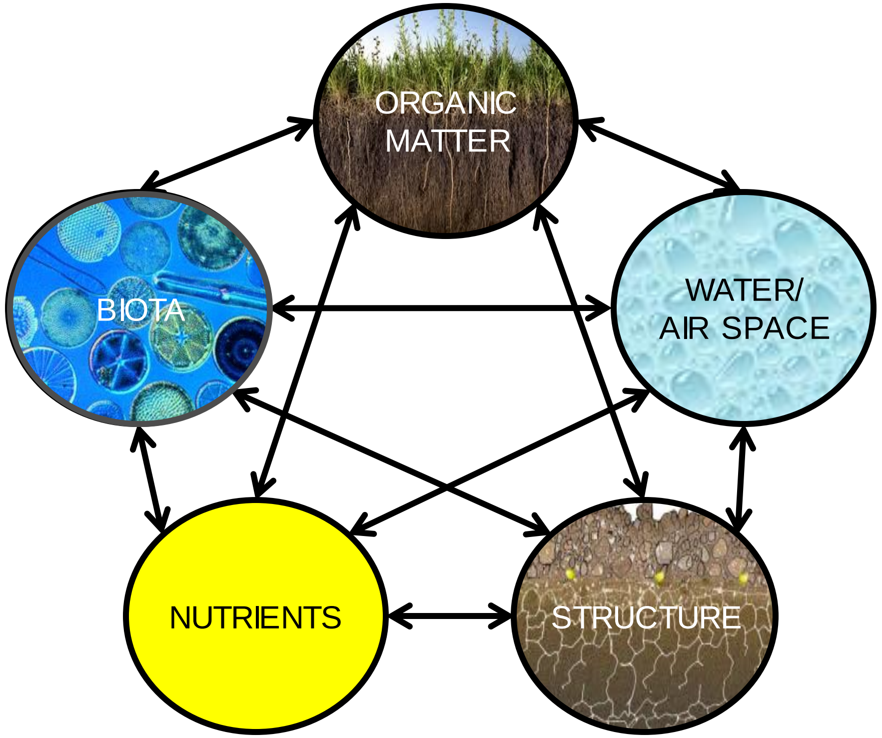
Soil quality and health are related to soil properties:

- **Physical** (texture, depth, structure, porosity, density, water holding capacity, infiltration rate, stability: aggregates and mass)
- **Biological** (flora and fauna e.g. seed bank and micro-biota)
- **Chemical** (nutrients, carbon, pH)

…and interactions between them: soil as a complex 'system'



http://moradi.lawr.ucdavis.edu/Research.php



Soil health: the pivotal 5
(after K Ritz, pers. comm)

3. Soil management practices for sustainable agriculture

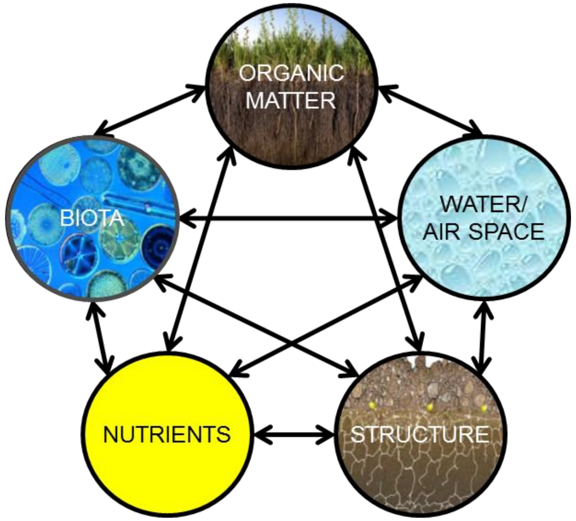
Aim: "To maintain a fertile seedbed and root zone, whilst retaining maximum resistance to soil degradation"

1. Enhance productivity (quantity, quality and reliability of marketable yield)
   - Improve uptake of water and nutrients by roots
   - Reduce pests / diseases / weeds

2. Control soil degradation
   - Erosion; diffuse pollution; compaction; losses of C, organic matter and habitats; salinisation; acidification

3. Concept of "sustainable intensification"
   - Producing more (quantity/ quality/ reliability of marketable yield) with less environmental impact / damage

1 + 2 = 3 ☺

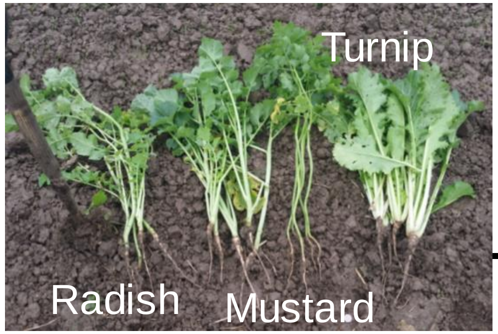


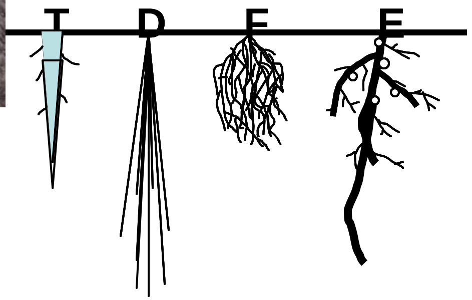
Soil health: the pivotal 5
(after K Ritz, pers. comm)

Soil erosion, Bedfordshire

3. Soil management practices for sustainable agriculture

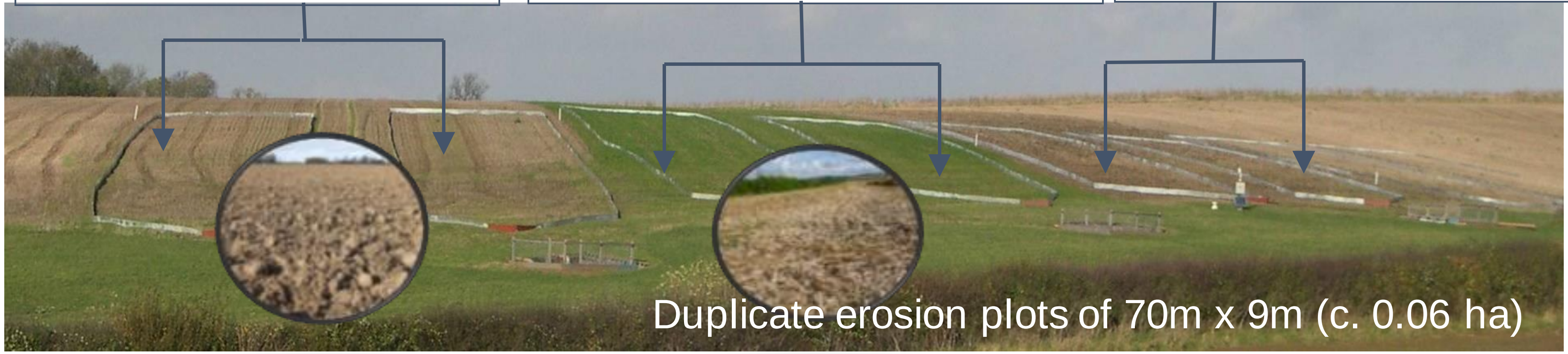
- Cultivations and tillage practices
- Cover cropping
- Soil (organic) amendments
- Field engineering
- Erosion control products

