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Crop health: Better decision making

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Leading the way in Agriculture and Rural Research, Education and Consulting

Crop doctoring

- Wider issues around managing crop health
- Contribution of applied science to better evidence & better decision making
- ‘No such career’ compared to doctors or vets
- Multiple hosts…many specialist disciplines
- Where does the generalist fit?

Careers for plant doctors

- Why is plant doctoring not seen as a career?
- Scientists rightly judged on the quality of their science through peer review of papers
- Applied / general journals score lower
- Research Excellence Framework now recognises impact
- Re-attach value to the generalist & to effective KE

Russian radios
Measures of productivity – ask and it will be given

Better links needed

Industry

Scientists

Teaching

science gives evidence base

Case study Ramularia – applied through to basic science

- Leaf spotting first picked up in monitoring and clinic samples
- Levy board funding identified initial control strategies
- Efficacy trials from companies
- Core research identified risk warning criteria
- Warnings now issues to growers at key growth stages
- Ramularia genome sequenced and submitted for publication
- Spin out projects with industry /PhDs

Making better crop protection decisions

- Decisions about actions to manage crop / plant health issues are made within a hierarchy of ‘off farm’ policy and regulatory issues and ‘on-farm’ information.

- Better decisions = more efficient and sustainable plant protection / crop production.

An accurate diagnosis is only the start…

- Deciding to treat
- Treatment options
- Client attitude to risk

- Managing crop health has economic, social and environmental costs
- Multiple decision makers / shared decision making

Better decisions…

Crop clinic – GP and A&E in one

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- Seasonal experience in common and unusual problems
- Early warning of new problems

- Evidence gathering
- Assessing risk
- Decision making
- KE and engagement with stakeholders

Combinable crops

Straight forward diagnoses are only a small part of the job

Cash crops – high stakes

Oops …..operator error

The sublime to the serious….

The ones that scare you…

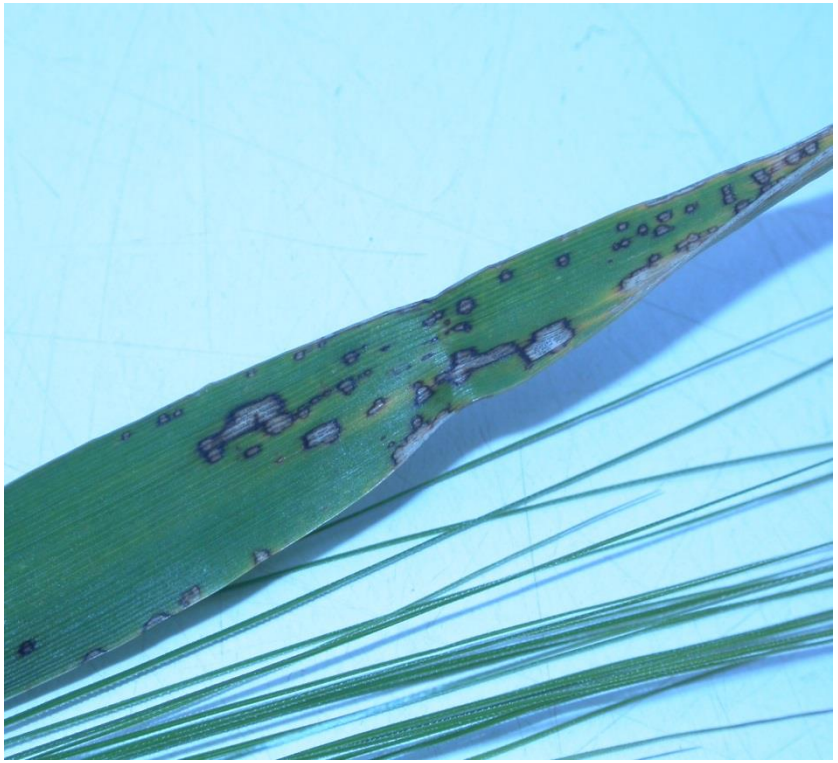
wart disease

fireblight

and the ones that make your week…

Omphalina in cereals

(picture courtesy TEAGASG)



Halo spot in barley

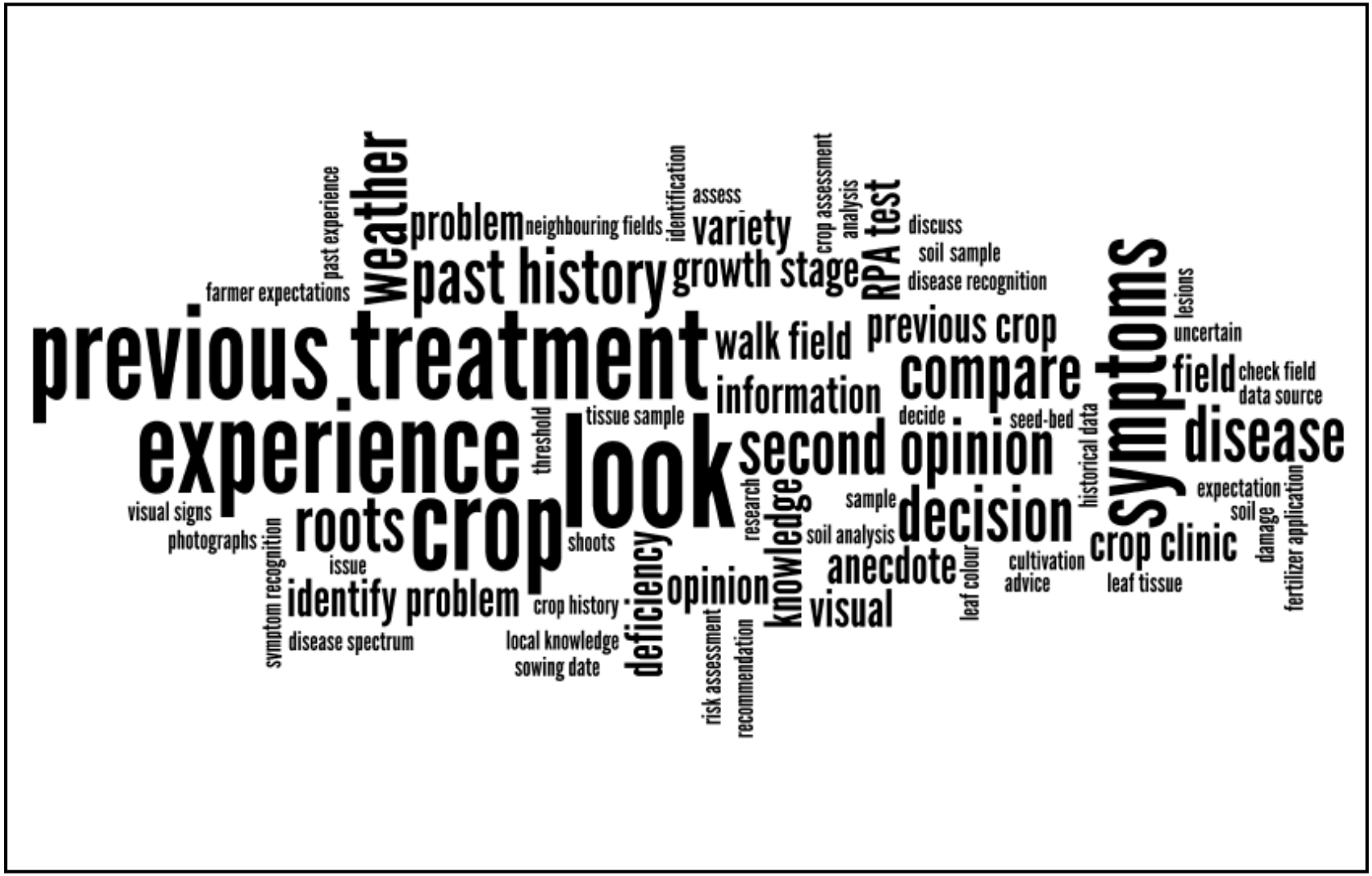
Even the definition of diagnosis is blurred…

- Working / operational description of a diagnosis presented to differing groups of practitioners or students

