

The other pandemic: resistant ager-rævehale i England



Paul Neve

**Plant & Environmental
Sciences, University of
Copenhagen**

Who am I?



1999 – 2005 Australian Herbicide Resistance Initiative,
University of Western Australia



2005 – 2013 University of Warwick, Weed ecology,
evolution and management



2021 – Professor, Plant & Environmental Sciences,
University of Copenhagen



2014 – 2020 Rothamsted Research, Head of Smart
Crop Protection Programme

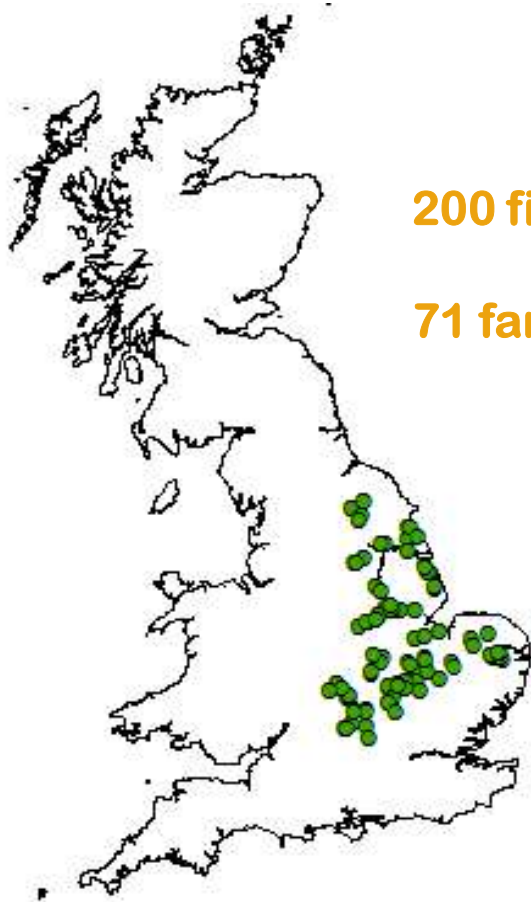
Herbicide resistant blackgrass, 2014



A blackgrass farm network



Black-Grass Resistance Initiative



200 fields

71 farms

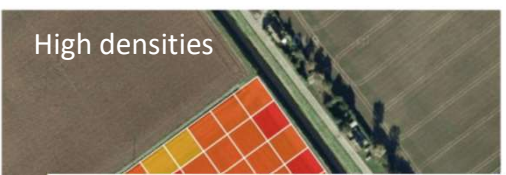
- Field maps
- Resistance tests (glasshouse, molecular)
- Field management data
- Environmental data (soils, weather etc.)