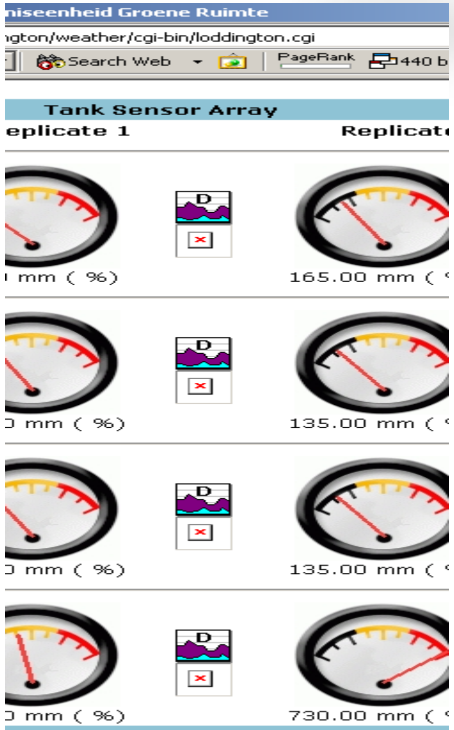


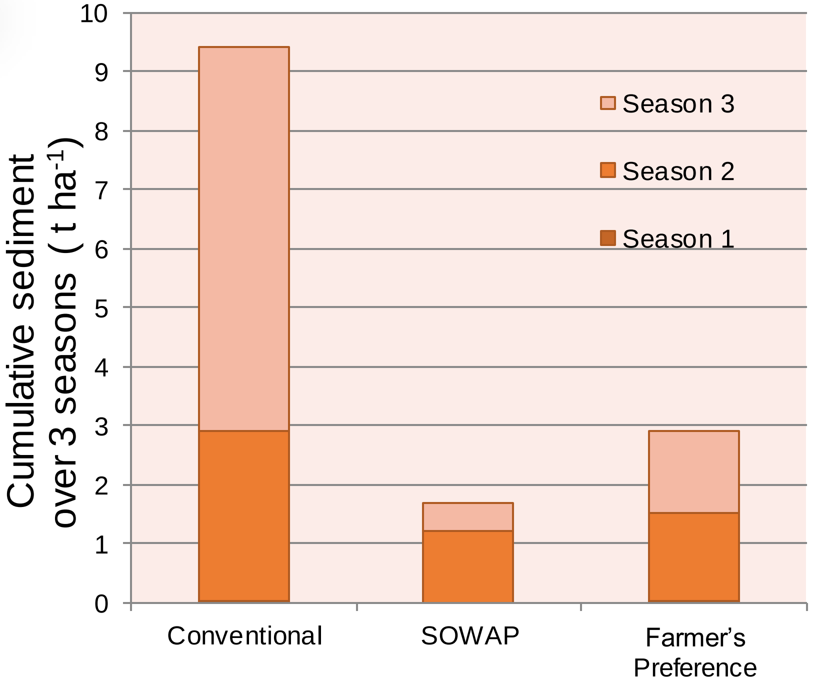


Soil management practices for sustainable agriculture: Soil and Water Protection in Northern Europe (SOWAP)

Conventional practice | SOWAP (Minimum tillage) | Farmer’s Preference







Soil management practices for sustainable agriculture: Reduced tillage systems (Dr Mikhail Giannitsopoulos)

Control Treatment: Two Pass

Claydon Hybrid

Sumo DTS

Mzuri Pro-Til 3

Vaderstad Seed Hawk

Vaderstad Rapid A

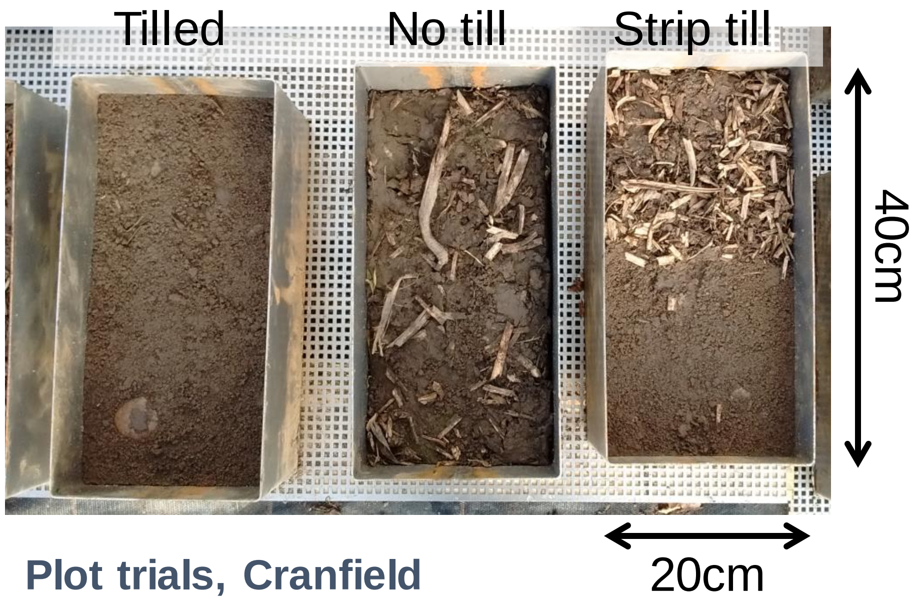
Results: How tillage affects soil quality

Different letters show statistically significant differences

	Penetration resistance MPa	**Organic carbon (%)**	Microbial biomass carbon (μg C g soil^{-1})	**Earth worms / m²**
Control	0.50 ^{c}	**2.710 ^{b}**	339.1 ^{b}	**75.0 ^{c}**
Claydon Hybrid	0.60 ^{bc}	**2.789 ^{ab}**	321.8 ^{b}	**118.8 ^{b}**
Mzuri Pro Til	0.70 ^{ab}	**2.829 ^{ab}**	380.2 ^{ab}	**137.5 ^{b}**
Sumo DTS	0.61 ^{abc}	**2.714 ^{b}**	379.8 ^{ab}	**103.1 ^{bc}**
Vaderstads	0.76 ^{a}	**2.985 ^{a}**	443.8 ^{a}	**187.5 ^{a}**

