

Institute for Agri-Food Research and Innovation



### Crop Protection: From a Reactive to a Proactive Approach

Rob Edwards  
Northern Farming Conference  
11<sup>th</sup> November 2015

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### Overview: Focus on Crop Protection

- A reminder of the challenge
- The need for change
- New approaches
- Moving from cure to prevention

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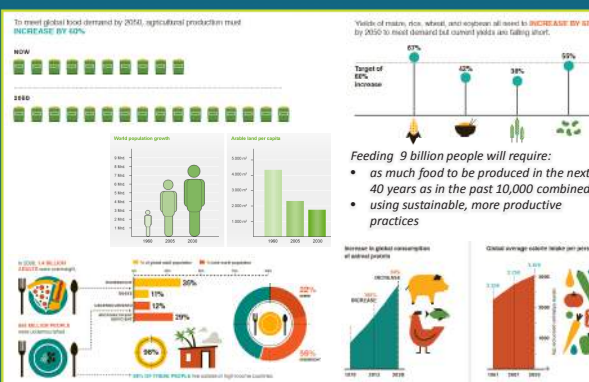
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### Agricultural Challenge: 2050

To meet global food demand by 2050, agricultural production must INCREASE BY 60%

Yields of maize, rice, wheat, and soybean will need to INCREASE BY 63%, by 2050 to meet demand but current yields are falling short.



**Feeding 9 billion people will require:**

- as much food to be produced in the next 40 years as in the past 10,000 combined
- using sustainable, more productive practices

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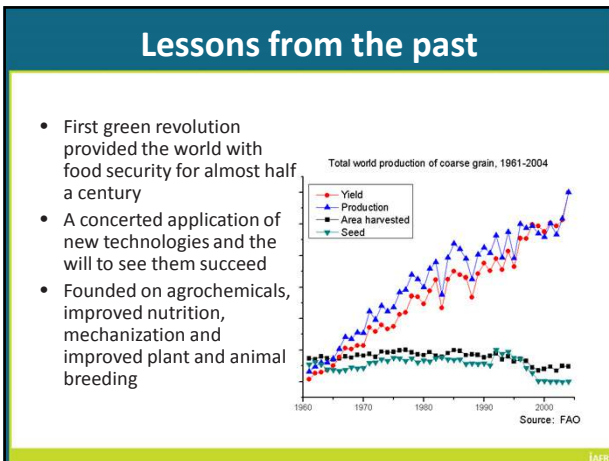
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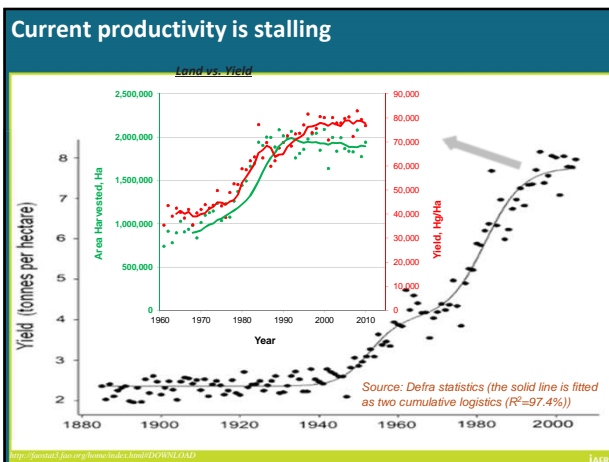
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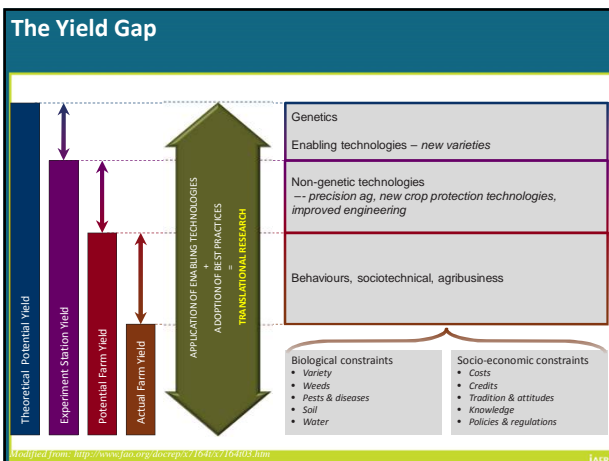
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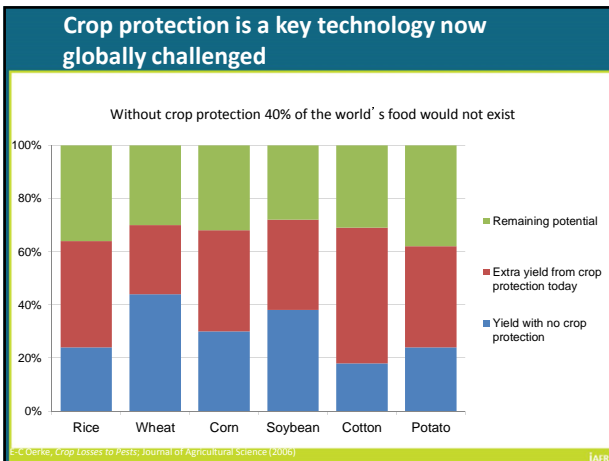
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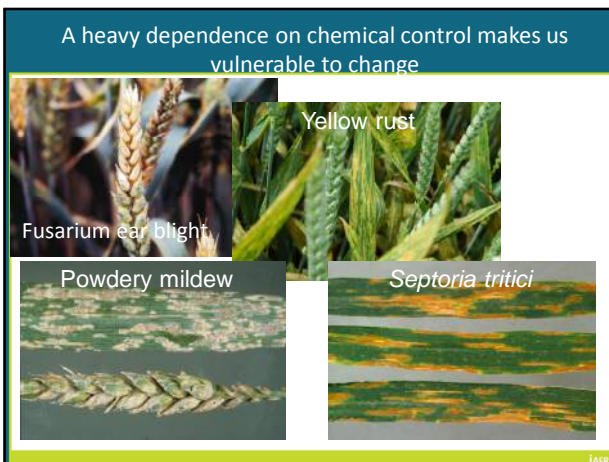
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### The effect of EU Pesticide Legislation- from Risk to Hazard based assessment