2014: Black-grass abundance

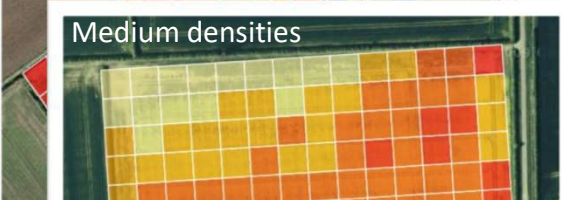


Black-Grass Resistance Initiative

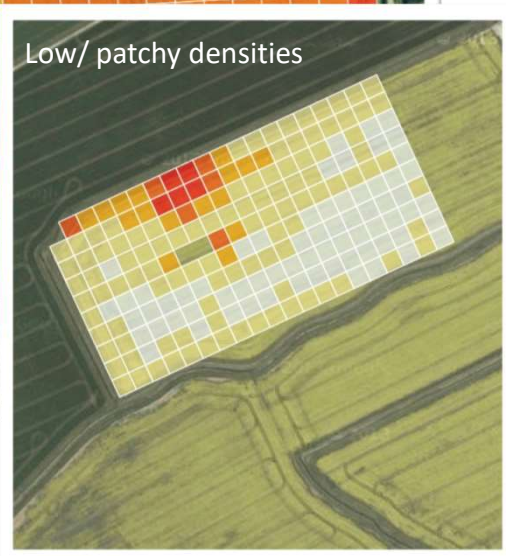
High densities



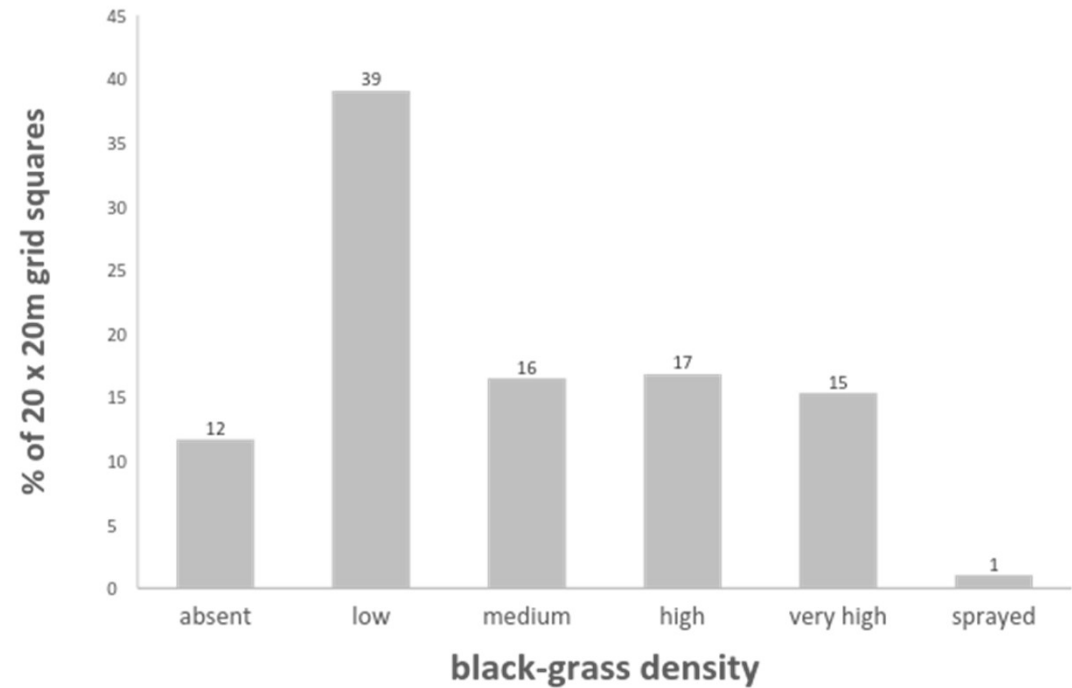
Medium densities



Low/ patchy densities



- 0 = absent
- 1 = 1-160 plants
- 2 = 16-450 plants
- 3 = 451-1450 plants
- 4 = 1450+ plants

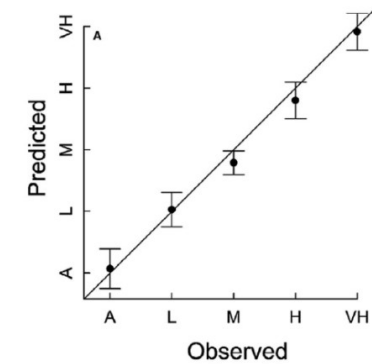
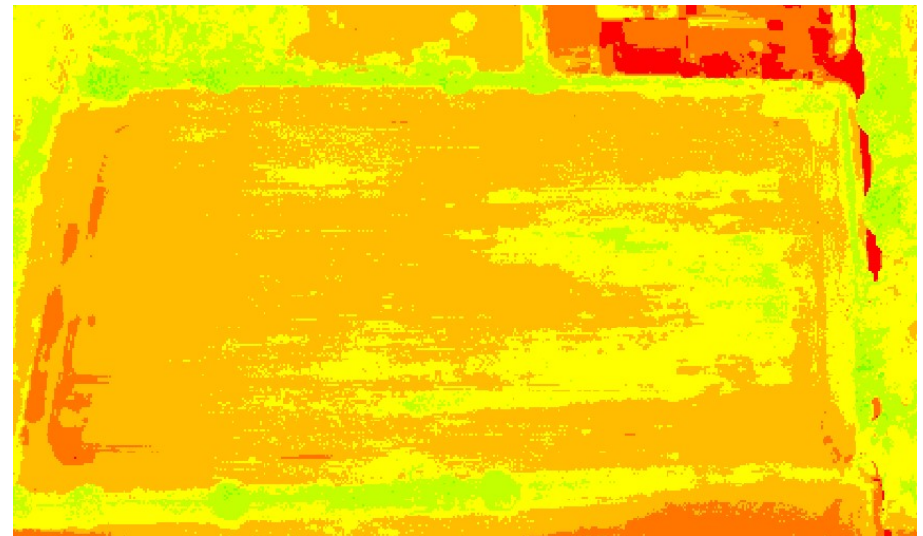
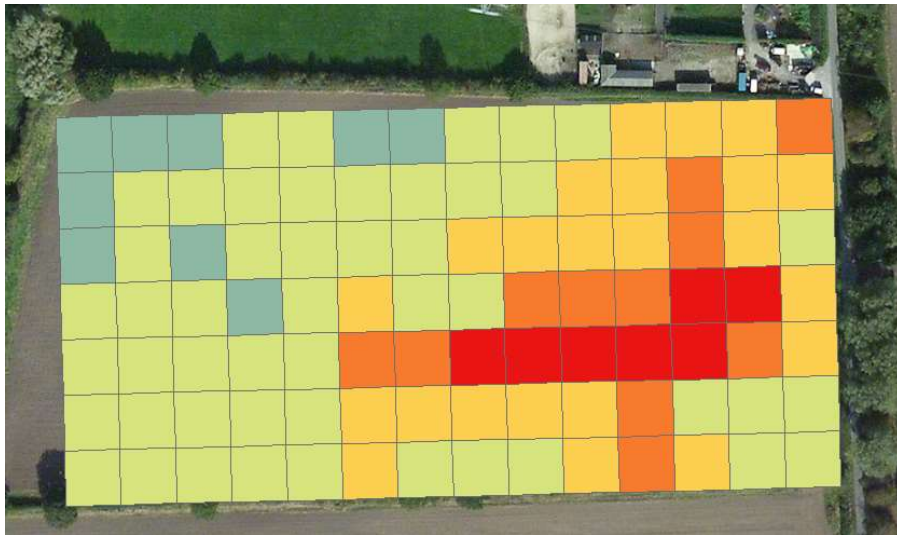