3. Soil management practices for sustainable agriculture: Can strip tillage improve soil health? (Dr. Iain Dummett)

Field trials, Lincolnshire



Plot trials, Cranfield

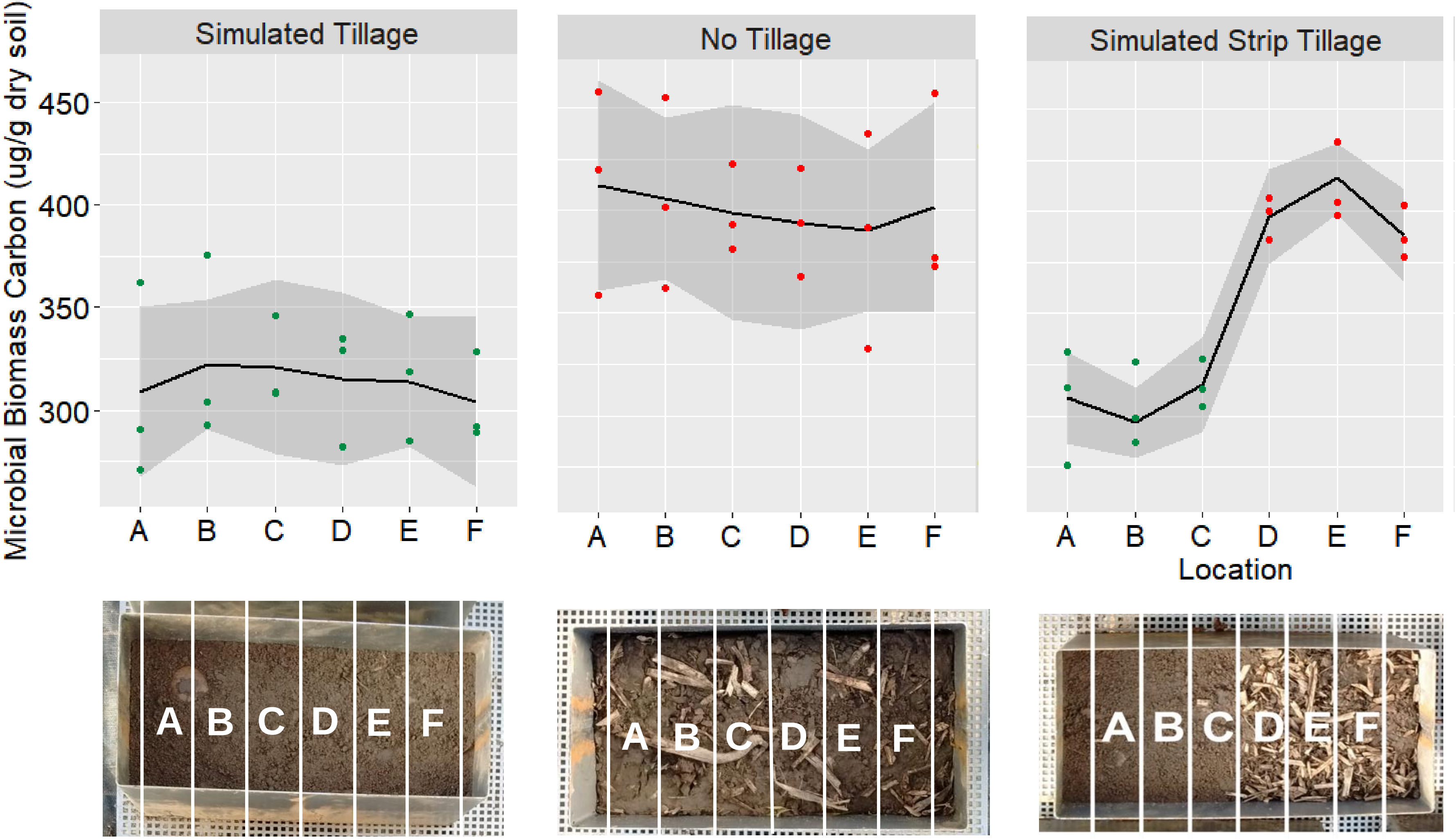
Disturbed v undisturbed areas at field and row width scale

- Does tillage reduce soil biology (fungi, bacteria, earthworms)?
- Does the rate of soil biology recovery increase nearer the untilled plot?
- Can soil microbes recolonise from untilled plots to tilled plots?

Subsoiler

Specialist strip tillage implement

3. Soil management practices for sustainable agriculture: Can strip tillage improve soil health? (Dr. Iain Dummett)

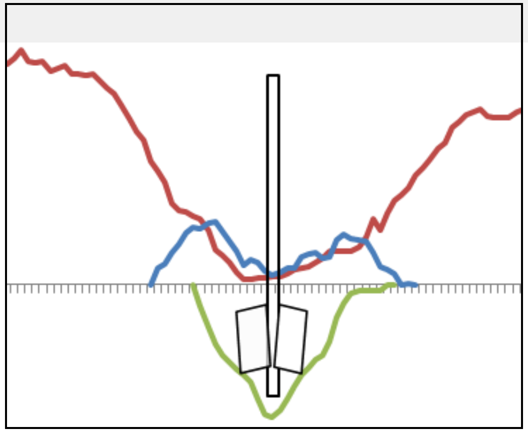
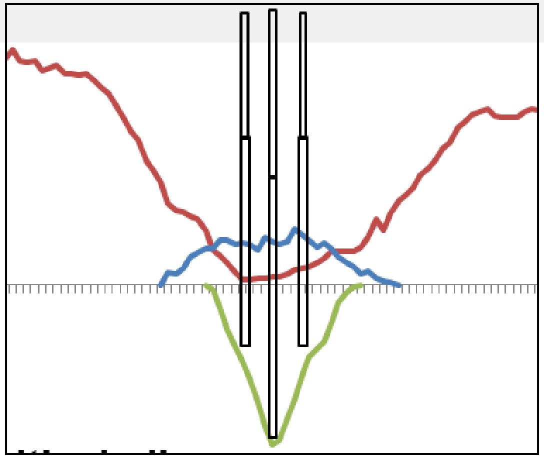
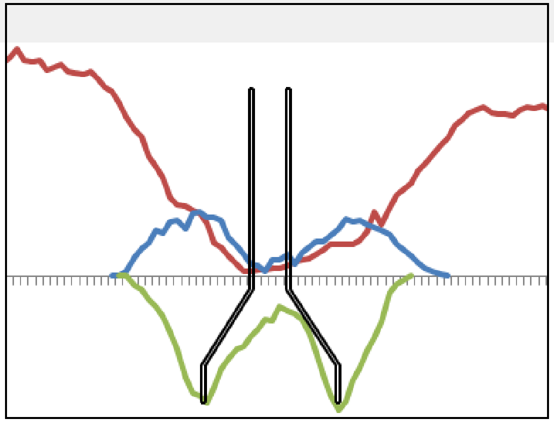


Cranfield University

3. Soil management practices for sustainable agriculture: Optimising soil disturbance and use of mulches for soil erosion and runoff control (Dr. Joanne Niziolomski)