*Sets out restrictions on selling, supplying or storing pesticides and precautions to protect the health of humans, the environment, and particularly water, when using pesticides*

- 1986
  - The Control of Pesticides Regulations (SI 1986/1510)
- 1991
  - The Plant Protection Products Directive (91/414/EEC)
- 1997
  - Control of Pesticides (Amendment) Regulations (SI 1997/188)
- 2005
  - The 91/414 Directive is implemented in the UK by the Plant Protection Products Regulations (PPPR)
- 2011
  - European legislation, Regulation (EC) No 1107/2009

Environment  
+  
Safety  
=  
Risk vs. Hazard  
(endocrine disruptors only)  
=  
Cost increase in registration

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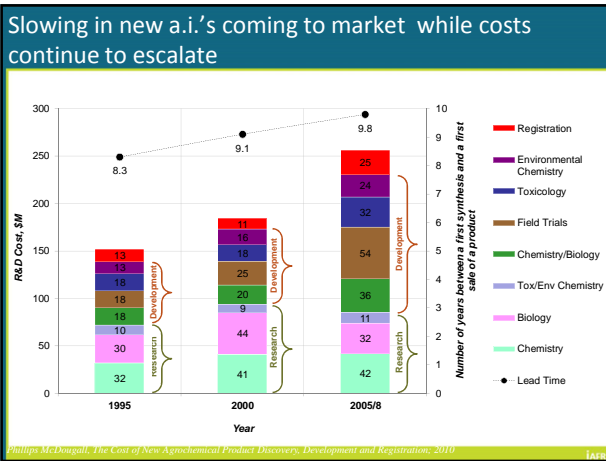
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### The makings of a perfect storm

- Limited rotations and cultural practice
- High dependence on chemical control
- Reduction in existing arsenal
- Few new modes of action

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### Time for a new approach: Innovation in Crop Health and Protection- GO-Science Report 2014

- Better Integration of existing (chemical) and developing (biotech, engineering) technologies
- Fast tracking translation of basic science to new approaches in pest/ weed control (eg: omics)
- National resistance monitoring and intervention
- Better use of data systems/ predictive modeling
- Knowledge transfer
- New skills development
- Proactive engagement with regulators

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### The Problem with Black-grass

- Herbicide resistance now widespread in **black-grass** and rye-grass affecting 1.2 M Ha, reported on 16,000 farms in 34 counties
- Autumn germinating out-crossing weed (rapid evolution)
- Responsible for up to 20%- 100% yield losses in wheat (highly competitive)