- Black-grass present in 88% of 25,000 sampled quadrats
- High or very high in 32%
- South to north gradient (more in south)

Automating weed mapping with UAVs



Black-Grass Resistance Initiative



Lambert et al. *Weed Research* 2017.

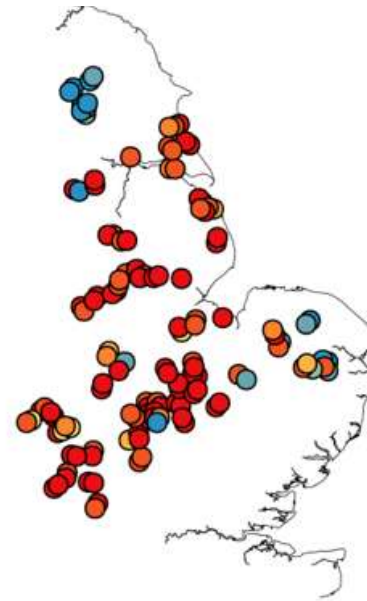
Herbicide resistance at a national scale



Black-Grass Resistance Initiative

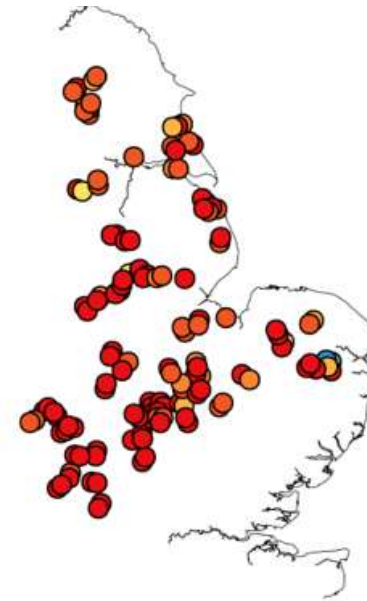


Mesosulfuron (ALS)



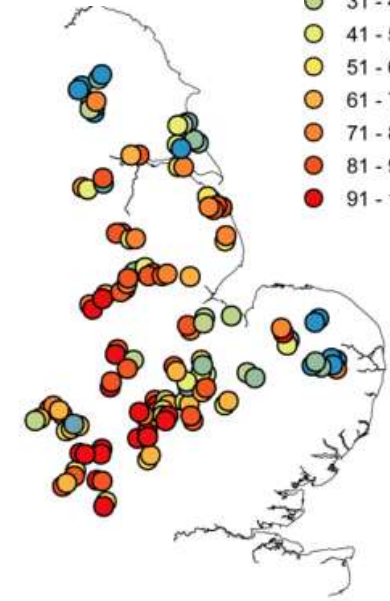
75% resistance

Fenoxaprop(ACCCase)



90% resistance

Cycloxydim (ACCCase)



56% resistance

% Survival

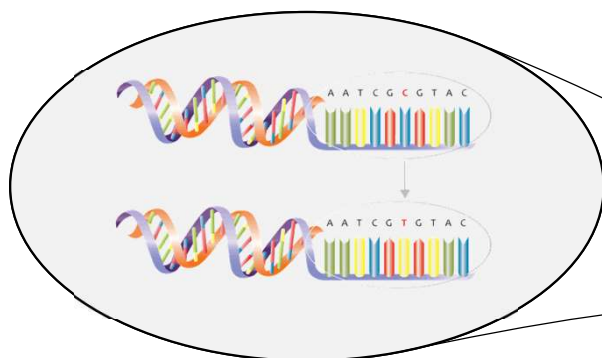
- 0 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50
- 51 - 60
- 61 - 70
- 71 - 80
- 81 - 90
- 91 - 100

Types of resistance in blackgrass



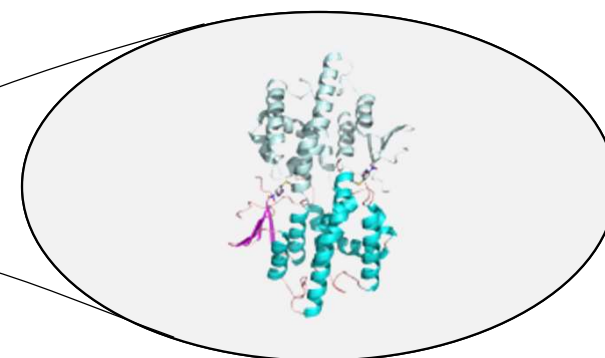
Black-Grass Resistance Initiative

Target-site resistance (TSR)