Field trial tillage / implement treatments

Winged_soil_bin.mp4

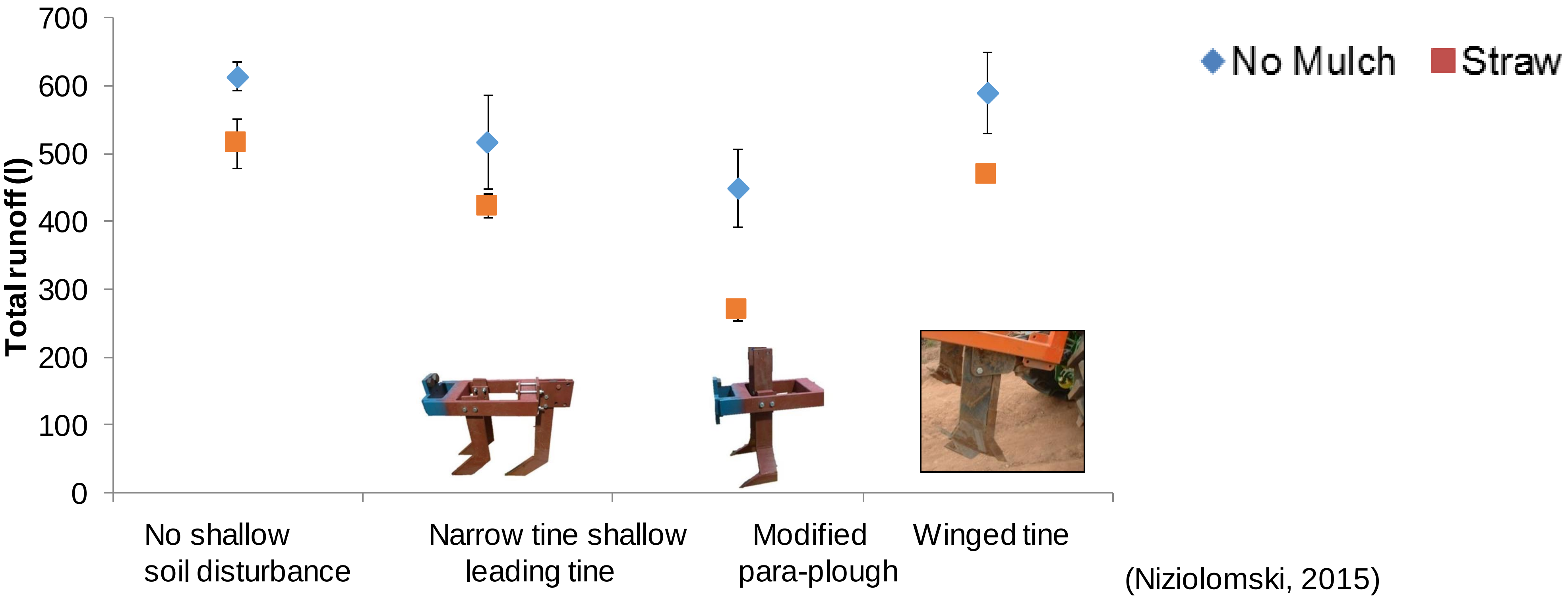
Shallow soil disturbance (175 mm), both with and without straw mulch (6 t ha^{-1}).		
Winged tine	**Narrow with two shallow leading tines**	**Modified para-plough**
		
		

Testing tillage implements in the soil bin

(Iain Dummett, PhD student, Frontier Agriculture, Douglas Bomford Trust)

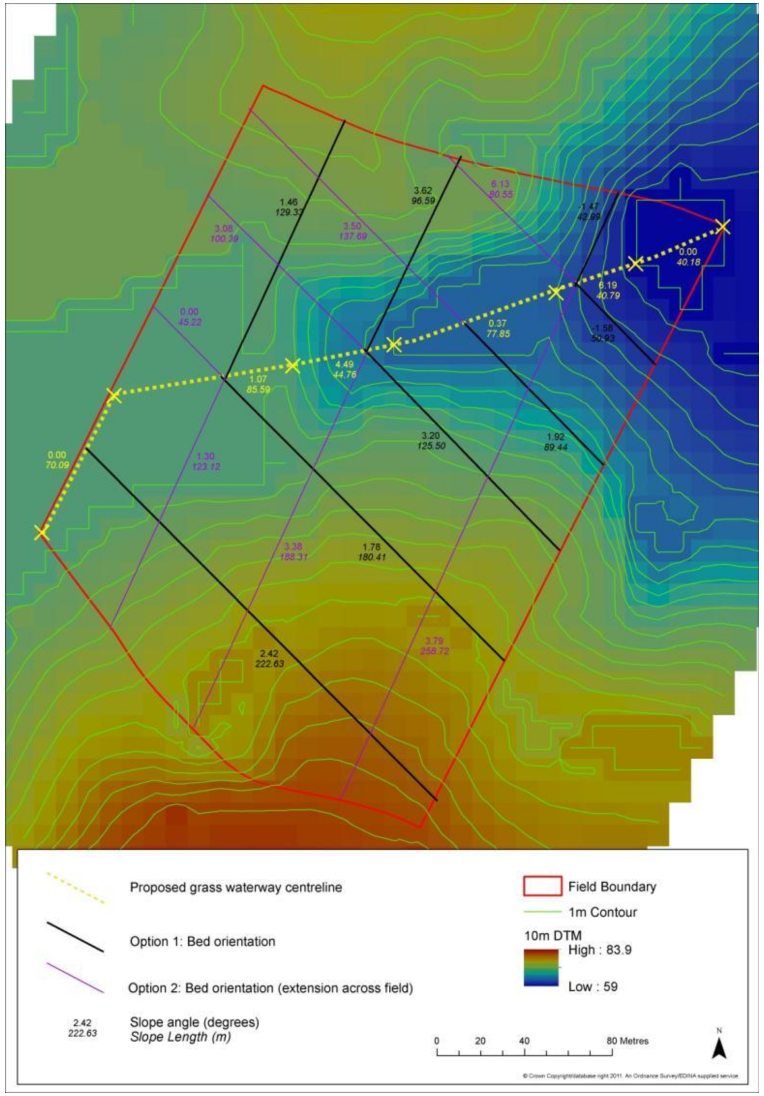
Soil disturbance field trial results: Total runoff volume (l)

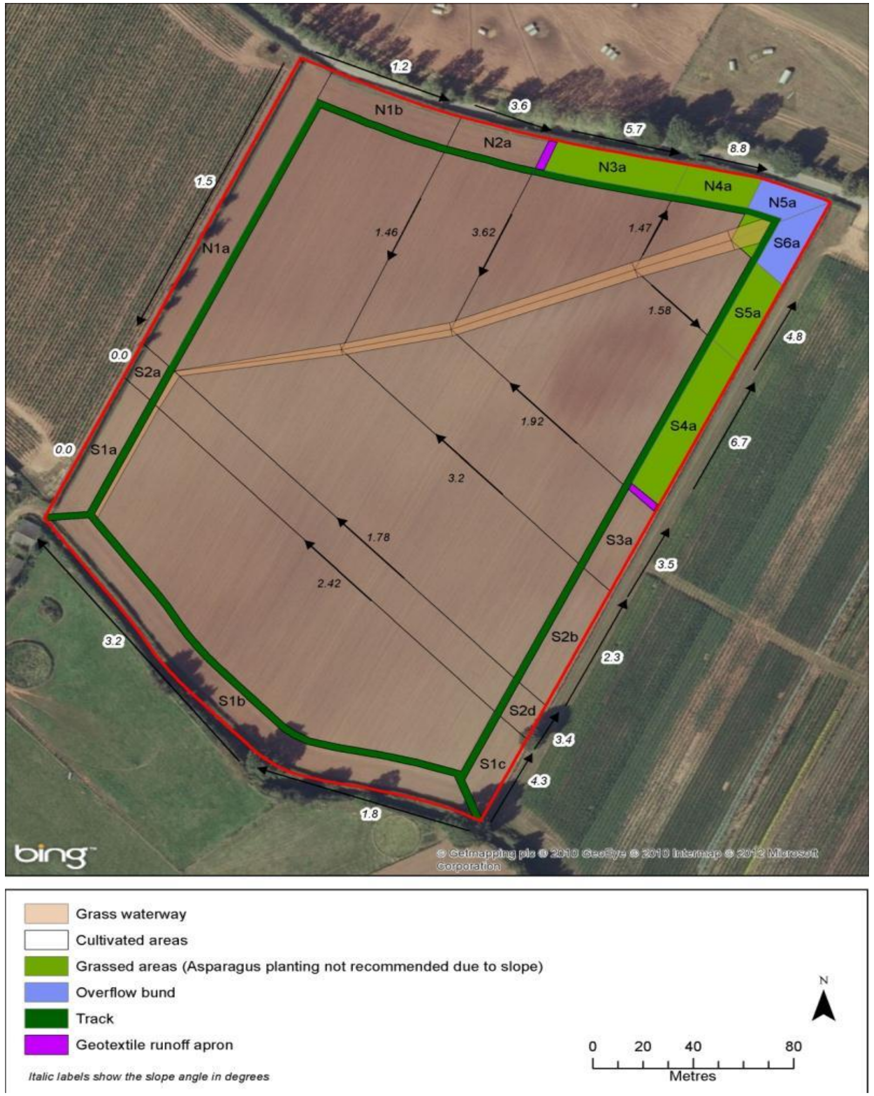
- Straw mulch always reduced runoff
- MPP with straw reduced total runoff significantly ($p<0.05$) compared with all other treatments.