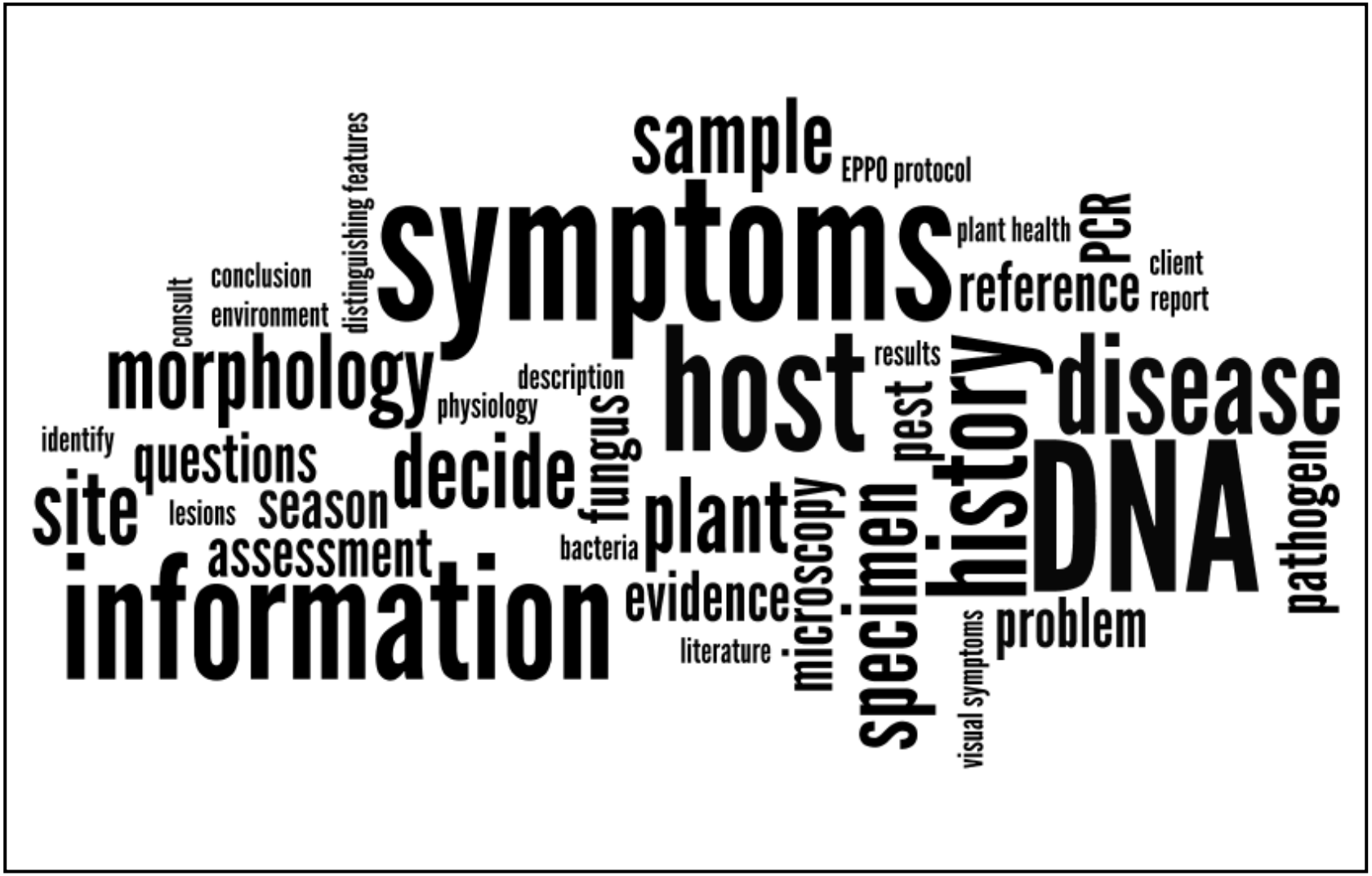
Group 1 – BASIS trainees

Group 2 – 2 year students

Group 3 - Consultants



Group 4 – UKPD diagnosticians



Managing plant health

Prevent ingress of new problems

Manage established disease burden

Defining plant health priorities – policy context

: *a classic example of a multilevel* (*hierarchical*) *decision problem*

"A key characteristic of agricultural (or economic) policy problems is that the government, or other policy makers, have only a limited range of variables under their direct control."

Candler et al. 1981

Lower down the hierarchy, a myriad of decentralized decision makers – including farmers, forestry and woodland managers, smallholders, commercial nurseries and garden centres and the gardeners who use them – all make decisions that may impact plant health, following a variety of behavioural rules.

Good decision making underpins good farming

But .. constraints on decision making

- Regulatory withdrawal of pesticides / resistance development
- Market barriers to uptake of some possible options such as new varieties.

Evidence based policy – plant health review

Current EU framework aims to protect European agriculture and forestry by preventing the entry and spread of non-native harmful organisms of plants.

- Increased risks arising from globalisation
- Insufficient focus on prevention in relation to increased imports of high risk commodities
- A need to prioritise harmful organisms at EU level across all Member States
- A need for better measures for controlling the presence and natural spread of harmful organisms which manage to enter the Union territory
- A need for modernising and upgrading the measures concerning the phytosanitary control of intra-EU movements (plant passports and protected zones).

The Plant Health Risk Register

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"The Plant Health Risk Register represents a major step in implementing the recommendations of the independent Task Force on Tree Health and Plant Biosecurity. It is a tool for government, industry and stakeholders to prioritise action against pests and diseases which threaten our crops, trees, gardens and countryside."

The Food & Environment Research Agency

Good decision making

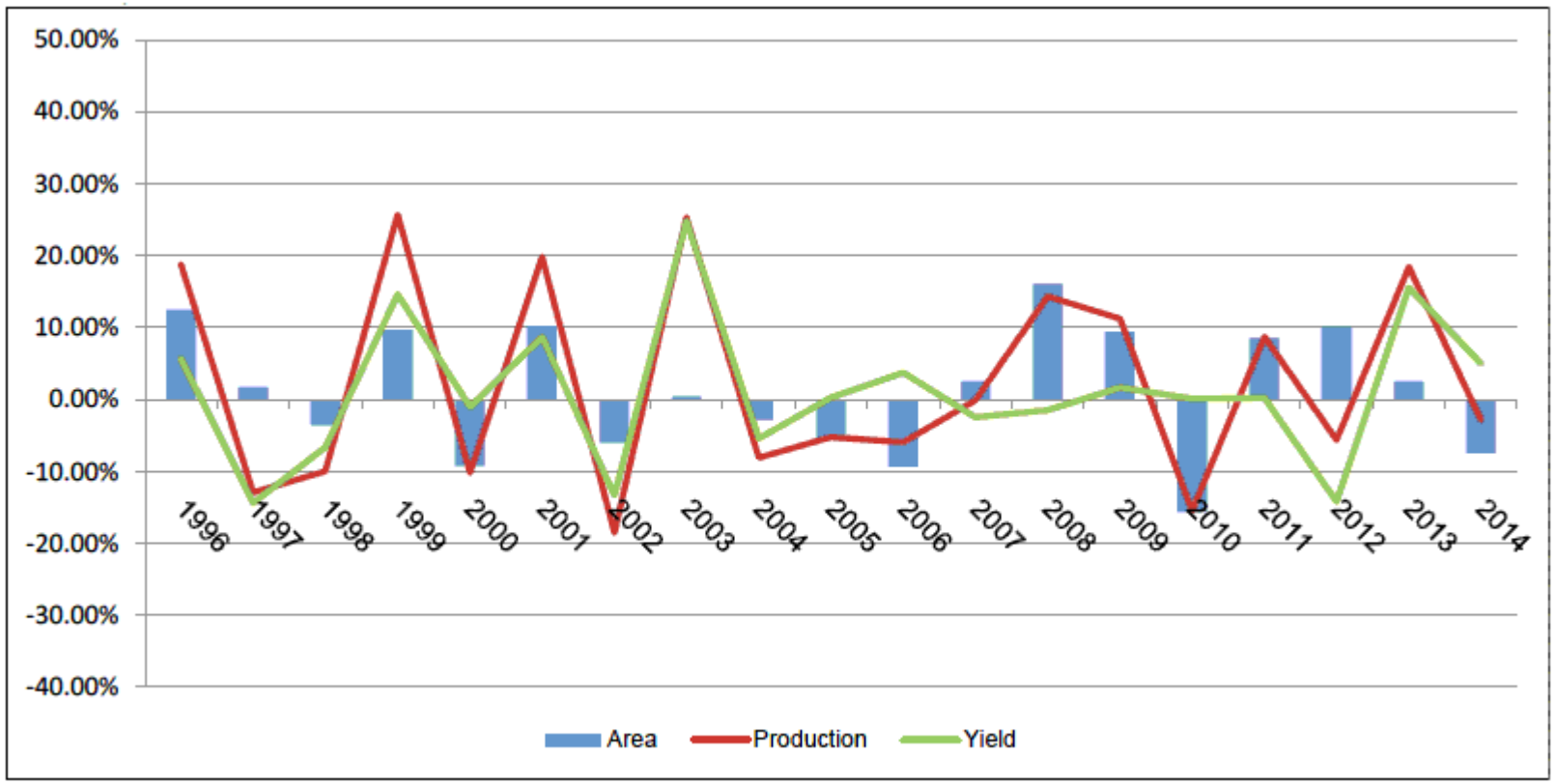
- Helping growers to judge risk and make better decisions
- Fungicide resistance as an example of judging risk in a more complex environment

Issues particular to UK

- Relatively high disease burden
- Intensive crop production
- High yields
- Conducive weather

- High level of inputs

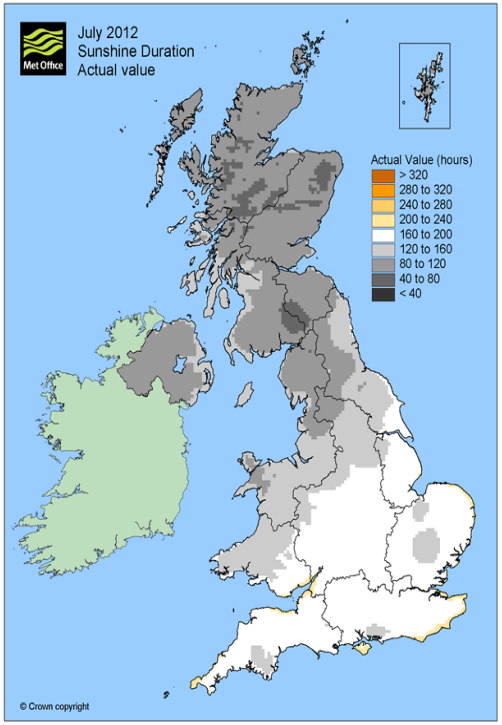
Judging risk in a crop context

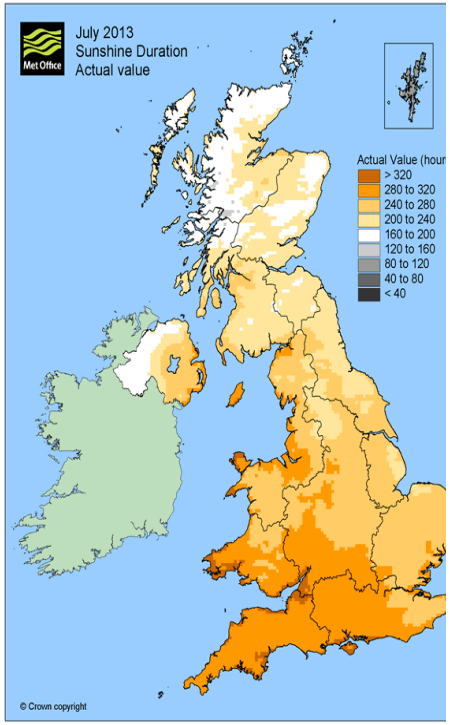


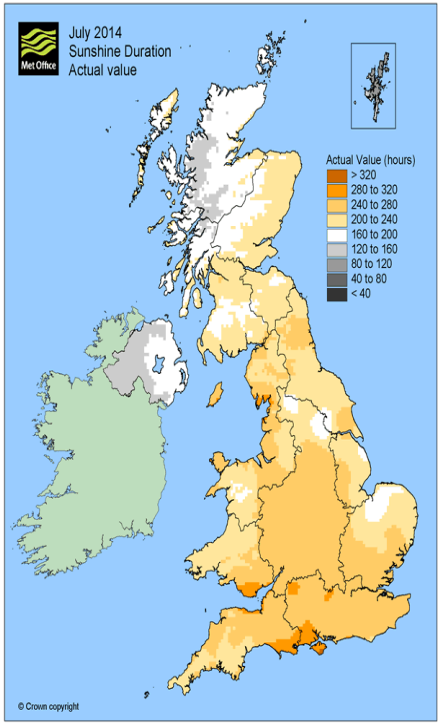
The Scottish Government
Riaghaltas na h-Alba