- Based on modification of target enzyme
- Resistance to one mode-of-action
- One gene

Metabolic resistance (NTSR)



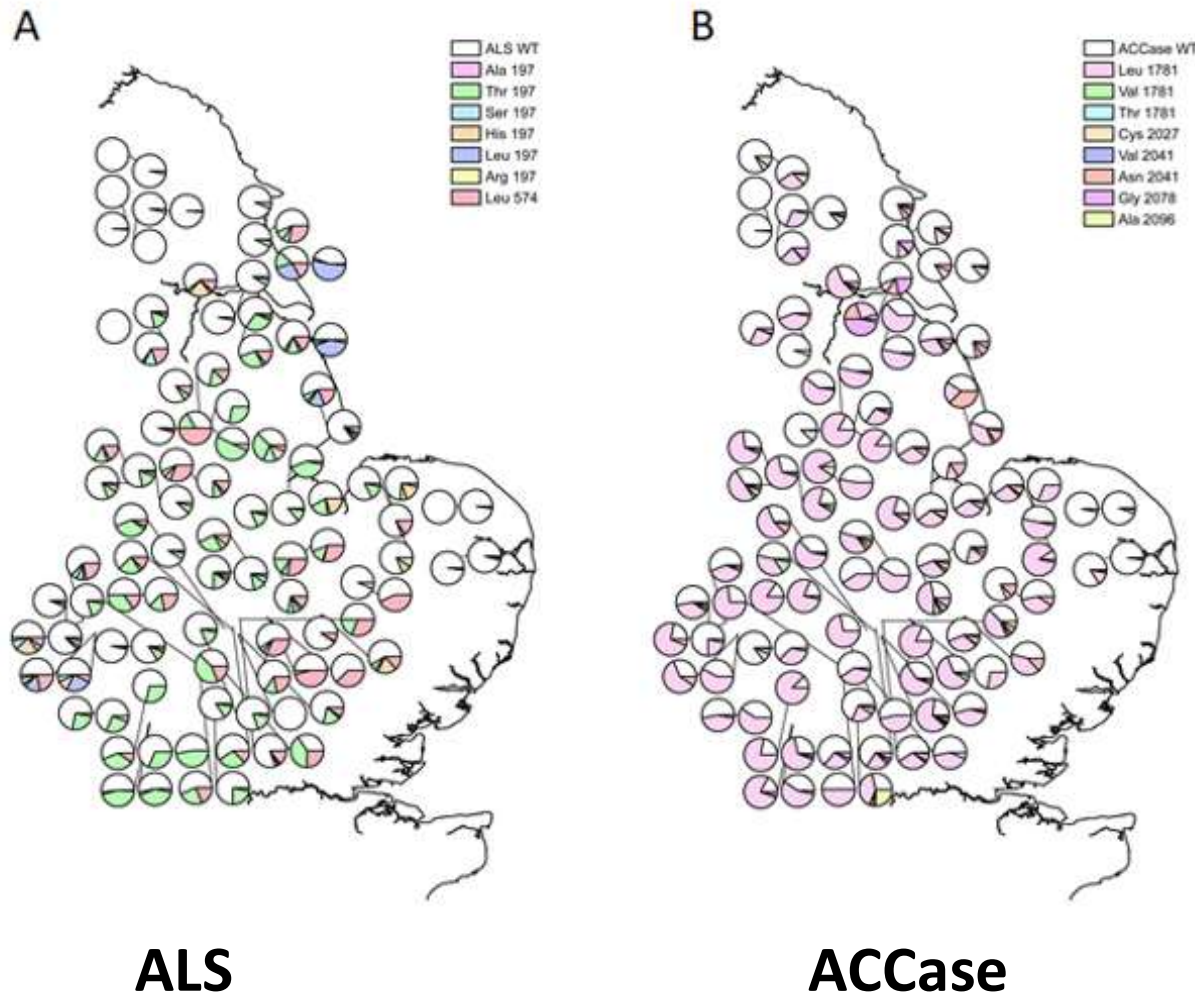
- Based on proteins that metabolise herbicides
- Resistance to multiple modes of action
- Many genes