(Niziolomski, 2015)

3. Soil management practices for sustainable agriculture: Use of grassed waterways for erosion and runoff control





3. Soil management practices for sustainable agriculture: Use of grass waterways to control runoff and soil loss

3. Soil management practices for sustainable agriculture:

Application of organic wastes to restore soil health and productivity of a degraded soil (Dr. Benedict Unagwu)

Improve Soil Quality Indicators (SQIs)?

Mushroom compost

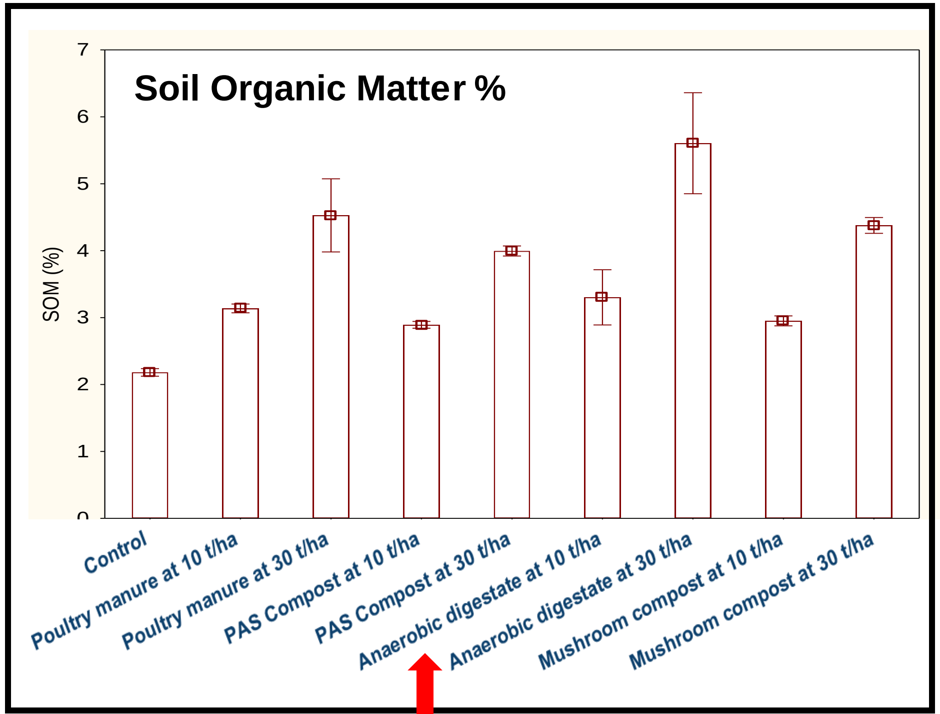
Increase crop yield?

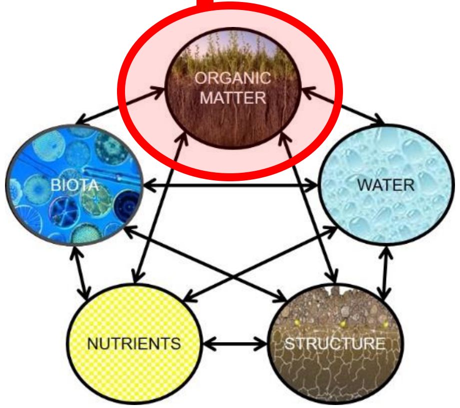
Poultry manure

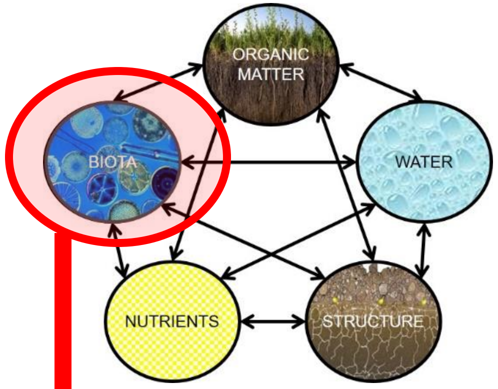
PAS compost (green waste)