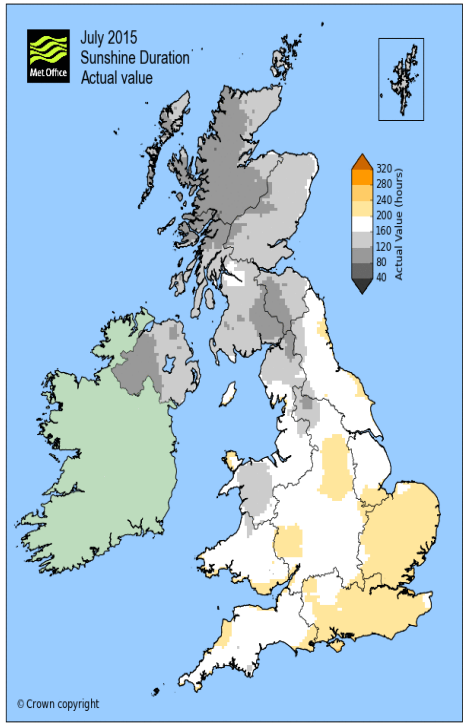
http://www.gov.scot/Publications/2014/12/2462/5#c4

Sunshine hours July 2012, to 2015

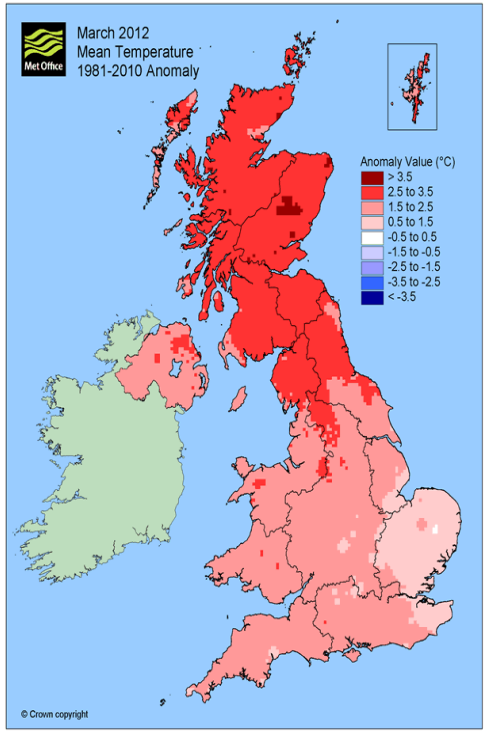


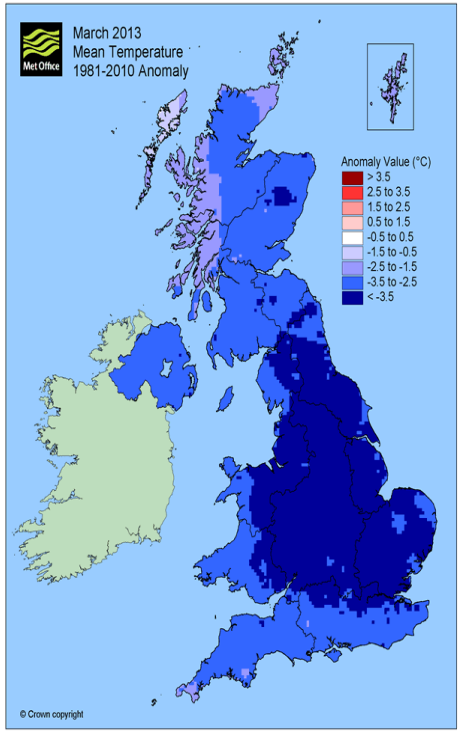


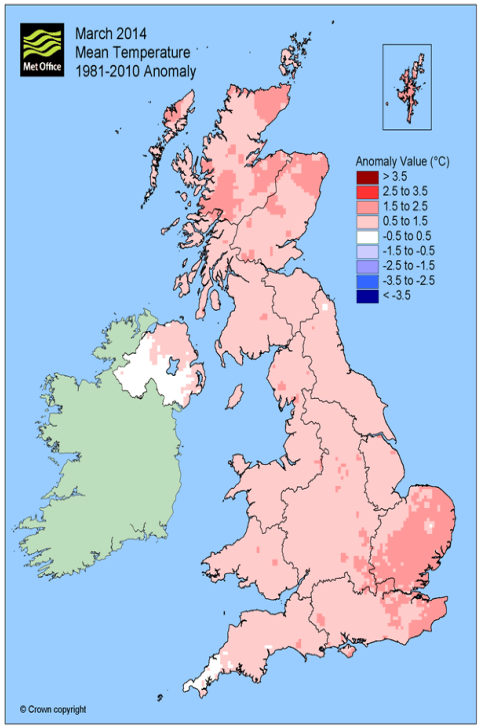


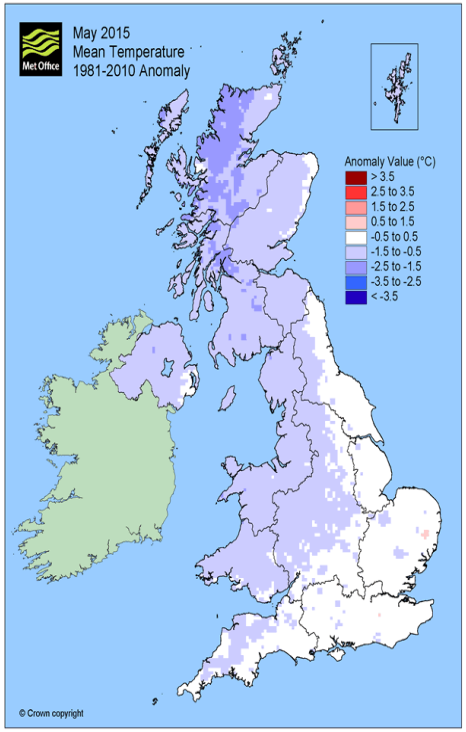


Mean temperatures spring 2012-2015 compared to long term average









Underlying trends / seasonal variation

- Fewer hard winters
- Limited rotations
- Susceptible but marketable varieties

2011/2012 crop season

- Wet autumn
- Poor overwintering in wet soils
- Spring drought in South (not in north!) wet all summer
- Difficulties in timing sprays
- Lack of sunshine
- Low responses to fungicides
- Delayed 2012 harvest

2012 /2013 crop season

- Delayed 2012 harvest led to late drilling
- Record levels of spring crops
- Cold spring/slow growth
- Low disease levels
- Hot July lead to early ripening of some crops
- Low responses to fungicides

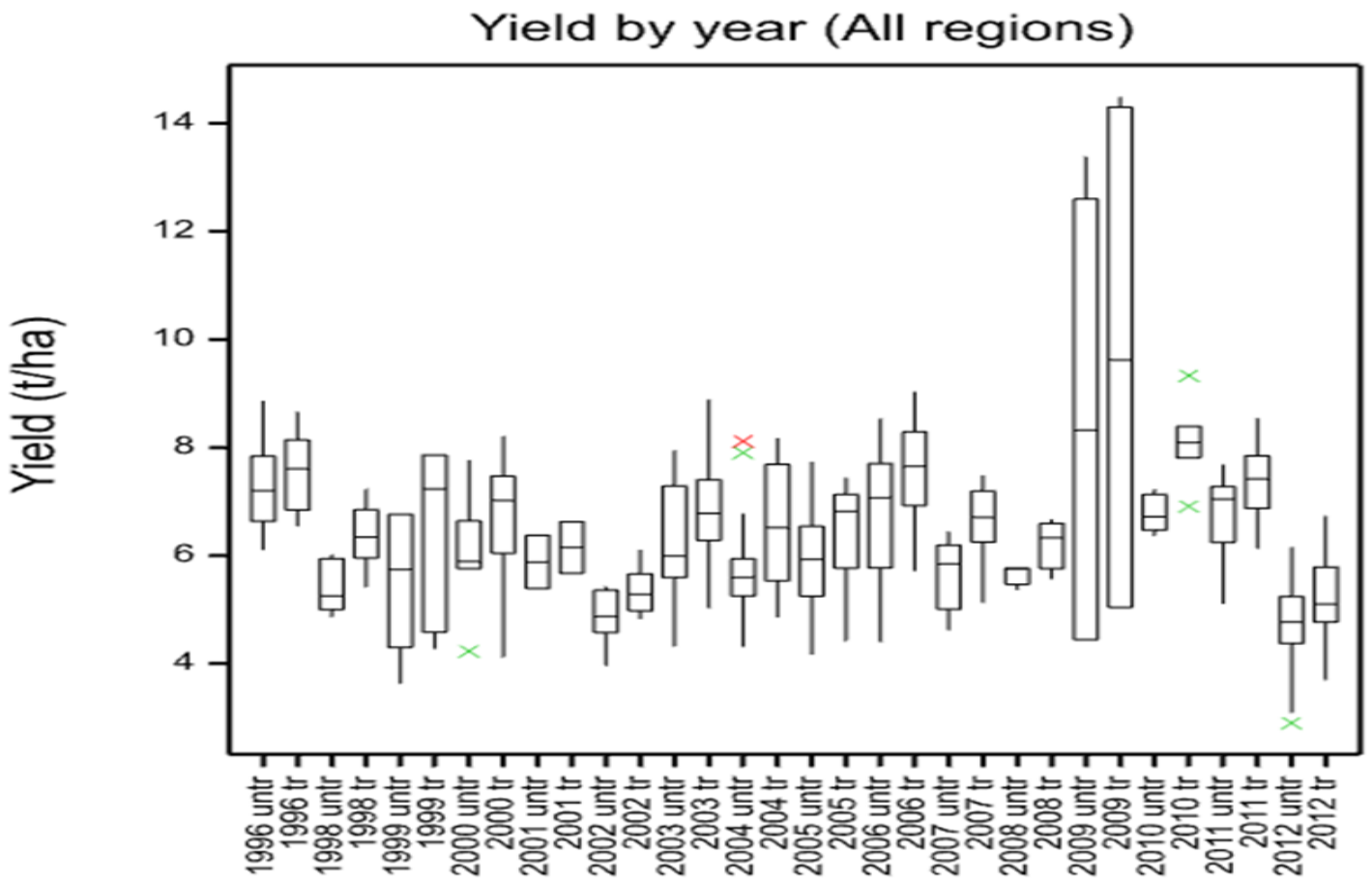
2013/2014 season

- Early drilling
- Warm autumn with disease present early
- Very few winter frosts
- Early growth of crops and diseases in spring
- Warm / wet conditions over critical timings
- Exceptionally high disease levels
- Good potential in crops
- Huge responses to fungicides