Target site resistance in blackgrass



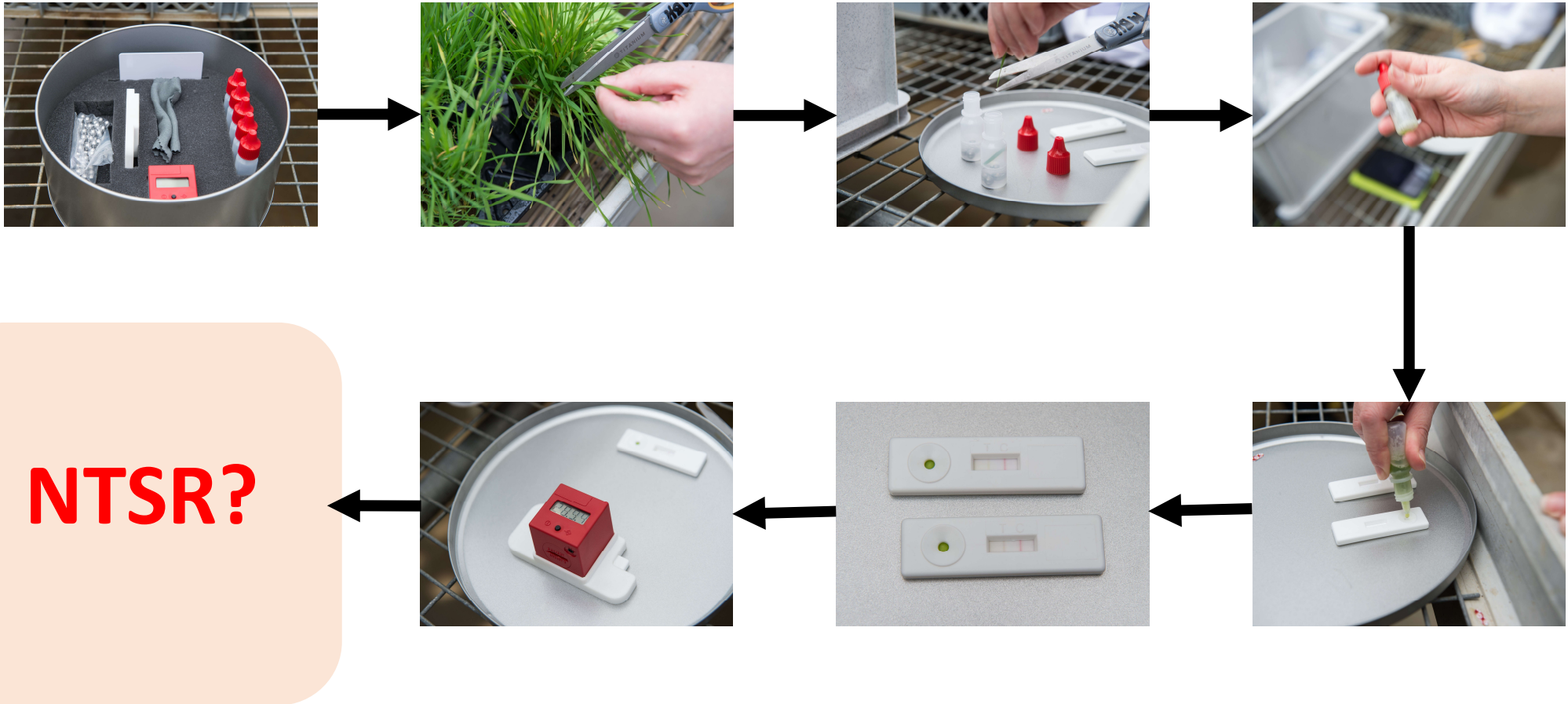
Black-Grass Resistance Initiative



TSR is frequent and widespread, but it does not account for all resistance we see.

NTSR is also important.

A field test for non-target site resistance



Commercial production



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TO USE DEVICE TO
DIAGNOSE NON-TARGET
SITE RESISTANCE
TO HERBICIDES IN
BLACKGRASS.
TAKE BACK YOUR FIELD!

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About BReD.

- 1 A technology that works on farm and gives new data within minutes of testing.
- 2 An accurate identification of NTSR black-grass is the first step for planning effective grass-weed control
- 3 A real-time detection of Non-Target Site Resistance (NTSR) black-grass provides information for growers to make immediate adjustments to black-grass control and to monitor the effectiveness of strategies to tackle it.
- 4 A quick and easy to use detection method enables growers to map NTSR black-grass in different areas of the fields within hours.
- 5 A decision tool to predict the likely effectiveness of post-emergence herbicide treatment prior to application.