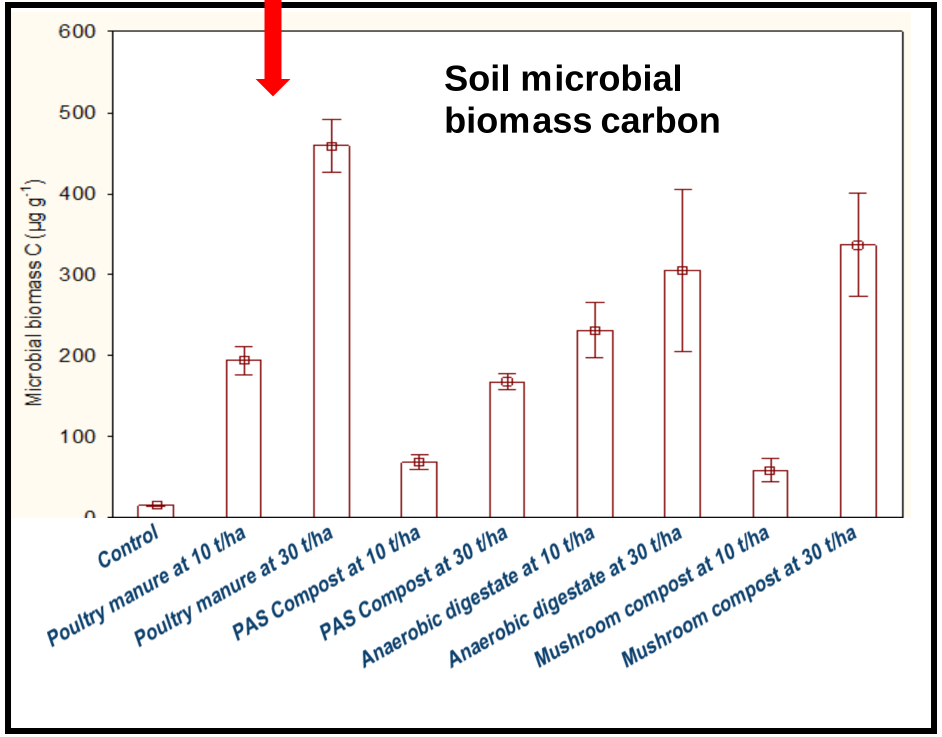
Anaerobic digestate

3. Soil management practices for sustainable agriculture: Effect of organic amendments on soil health indicators



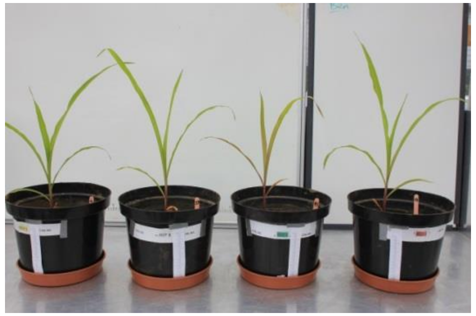




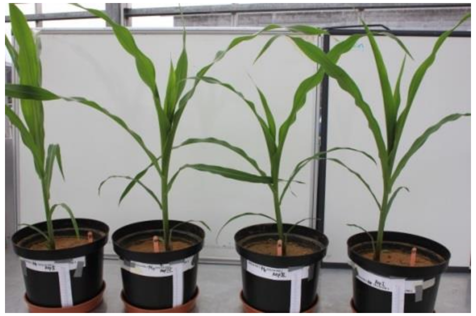


N.B. Error bars denote one standard error of the mean

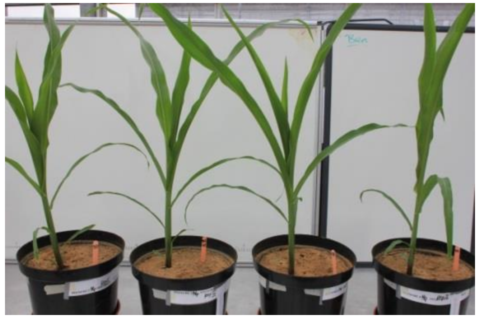
Amendment effects on maize height and biomass