2015….started same way so disease burden high …cold spring reversed

Variable responses in trial data

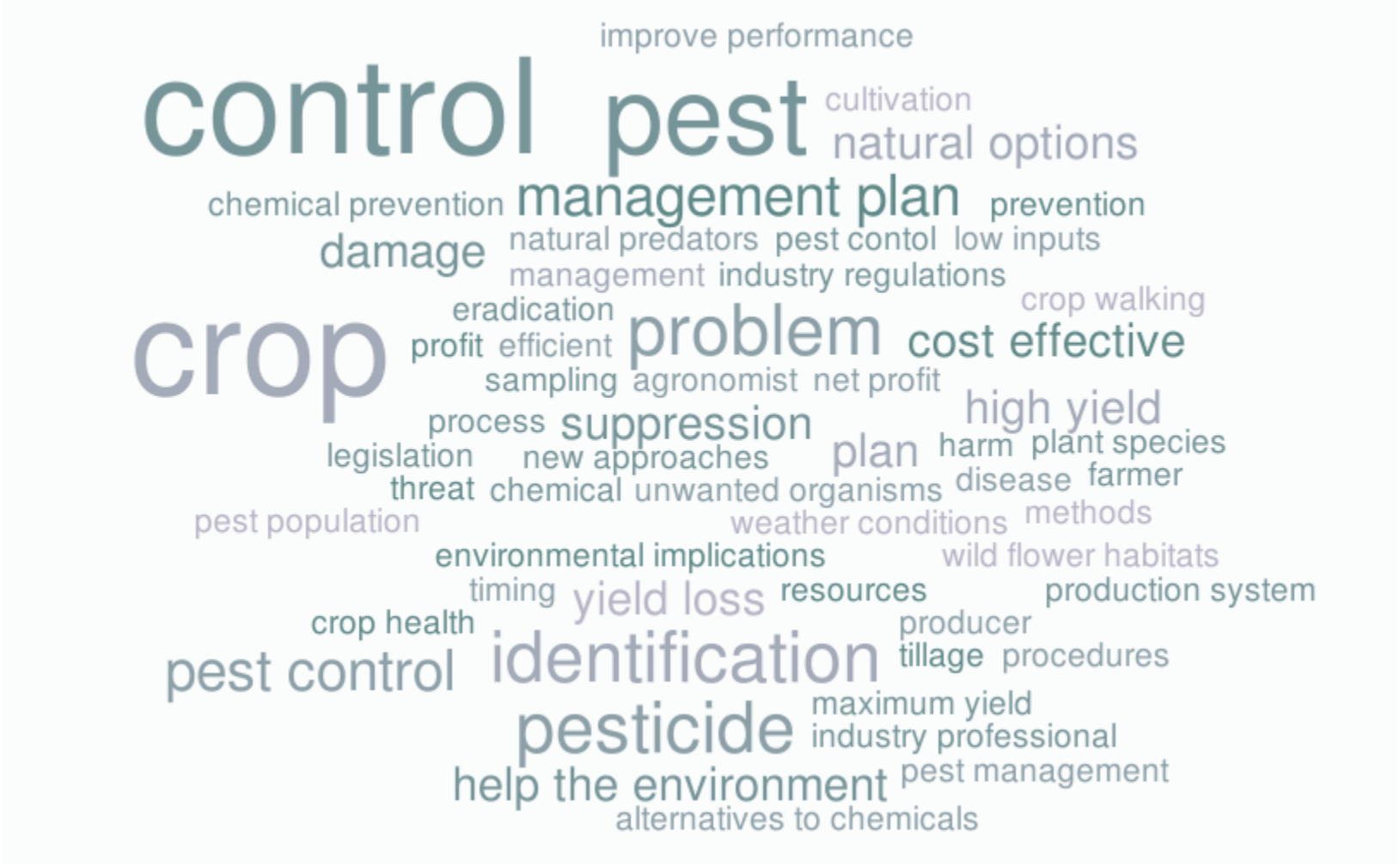
Variable responses in trial data



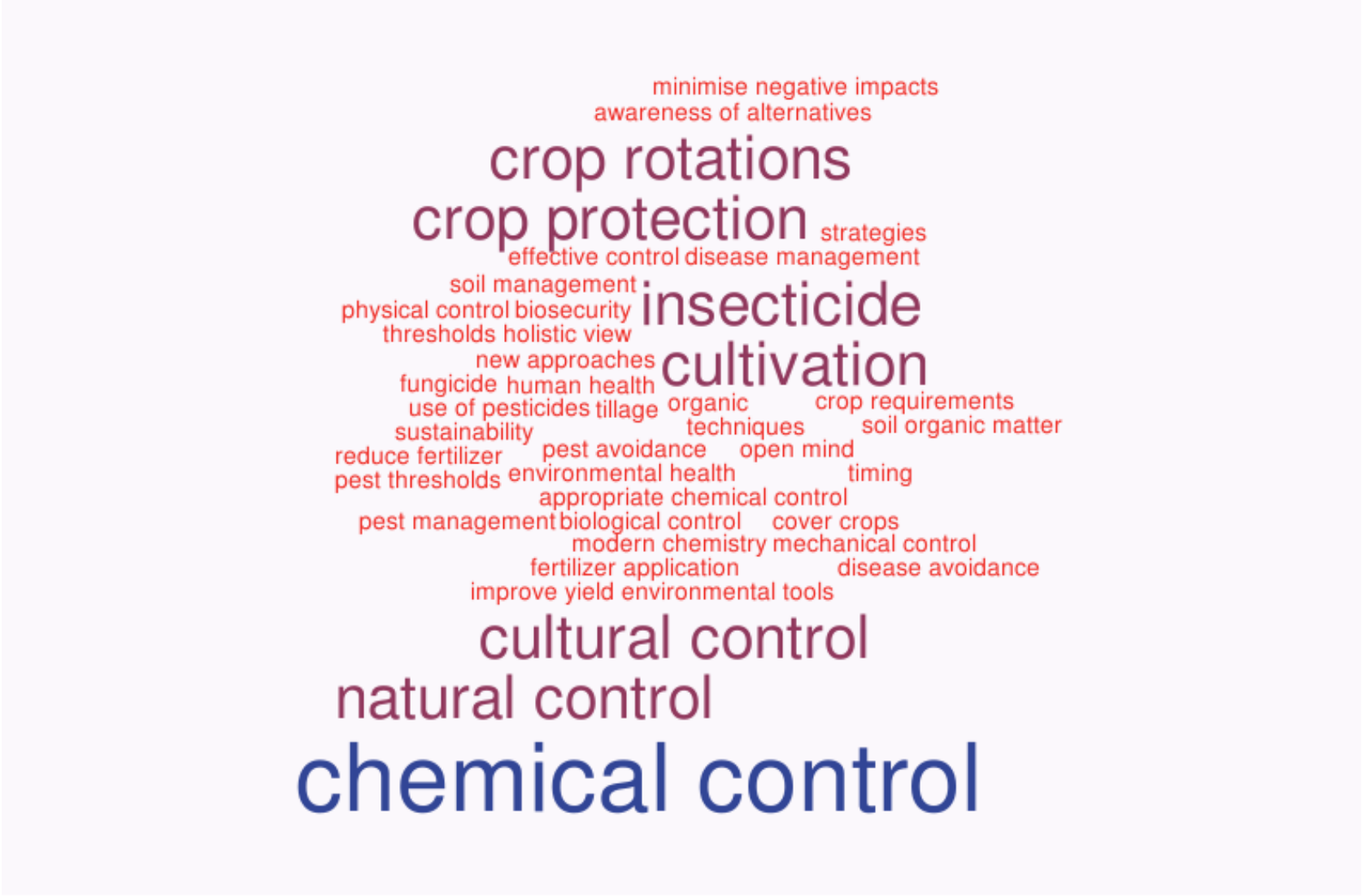
Sustainable crop protection issues

- Very different yield potential in crops between seasons
- Very different disease pressure between seasons
- Different growth patterns each year
- Effective control interventions vary over time
- Economic, environmental and social costs to treatment
- Need for more integrated practices
- What does IPM mean to stakeholders

Group 1- students



Group 2 – industry workshop



Good decision making in the field

- Starts with accurate diagnosis
- Gathering of evidence
- Quantification of risk of economic damage
- Appraisal of options
- Attitudes to risk vary

Ear blight in barley

Judging risk

What information is available to decision makers?

Generic risk / own experience

Evidence from in-season monitoring / warnings

Specific site / crop information / diagnosis

Disease pressure varies each season – monitoring and surveillance are important tools