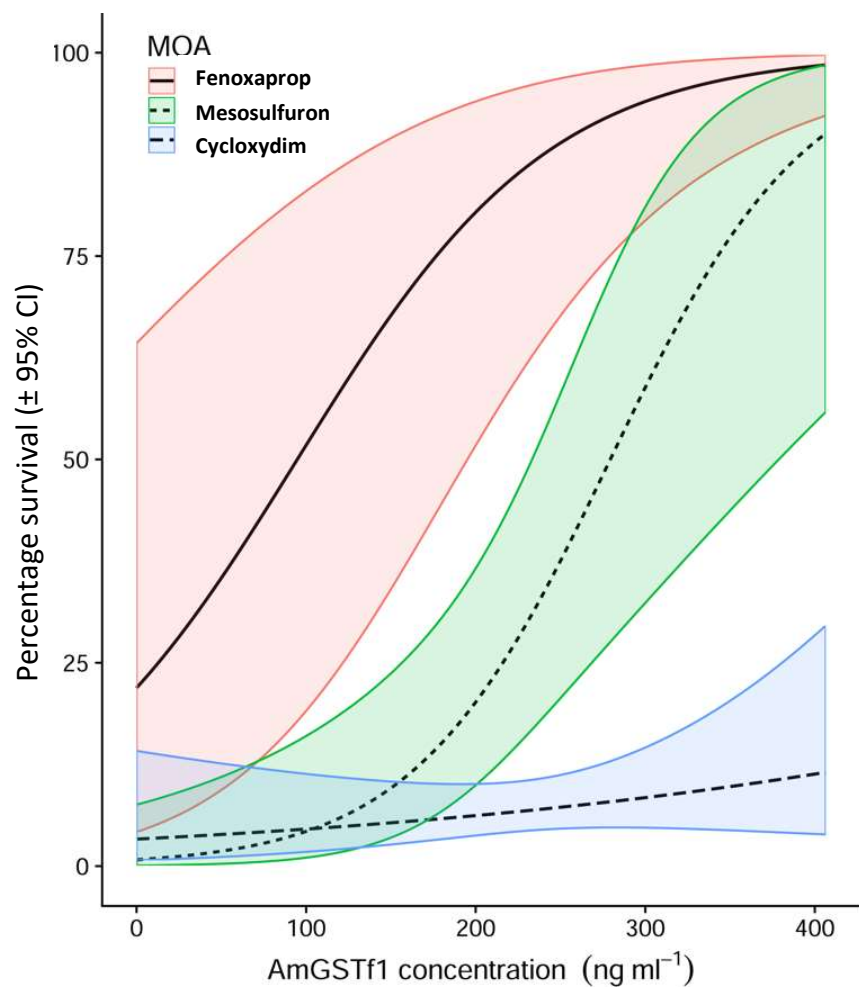
LEARN MORE

PURCHASE

Non-target site resistance in blackgrass

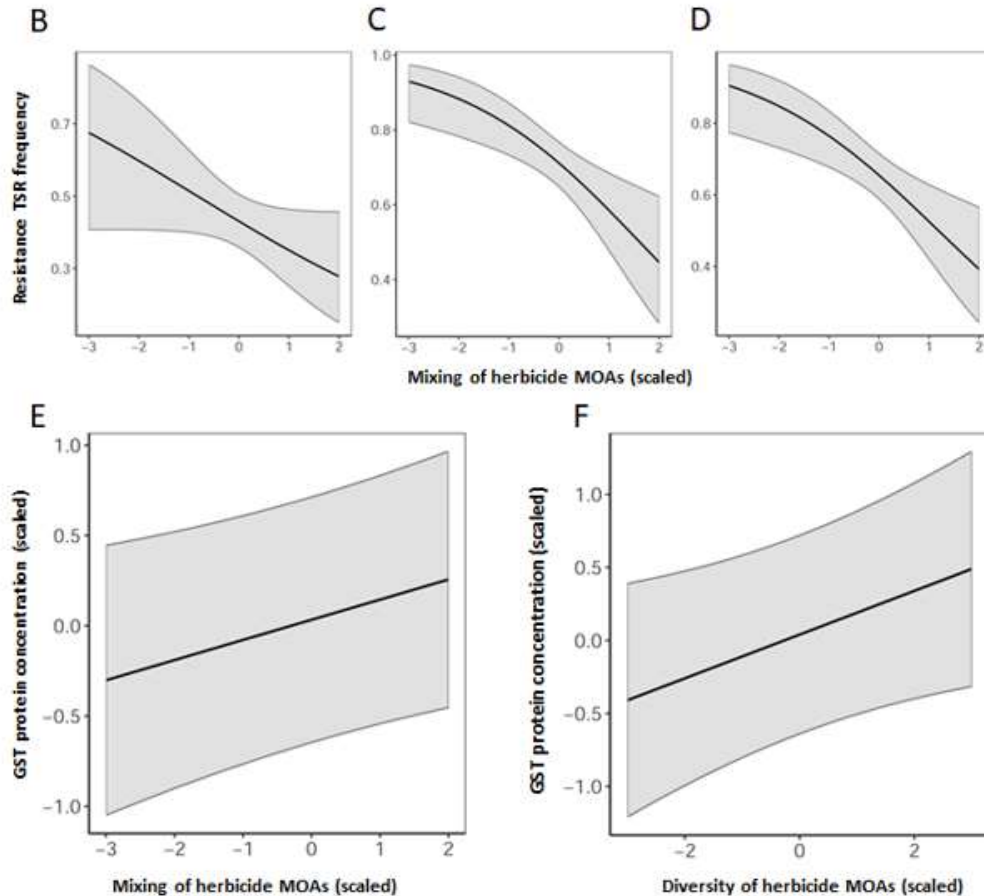


Black-Grass Resistance Initiative



	TSR	NTSR
Fenoxaprop	✓	✓
Cycloxydim	✓	✗
Mesosulfuron	✓	✓

You cannot manage herbicide resistance with herbicides alone



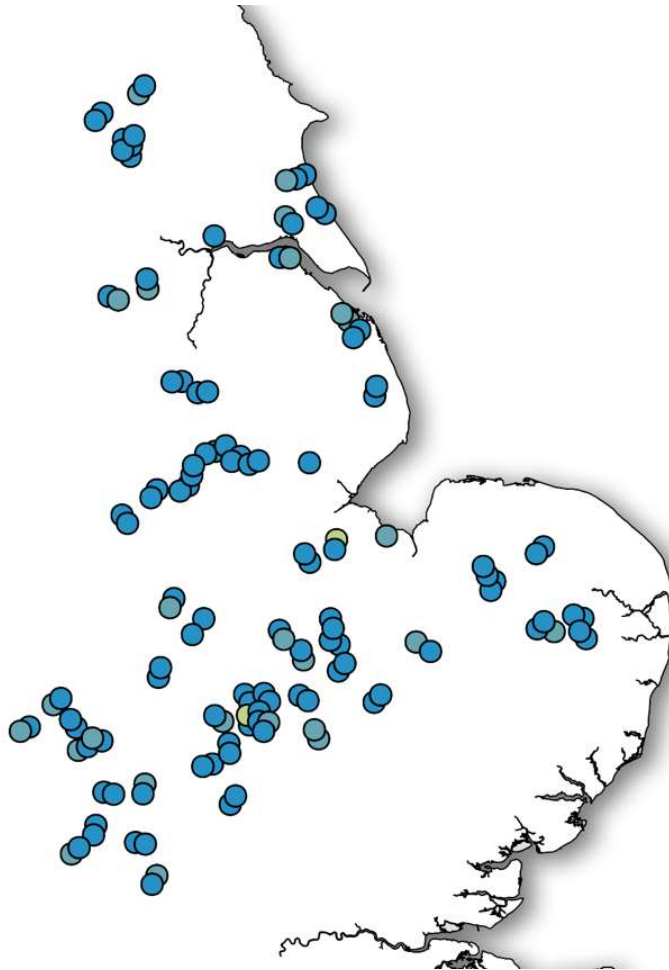