control

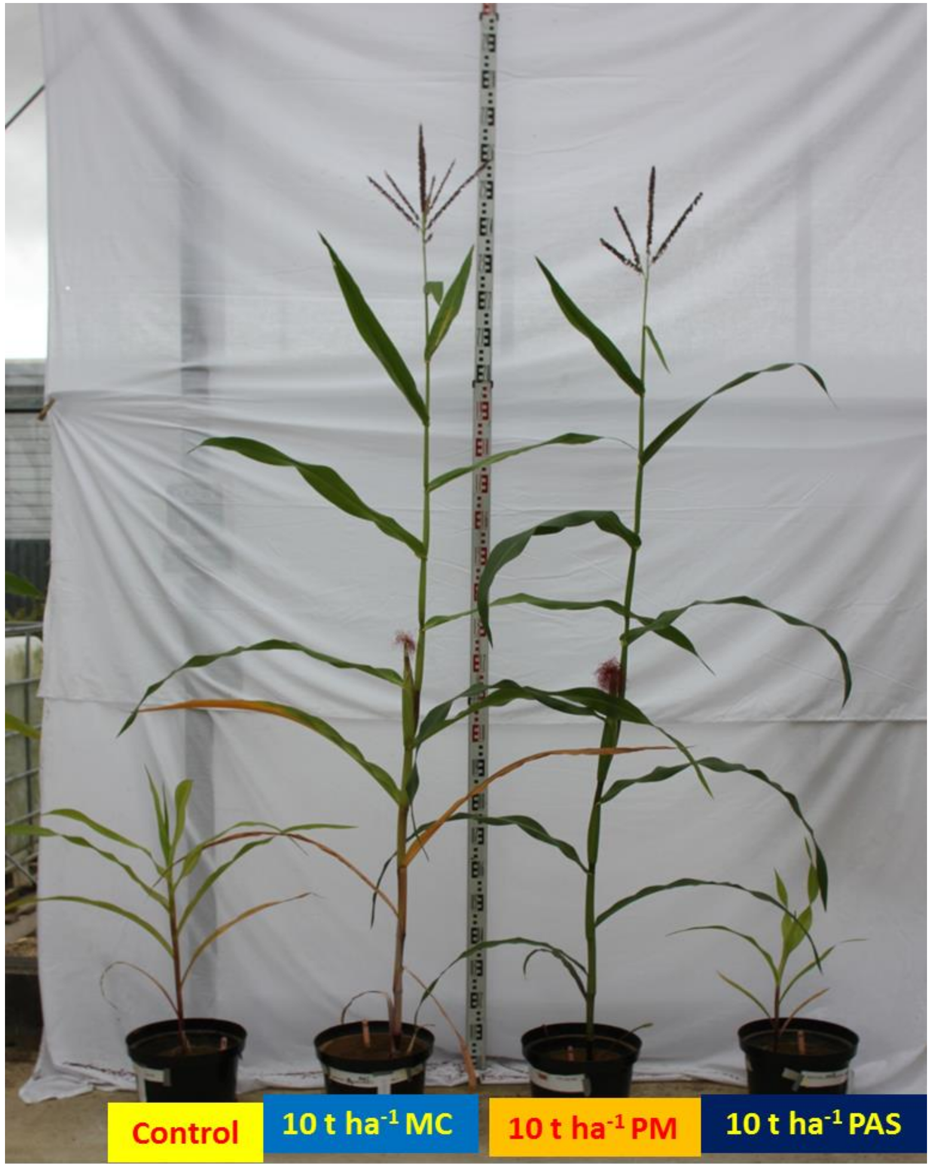


10 t ha^{-1} Poultry Manure



10 t ha^{-1} Mushroom Compost

At 3 weeks after planting

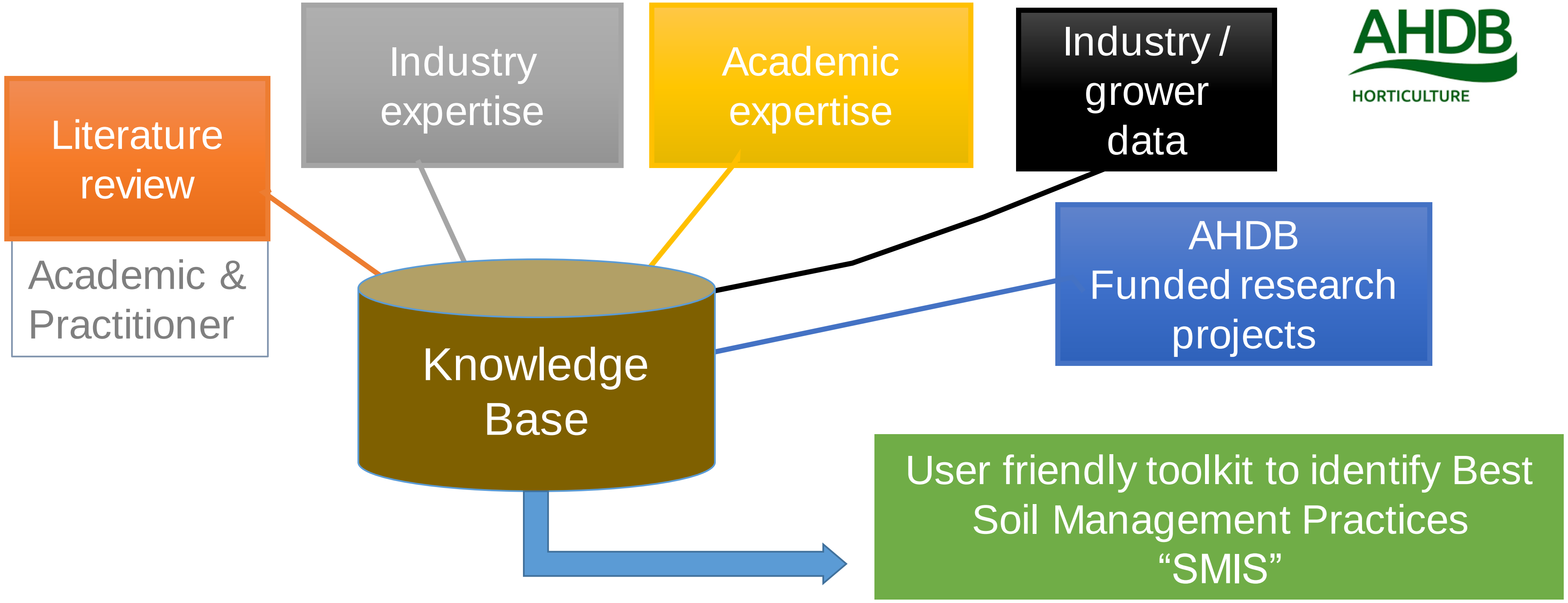


At tasseling (9 weeks after planting)

3. Soil management practices for sustainable agriculture:

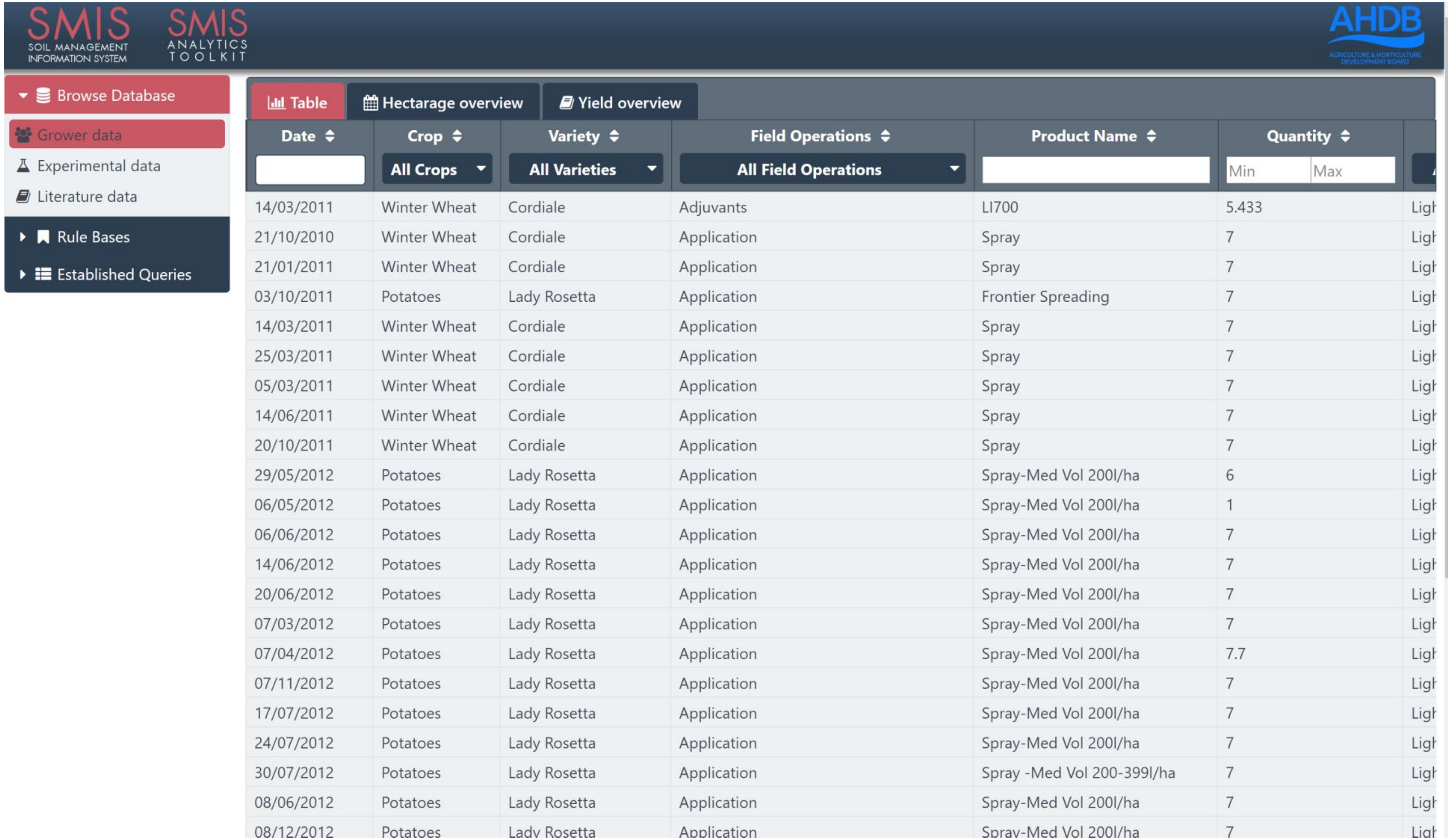
Development of a Soil Management Information System (SMIS)

- Innovative database, able to **hold and manage linkages** between diverse sources of information on soil management practices and outcomes.
- An interactive toolkit – designed to give growers, agronomists and land managers access to guidance on optimal soil management practices.
- The key 'Data Sources' in SMIS are:



http://www.smis.ahdb.org.uk/growers

> 325,000 grower records (anonymised)