Source: Defra

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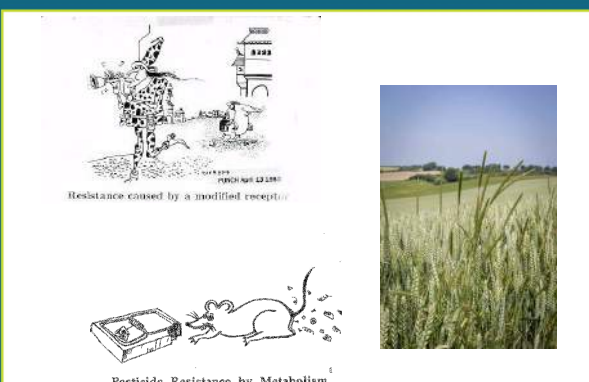
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### Target site and Non-Target site Resistance to Agrochemicals



Resistance caused by a modified receptor

Pesticide Resistance by Metabolism

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### Black-grass Resistance Initiative (BGRi): The battle to combat black-grass

A major (£3.5 million) interdisciplinary project that harnesses latest thinking in biochemistry, ecology, molecular evolution and weed science to provide the basic knowledge to provide solutions

Integrated with knowledge exchange with the farming and agronomy sectors




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### An integrated workplan directed at translation

Core Questions	Work Packages	Outputs
Molecular mechanisms?	WP 1	Diagrams, Tables
Scale of the problem?	WP 2	Reviewers, Audits
Key drivers of emergence?	WP 3	Predictive Models
Practical evolutionary theory?	WP 4	Management Prescriptions
Management consequences?	WP 5	

5 fully integrated work packages




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### A Systematic and Scientific Audit of Resistance



**First two field seasons completed**

- 71 farms, 138 fields surveyed & resurveyed
- 190 seed populations collected
- Field management data collated




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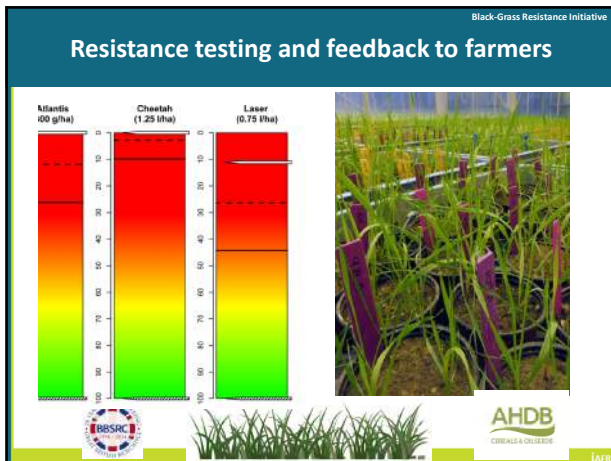
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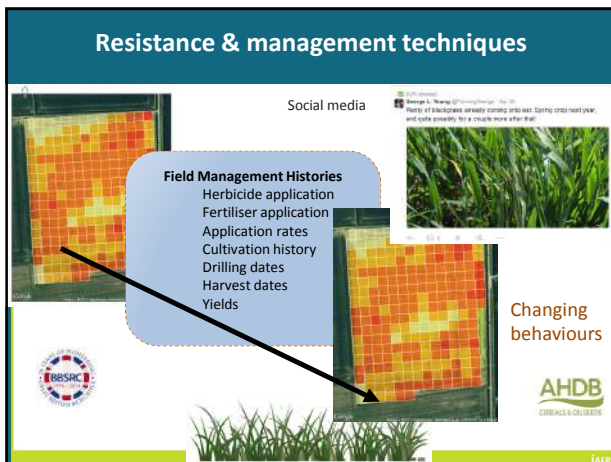
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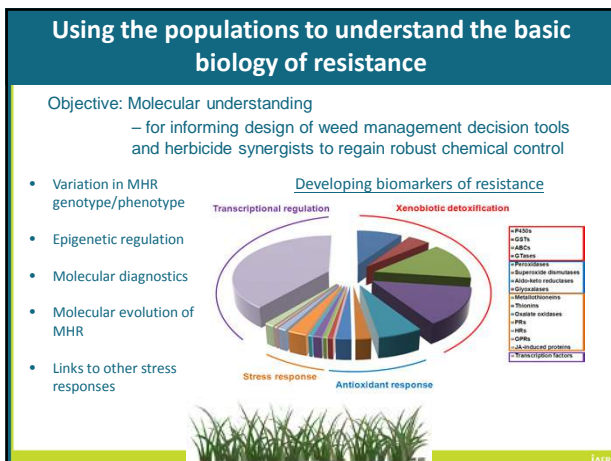
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### Identifying new routes to counteracting resistance