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CropMonitor™

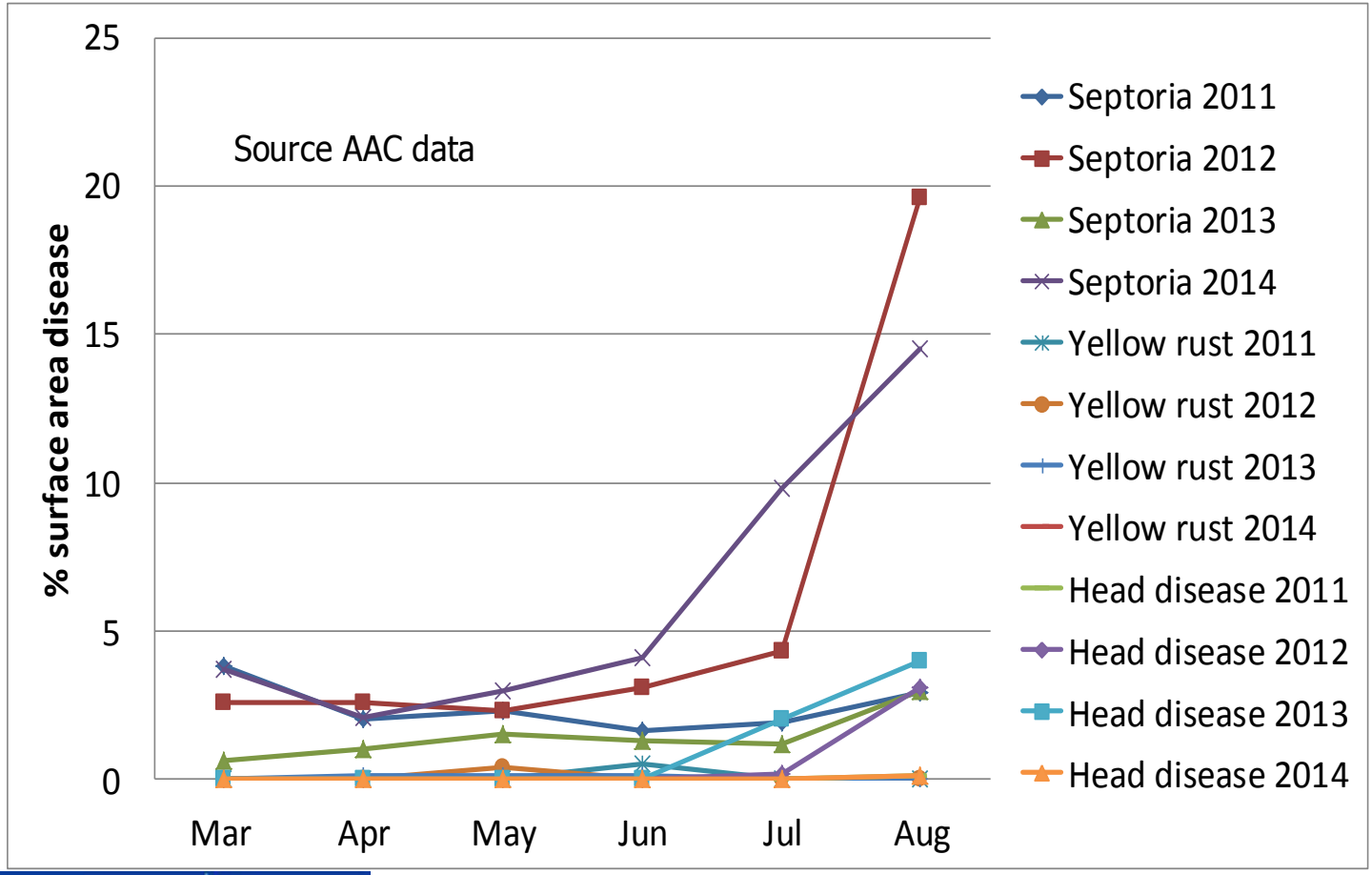
The Scottish Government

SRUC

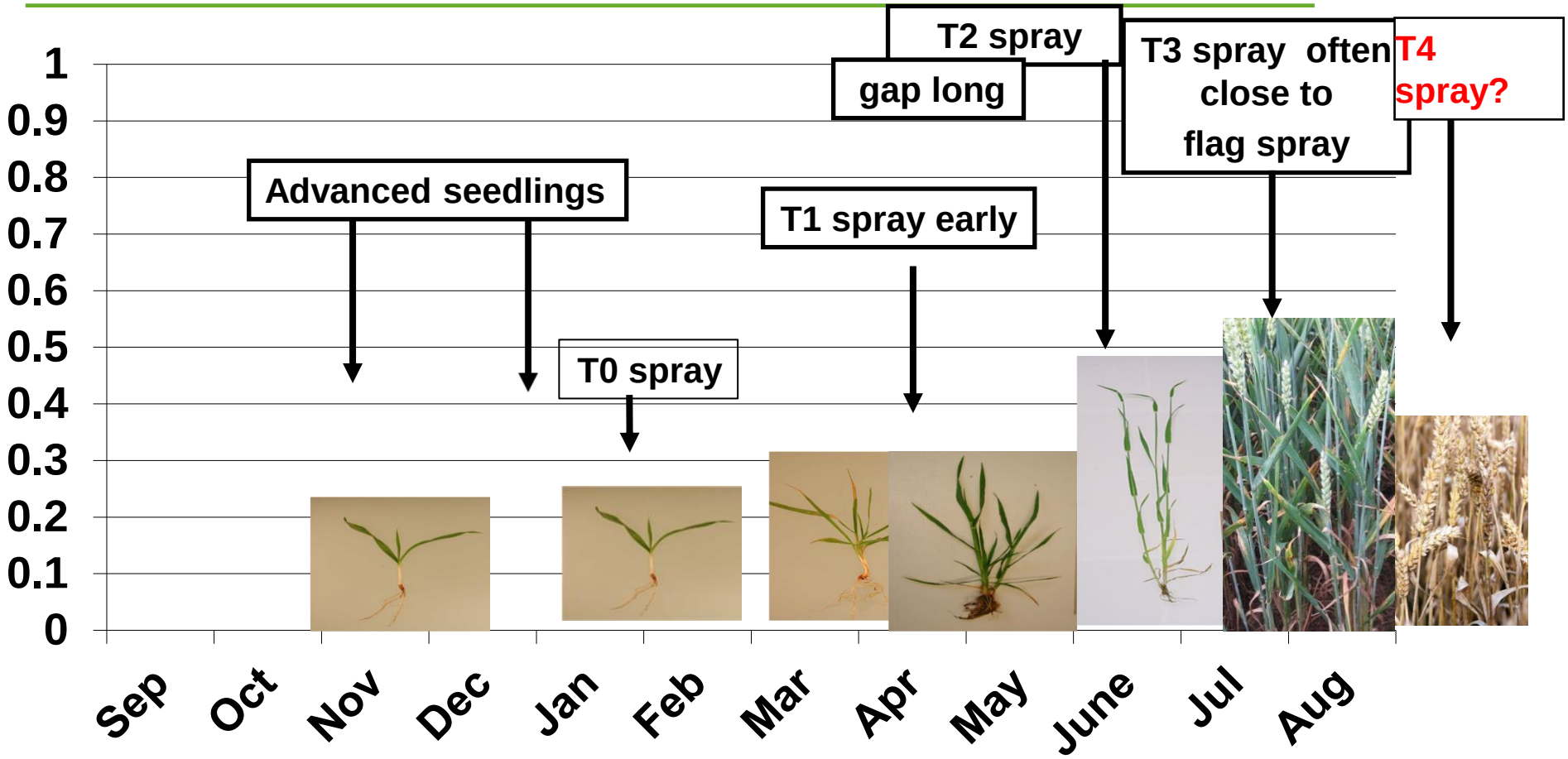
The Scottish Government's
VETERINARY & ADVISORY SERVICES PROGRAMME

What information is available:-

Disease pressure varies with season

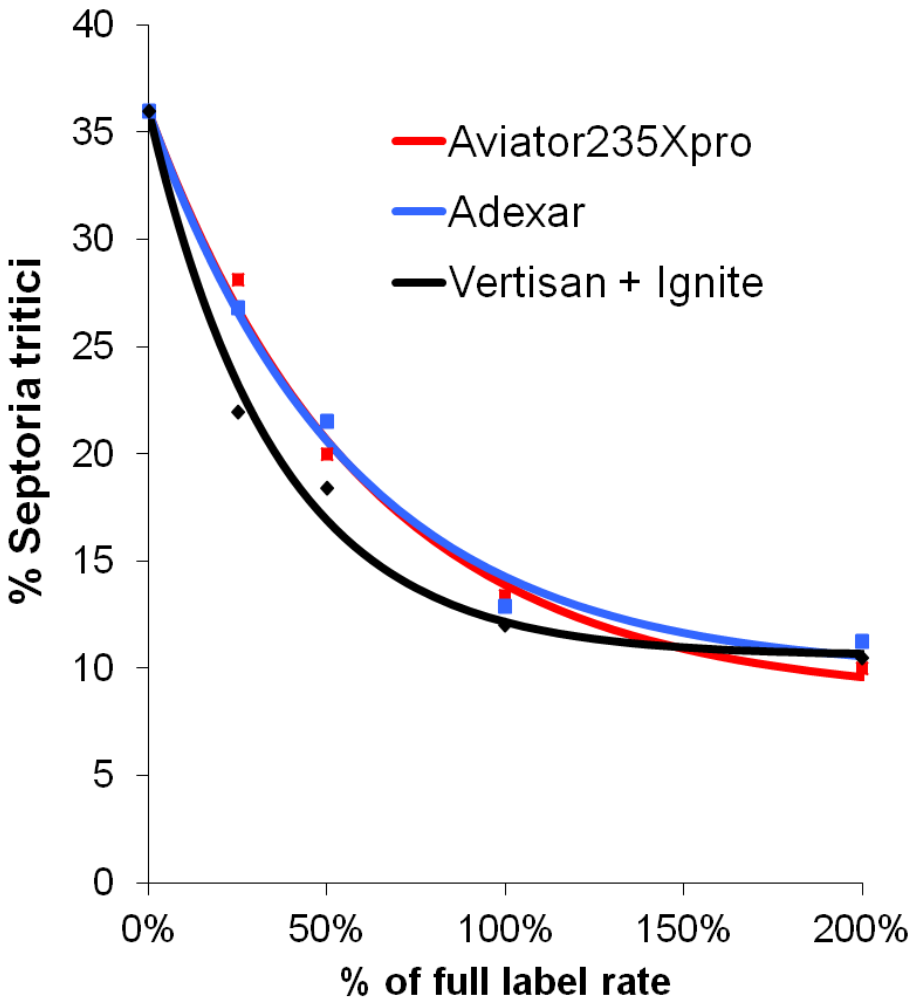


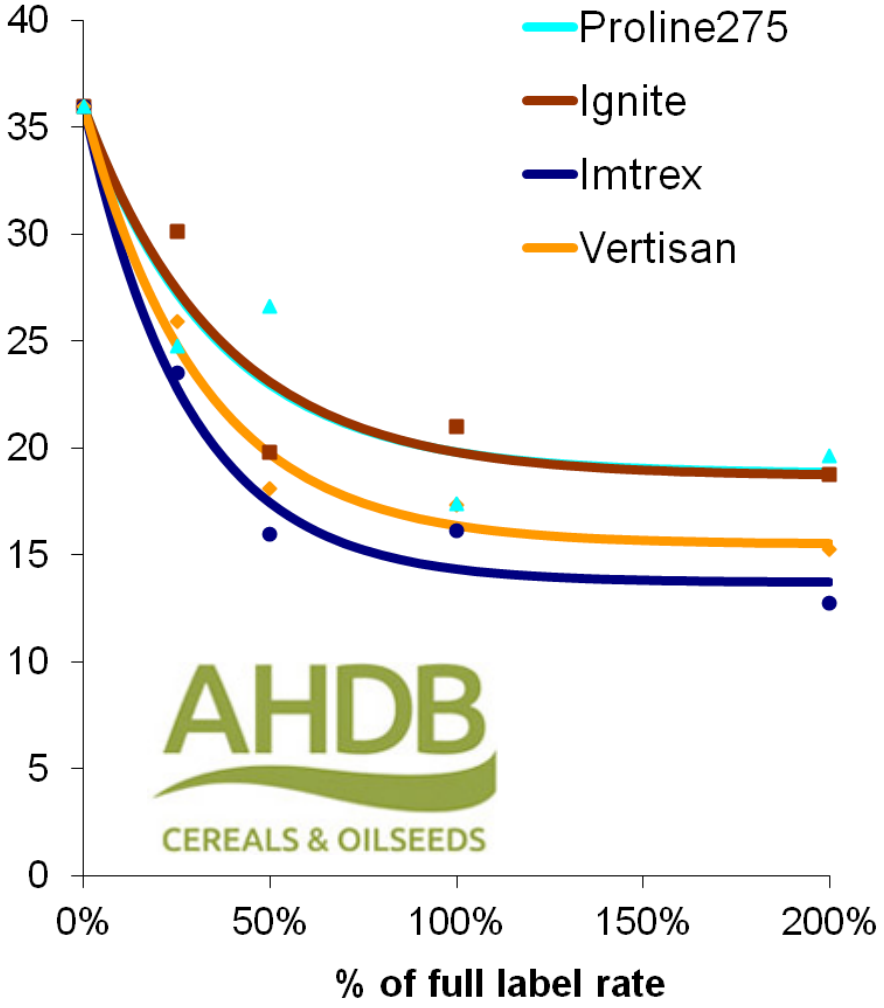
Poor control sometimes explained by difficulties with timing spray applications