Date	Crop	Variety	Field Operations	Product Name	Quantity	
	All Crops	All Varieties	All Field Operations		Min Max	
14/03/2011	Winter Wheat	Cordiale	Adjuvants	LI700	5.433	Ligh
21/10/2010	Winter Wheat	Cordiale	Application	Spray	7	Ligh
21/01/2011	Winter Wheat	Cordiale	Application	Spray	7	Ligh
03/10/2011	Potatoes	Lady Rosetta	Application	Frontier Spreading	7	Ligh
14/03/2011	Winter Wheat	Cordiale	Application	Spray	7	Ligh
25/03/2011	Winter Wheat	Cordiale	Application	Spray	7	Ligh
05/03/2011	Winter Wheat	Cordiale	Application	Spray	7	Ligh
14/06/2011	Winter Wheat	Cordiale	Application	Spray	7	Ligh
20/10/2011	Winter Wheat	Cordiale	Application	Spray	7	Ligh
29/05/2012	Potatoes	Lady Rosetta	Application	Spray-Med Vol 200l/ha	6	Ligh
06/05/2012	Potatoes	Lady Rosetta	Application	Spray-Med Vol 200l/ha	1	Ligh
06/06/2012	Potatoes	Lady Rosetta	Application	Spray-Med Vol 200l/ha	7	Ligh
14/06/2012	Potatoes	Lady Rosetta	Application	Spray-Med Vol 200l/ha	7	Ligh
20/06/2012	Potatoes	Lady Rosetta	Application	Spray-Med Vol 200l/ha	7	Ligh
07/03/2012	Potatoes	Lady Rosetta	Application	Spray-Med Vol 200l/ha	7	Ligh
07/04/2012	Potatoes	Lady Rosetta	Application	Spray-Med Vol 200l/ha	7.7	Ligh
07/11/2012	Potatoes	Lady Rosetta	Application	Spray-Med Vol 200l/ha	7	Ligh
17/07/2012	Potatoes	Lady Rosetta	Application	Spray-Med Vol 200l/ha	7	Ligh
24/07/2012	Potatoes	Lady Rosetta	Application	Spray-Med Vol 200l/ha	7	Ligh
30/07/2012	Potatoes	Lady Rosetta	Application	Spray -Med Vol 200-399l/ha	7	Ligh
08/06/2012	Potatoes	Lady Rosetta	Application	Spray-Med Vol 200l/ha	7	Ligh
08/12/2012	Potatoes	Lady Rosetta	Application	Spray-Med Vol 200l/ha	7	Ligh

http://www.smis.ahdb.org.uk/growers

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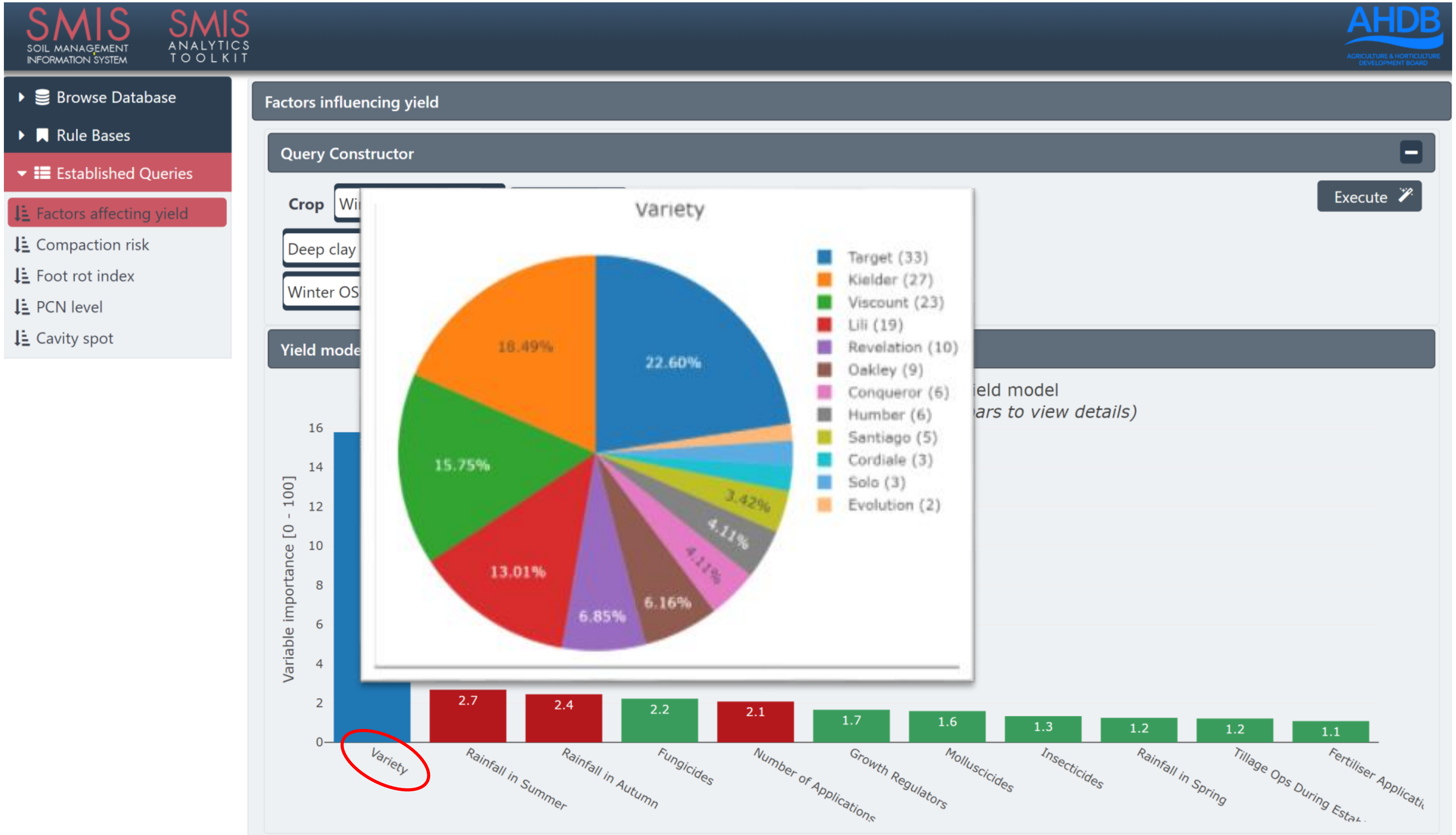
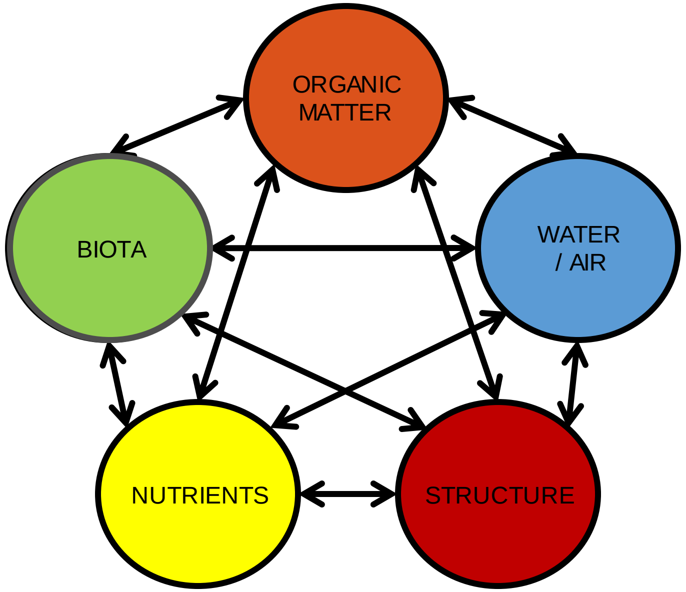


4. Take home messages

- Soils are under pressure to increase food, fodder, fibre and (bio)fuel production without damaging the environment
- Soil management can improve soil health and crop productivity
- Cost effectiveness of practices will be site specific and must fit into current farming practices
  - socio-economic context
  - infrastructure / machinery available
  - farmer perception/ psychology / planning horizon
- Ultimate goal is economically, socially and environmentally acceptable food production

= “sustainable intensification”



Cranfield Environment and Agrifood

Thank you for your attention.

Any questions?

Improving soil health: applying soil management research into practice

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