TSR is reduced by using diverse herbicides

NTSR is increased when using diverse herbicides

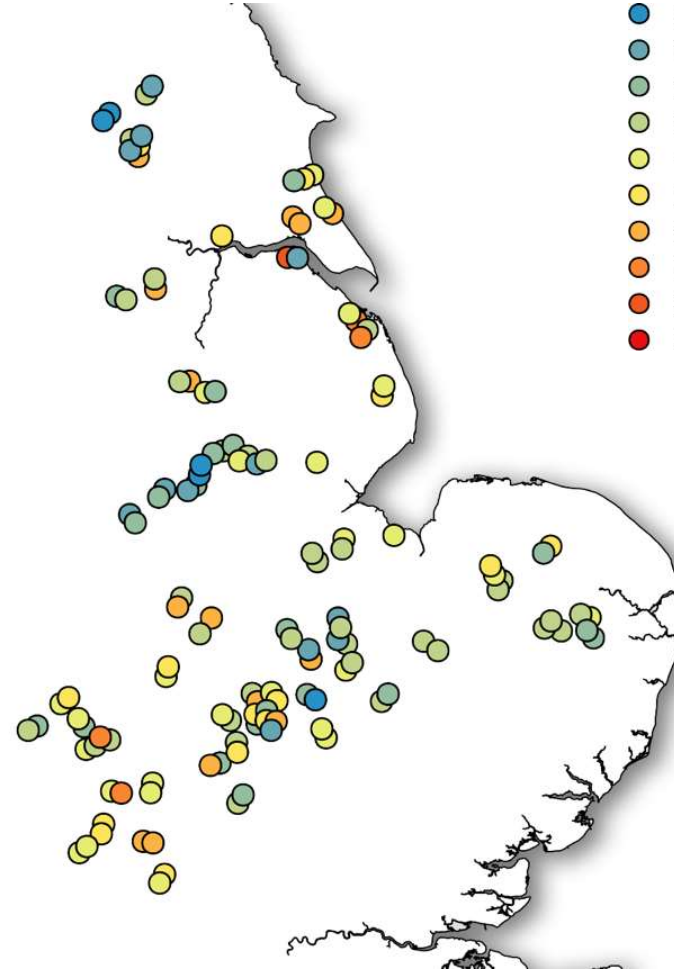
Comont et al. (2021). Evolution of generalist resistance to herbicide mixtures reveals a trade-off in resistance management. *Nature Communications*.

Glyphosate is working but for how long?