Trial data

Using the most effective options Septoria



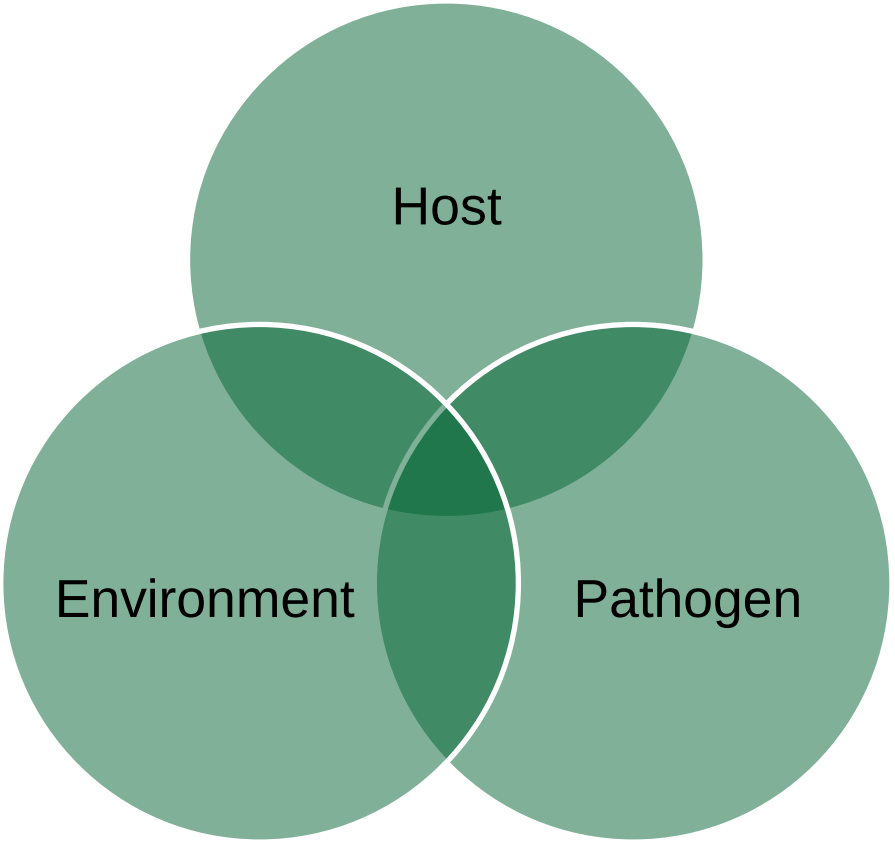


Sources of evidence - Detailed met station data (and spore trap data)

- Spore trap data can be used to track emergence of established, emerging or as yet unknown alien pathogens
- Paired weather and site data can be used to investigate epidemiology and key drivers

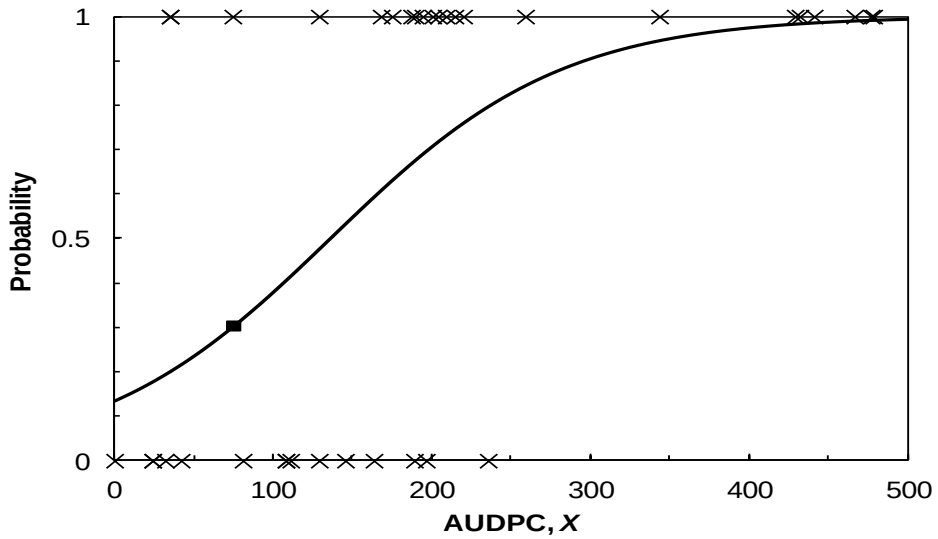
Predicting disease risk…..

- Simple thresholds
- Accumulating risk along a time line
- Available evidence / data
- Effectiveness of interventions
- Weighting of factors
- Risk algorithms



Developing risk methodology

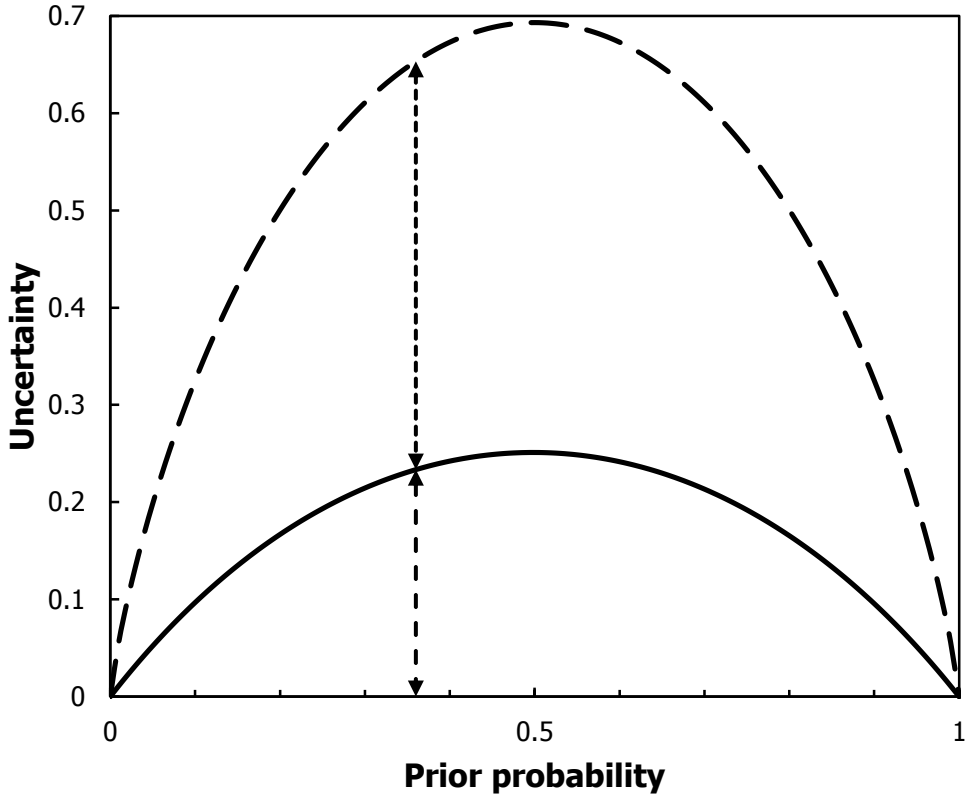
Hughes, G., Burnett, F. J., and Havis, N. D. 2013. Disease risk curves. Phytopathology 103: 1108–1114.



Ramularia leaf spot of barley. Logistic regression of crop status (need for treatment, binary variable 1/0) on the single explanatory variable 'AUDPC'. Data points are indicated ×; the point ■ indicates the economic threshold value for malting-quality barley crops based on 2010 prices.

Developing risk methodology

Hughes, G & Burnett, F. J. Information graphs for binary predictors. Phytopathology January 2015, Volume 105, Number 1: 9-17 (example below based on FHB risk prediction)



Eyespot – Calculation of risk on a timeline

Step 1. Pre-sowing risk score

Factor	Level	Risk points	Score
Region	East	0	
	North	1	
	West	5	
Soil type	Light	0	
	Medium	1	
	Heavy	4	
Previous crop	Non-host	0	
	Other cereal	7	
	Wheat	8	
Tillage	Minimum till	0	
	Plough	6	
Sowing date (before or after 6 October)	Late	0	
	Early	2	
		Pre-sowing risk score	

Step 2. Spring assessment to determine final eyespot risk

Pre-sowing risk score	Eyespot disease incidence at GS31-32				
	1%-4%	**5%-9%**	**10%-14%**	**15%-19%**	**≥20%**
1-4	L	LM	M	MH	H
5-9	LM	M	M	MH	H
10-14	M	M	MH	MH	H
15-19	MH	MH	MH	H	H
20-25	H	H	H	H	H

Final eyespot disease risk	Action
Low risk (L)	None required
Low-medium risk (LM)	
Medium risk (M)	Treatment may be justified where eyespot has been a recurring problem, leading to consistent yield reduction
Medium-high risk (MH)	
High risk (H)	Treatment may be justified even in fields where eyespot has been known to rarely cause yield damage

‘Mycotoxin’ risk score

Factor	Details	Risk
Region (see map)	High	4
	Moderate	2
	Low	-2
	Very low	-4
Previous Crop	Maize	6
	Other	0
Cultivation	Direct drilled	4
	Standard non-inversion tillage	3
	Intensive non-inversion tillage	2
	Plough (soil inversion)	0
Wheat variety	RL Resistance rating 1-5	1
	RL Resistance rating 6-9	0
	RL Resistance rating unknown	1
	Your pre-flowering score	
T3 fungicide	Under 50% dose rate of approved fungicide	0
	50-74% dose rate of approved fungicide	-2
	75% or above dose rate of approved fungicide	-3
Rainfall at flowering (GS59-69)	More than 80 mm	9
	40-80 mm	6
	10-40 mm	3
	Less than 10 mm	0
Rainfall pre-harvest (GS87 to harvest)	More than 120 mm	12
	80-120 mm	9
	40-80 mm	6
	20-40 mm	3
	Less than 20 mm	0
	Your final score	