Wild-type

Peldon

Cl

O=C1N=C(C=C(Cl)C1=O)[N+](=O)[O-]

a b c d

a b c d

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### Real time diagnostics: Moving to prevention rather than cure

LFD

LAMP reaction

ArrayTube (AT)

data matrix

probe array chip

Clondiag

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### The black-grass resistance initiative; a new way of working

- By integrating the best science with knowledge exchange with the farming sector
- An approach to making better use of what we have left
- The pressure on reducing our dependence on synthetic pesticides will continue
- Drawing on parallels with developments in human healthcare - What next ?

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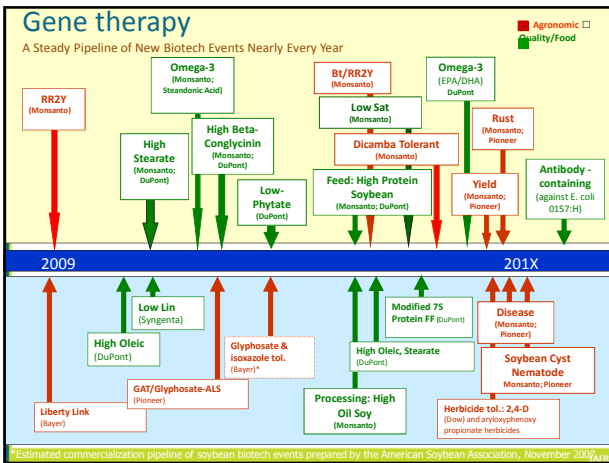
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### Prevention

- Where applied at a national level has proven successful in exclusion of exotics
- Can more be done at regional/ farm level ?

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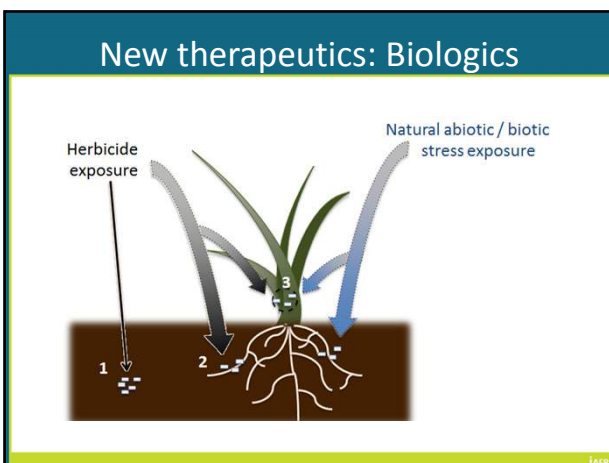
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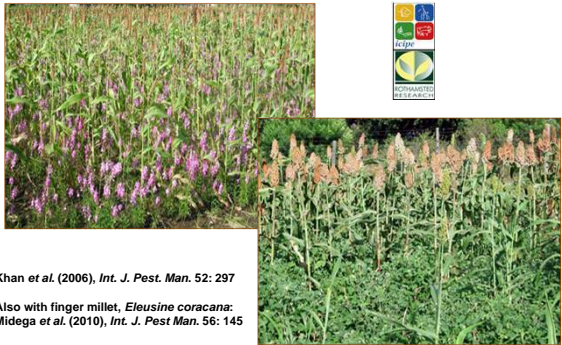
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### Natural therapy



Khan et al. (2006), *Int. J. Pest. Man.* 52: 297  
Also with finger millet, *Eleusine coracana*:  
Midega et al. (2010), *Int. J. Pest Man.* 56: 145

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### From Crop Protection to Crop Health

- No magic bullets but plenty of options in more integrated solutions
- Fast track innovation between end users and researchers
- Better uptake of new technologies



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### Acknowledgements



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CEREALS & OILSEEDS



**fera**  
The Food and Environment Research Agency



**THE UNIVERSITY of York**

Black-grass herbicide resistance initiative





**Durham University**



**BBSRC**  
bioscience for the future



**syngenta**



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### Contact IAFRI

<http://www.ncl.ac.uk/iafri>

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