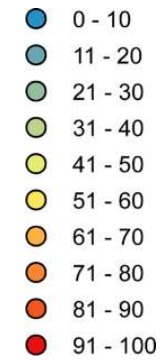
UK Field rate (540 g ha⁻¹)



¾ UK rate (405 g ha⁻¹)



% survival



The high cost of

HERBICIDE RESISTANCE

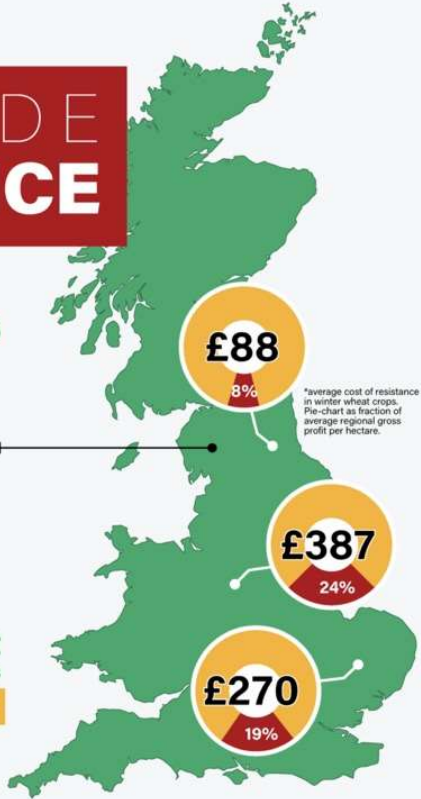
£0.4 billion in lost income for farmers
due to just one weed: **black-grass**

Cost per hectare

In high weed density areas the economic cost* of resistant black-grass can be about £450 per hectare or 37% of potential gross profit. At low weed density, the cost is around 7% / £75 per hectare.

820,000 Tonnes of wheat
lost due to herbicide resistant black-grass

THAT'S ABOUT 1.2 BILLION LOAVES OF BREAD



*average cost of resistance in winter wheat crops. Pie-chart as fraction of average regional gross profit per hectare.

WHAT CAN BE DONE?



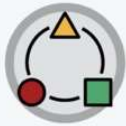
TAKE ACTION

Coordinate resistance management at the national scale



REDUCE USE

Reduce use and reliance on herbicides



DIVERSIFY

Use a diversity of crops and management practices to prevent and manage resistance



MONITOR

Impacts of reduced resistance on agronomic, economic and environmental performance.

Collecting data on blackgrass density, resistance status, management costs and yields enabled us to **count the cost** of blackgrass resistance.

Integrated management of blackgrass



Ploughing

69%

-82 to 96%

Delayed
autumn
sowing

31%

-64 to 97%

Competitive
cultivars

22%

8 to 45%

Spring crops

88%

78 to 96%

Sowing rate

26%

7 to 63%

Grass ley /
fallow break

70%

Every field with blackgrass is a blackgrass experiment!



2021

CALL FOR PROPOSALS - THEMATIC RESEARCH

GREEN TRANSITION



DANMARKS FRIE
FORSKNINGSFOND
INDEPENDENT RESEARCH
FUND DENMARK

A weed resistance farm network for Denmark?

With Aarhus University (Per Kudsk) and UK partners

National-scale monitoring and epidemiological modelling for sustainable weed management in agroecosystems.

Professor Paul Neve

Research idea. This project harnesses the latest technological advances at the interface of agriculture, ecology and modelling to reduce reliance on herbicides in Danish agriculture. The significant novelty in our approach is to consider “every farmer’s field as an experiment”, and we will work with farm and farmer data to develop real-world, data-driven models to optimise agroecological approaches to weed management, reducing reliance on synthetic herbicides. These epidemiological approaches have been pioneered by the project applicant in the UK, leading to publication of several high impact papers and industry engagement to develop end-user applications.

Blackgrass: problems and solutions

- **Resistance is at epidemic levels in England**
 - Very little post-emergence activity in cereals
 - Pre-emergence options continue to work well (with some loss of efficacy)
 - Glyphosate is critical – but can we keep it?
 - Metabolic resistance widespread and problematic for management
- **No new “silver bullets” on the horizon**
- **Integration and diversity are key**
- **New and ‘old’ technology can help to tackle blackgrass**
 - Cultural control works, but there are trade-offs
 - Monitoring, ‘big’ data and decision support are important
 - New herbicides, new technologies (harvest weed seed control, robotics, genetic solutions)
 - Regulation will continue to present challenges



Acknowledgements



Rob Edwards Alina Goldberg-Cavalleri Nawaporn Onkokesung

- Molecular genetics and biochemistry of NTSR



Ken Norris Alexa Varah

- Economic and environmental impacts



ROTHAMSTED
RESEARCH



Lieselot Nguyen Laura Crook Richard Hull



Paul Neve David Comont Andrea Dixon

- Genetics, ecology, evolution and management



The
University
Of
Sheffield.



Rob Freckleton Dylan Childs Helen Hicks Shaun Coutts

- Population biology, modelling & management

**Tak for at lytte.
Spørgsmål?**





Chaff tram- lining in the UK

Photo credit; Paul
Fogg, Frontier
Agriculture