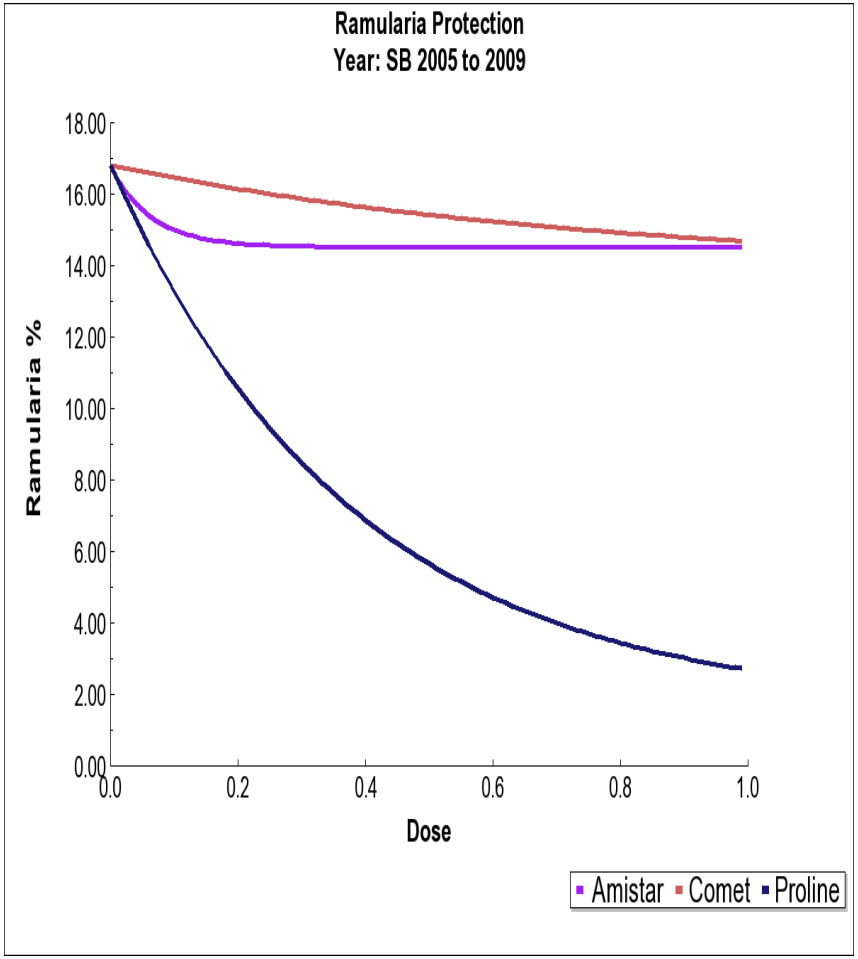
Decision making in a complex environment

Fungicide resistance – the current issues

- Fungicide resistance is eroding established actives and threatening newer ones
- Legislation brings additional threat of losses

So

- How do we use and steward all products to manage these issues?



Loss of field efficacy with QoI fungicides

Resistance management issues

- Loss of compounds with high activity and improved environmental profile.
- Reduced crop yield and quality
- Fewer options for effective disease control and resistance management
- Complex science, confused messages
- Difficulties in motivating industry to be collectively responsible

Introduction to the Fungicide Resistance Action Group -UK

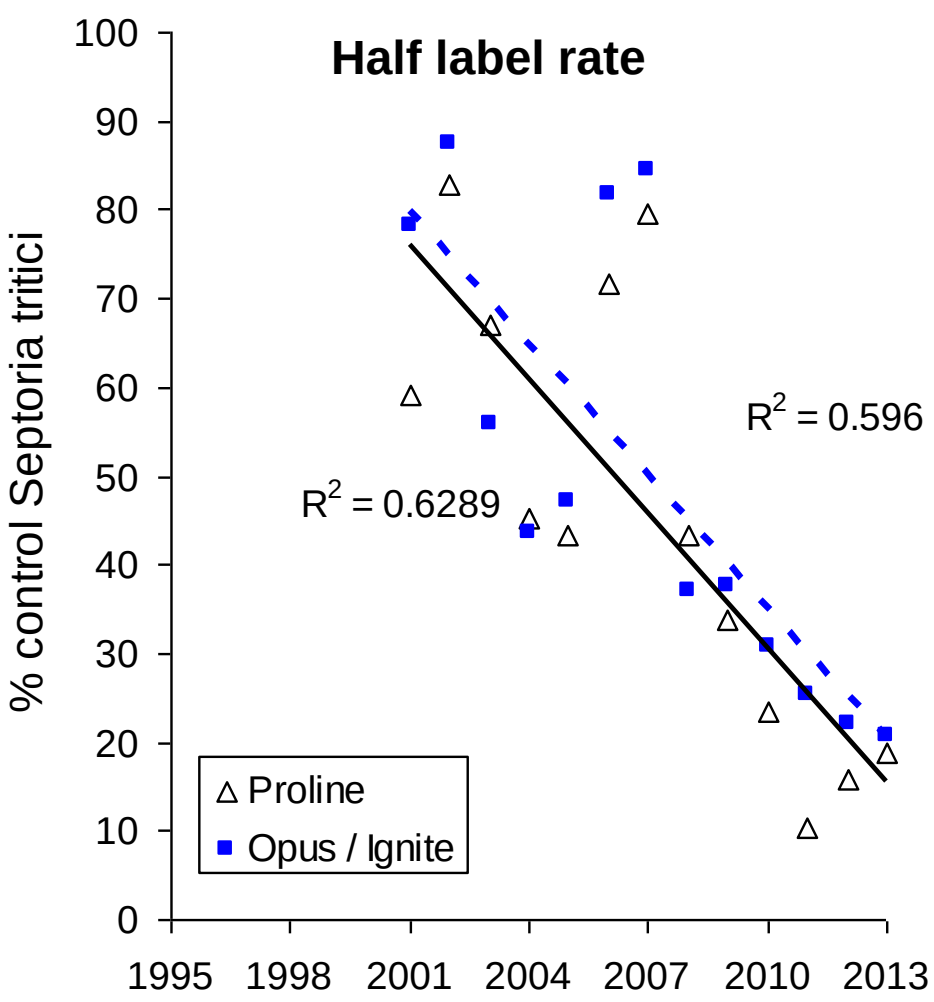
- 20 members + 4 specialist members
- Key independent researchers
- Agrochemical representatives
- Independent agronomist
- Chemicals Regulation Directorate

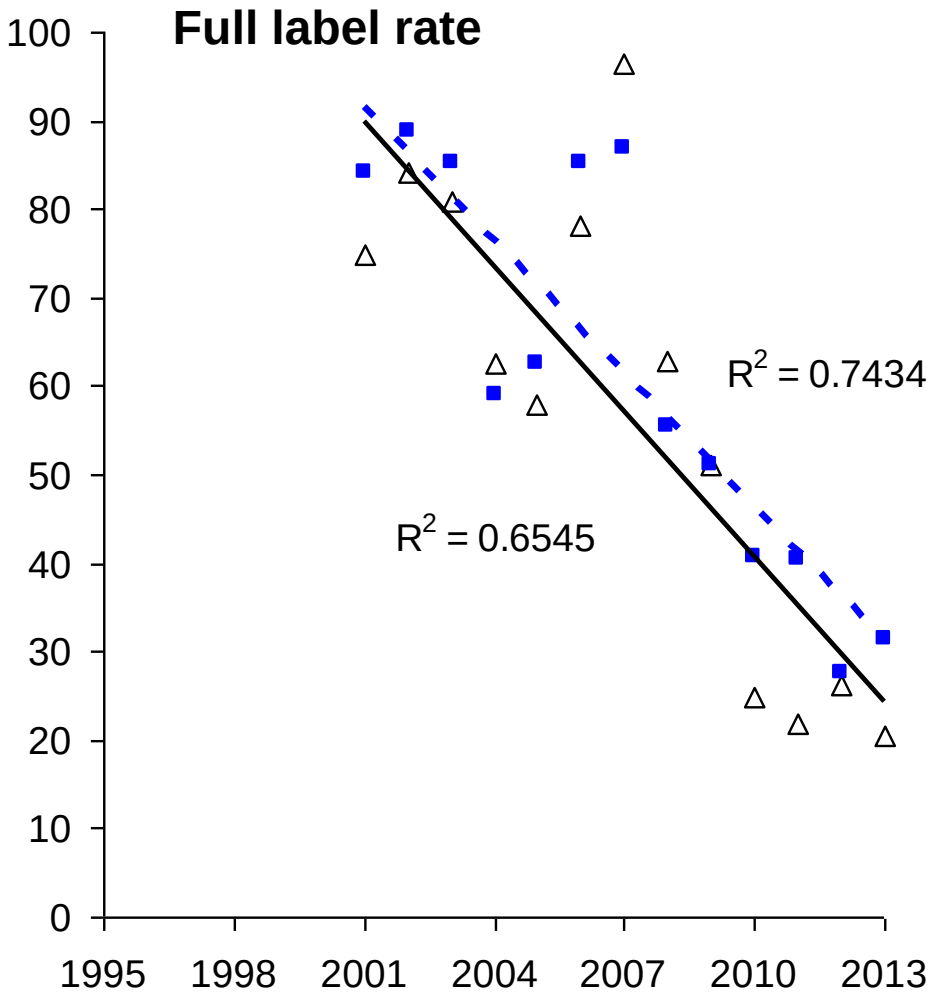
Aims of FRAG- UK

- To gather and interpret reports of fungicide resistance issues
- Arrive at UK consensus view
- To promote practical guidelines on status and management of fungicide resistance in UK
- To give evidence base for regulatory decisions
- To indicate areas where R and D is required

- To publicise the above and reduce incidences of resistance

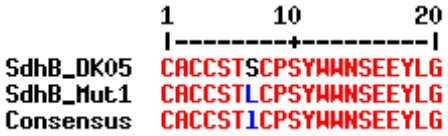
Sifting evidence – declines in efficacy over time





Molecular characterisation of mutants

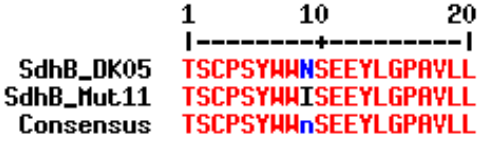
- Mut 1- SdhB



AA change: B- S 217 L

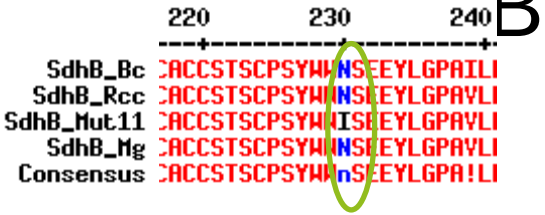
M. graminicola: B- S 218 F (lab mutant)

- Mut 11- SdhB



AA change: B- N 224 I

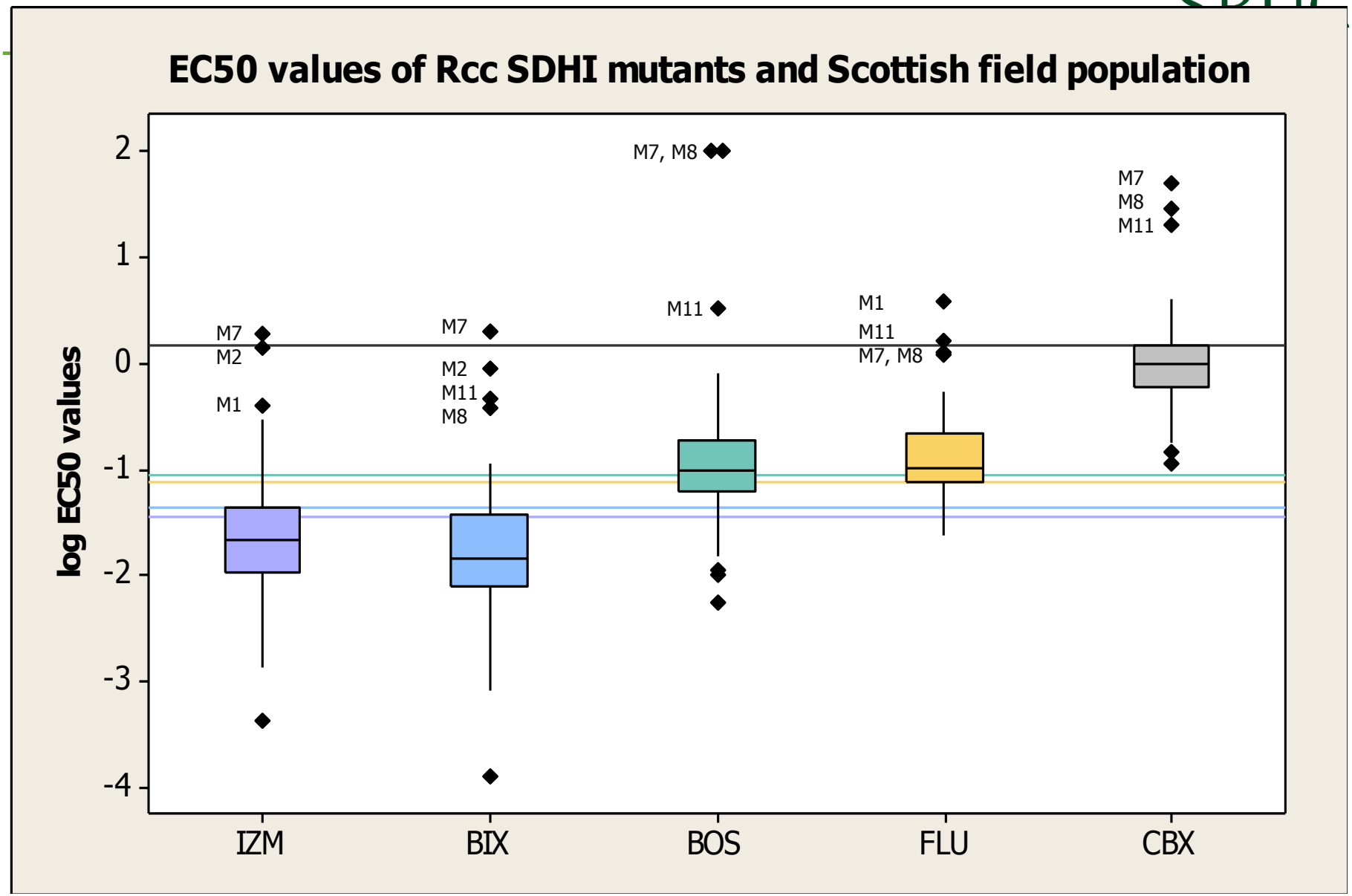
- Mut 11- SdhB



M. graminicola: B- N 225 I (lab mutant)

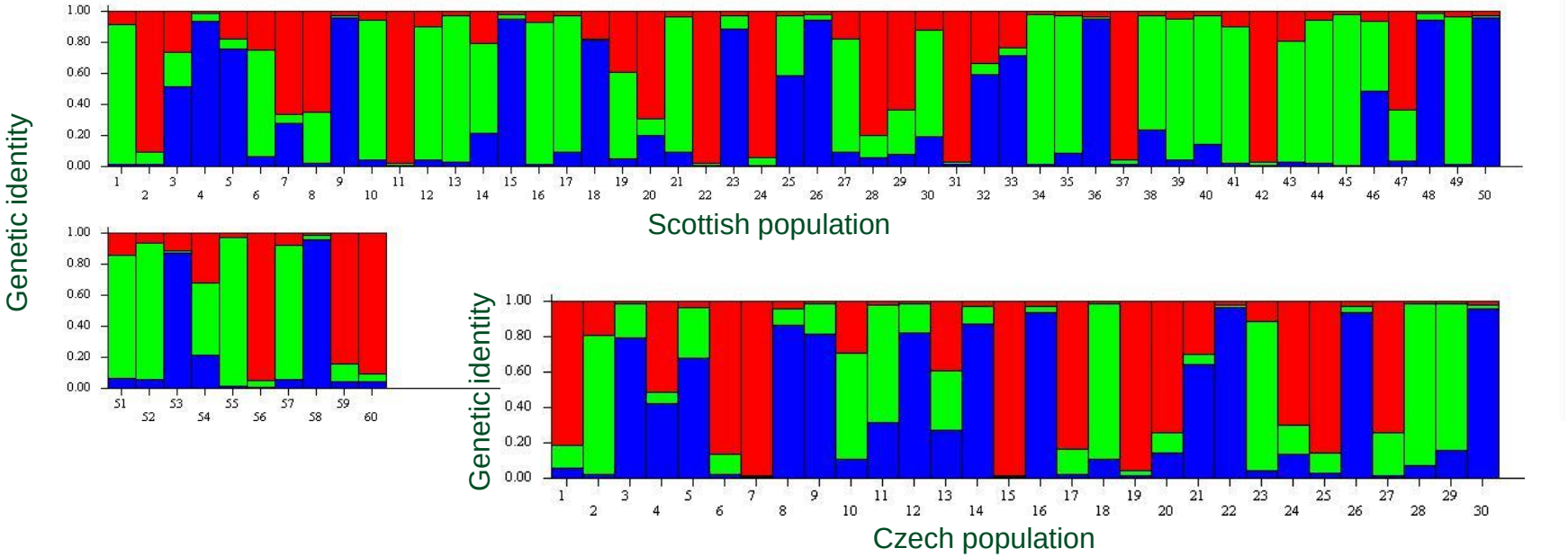
B. cinerea: B- N 230 I (field isolate)

Base line and UV laboratory mutants resistant to SDHIs



Population genetic studies

Genetic structure of Scottish and Czech populations of *Rcc*



- Only one clonal pair in each population
- Populations undergo substantial sexual reproduction, with some asexual reproduction occurring during the season
- Possibly relatively quick adaptation to environmental changes (i.e. fungicide applications, new cultivars)

What can we do to manage resistance?

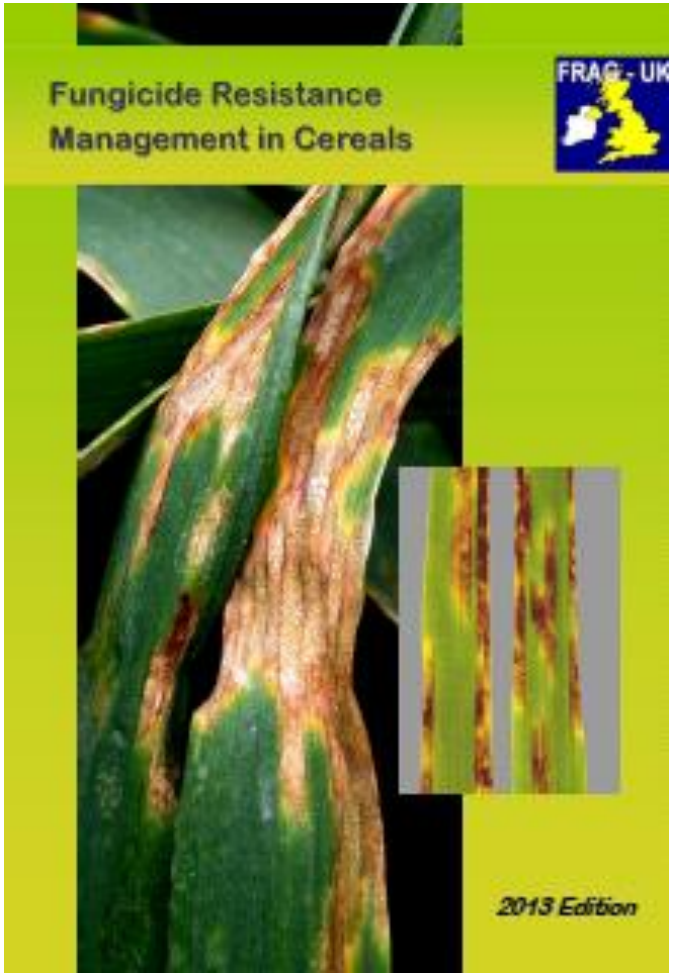
- Is dose rate important?
- Is application number important?
- How effective are mixtures?
- Would alternations be better?

Mix of regulation and stewardship

Key FRAG-UK outputs

- Website
- Guidelines
- Publicity (i.e. posters at HGCA / farmer or research events)
- Statements on topical issues (i.e. azole mixtures, SDHI usage)
- Talks at grower / industry meetings
- Papers / conferences
- UK regulatory authority contact – recommendations for label restrictions / changes

http://www.pesticides.gov.uk/guidance/industries/pesticides/advisory-groups/Resistance-Action-Groups/frag



Knowledge exchange: Taking science to the field

Better evidence / better decision making

Generalist overview / context / sense checking

Field evidence on effective interventions

Advancement in capability, ‘omics’, sensors

Thanks