



Science For A Better Life

The Weed Resistance Competence Centers (WRCC): Weed Resistance Research

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Agenda

- Weed Resistance is a global challenge
- The Weed Resistance Competence Center
- Partnerships
- Bayer's commitment to Integrated Weed Management
- Summary



Where is it ?

The challenge of feeding a growing global population is being made more difficult by the spread of herbicide resistant weeds. Farmers need a varied toolbox of available products and practices to combat the build-up of resistance.

2016: 250 different resistant species in **86** crops and **66** countries – and the trend is continuing upwards!

1/4
OF THE
WORST AND MOST
COMMON WEEDS
ARE ALREADY RESISTANT



The most problematic Weeds worldwide

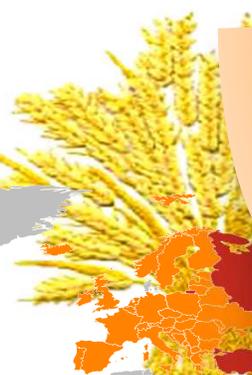
in Corn Farming

- Palmer amaranth (*Amaranthus palmeri*)
- Waterhemp (*Amaranthus tuberculatus*)
- Kochia (*Kochia scoparia*)
- Marestalk (*Conyza canadensis*)
- Ryegrass (*Lolium spp.*)
- Wild oat (*Avena fatua*)
- Johnson grass (*Sorghum halepense*)
- Giant ragweed (*Ambrosia trifida*)
- Panicum species



in Cereal Farming

- Black grass (*Alopecurus myosuroides*)
- Wild oat (*Avena spp.*)
- Loose silky-bent grass (*Apera spica venti*)
- Ryegrass (*Lolium spp.*)
- Brome grass (*Bromus spp.*)



in Soybean Farming

- *Digitaria insularis*
- *Eleusine indica*
- *Lolium spp.*
- *Chloris spp.*
- *Sorghum halepense*
- *Conyza spp.*
- *Euphorbia heterophylla*
- *Bidens spp.*
- *Amaranthus spp.*



in Rice Farming

- *Echinochloa spp.*
- *Leptochloa spp.*
- *Cyperus spp.*

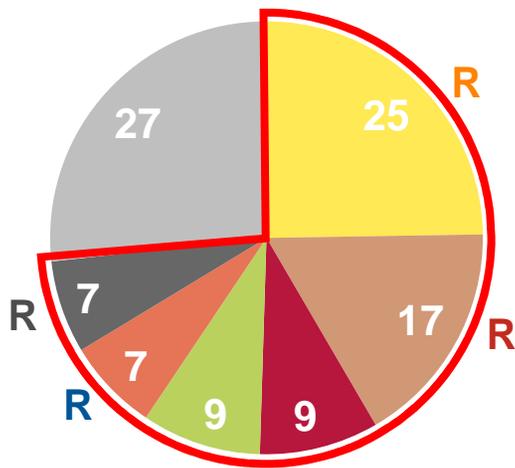




Global herbicide market by MoA

Only 6 MoA classes represent $\frac{3}{4}$ of the market

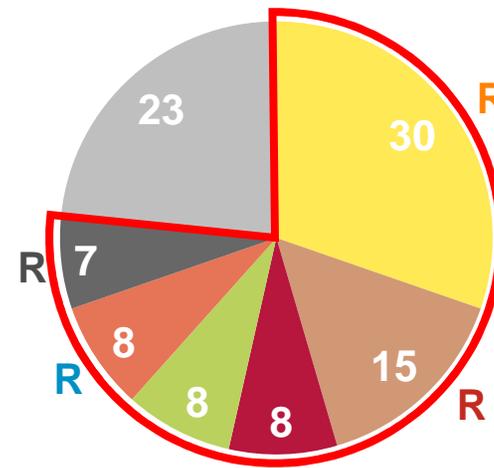
2014



Top 6

- EPSPS (G)
- ALS (B)
- VLCFA (K3)
- Auxins (O)
- ACCase (A)
- PSII (C1)
- Others

2009



- EPSPS (G)
- ALS (B)
- VLCFA (K3)
- Auxins (O)
- ACCase (A)
- PSII (C1)
- Others

Total Value **18 bn €**

Total Value **13 bn €**

Lack of herbicide diversity = strong resistance selection pressure

Total market value (€) as percent – Top 6 MoAs – AgroWin 2014, 2009 **R: denotes serious resistance issues**



Mission and Objectives of the Weed Resistance Competence Center

As a scientific foundation, the Weed Resistance Competence Center acts as Bayer's global reference center for weed resistance management.

The Weed Resistance Competence Center has three objectives:

1. It strives to be the leader in weed resistance competence, **understanding resistance to herbicides** – how resistance mechanisms work, how resistance evolves, and **how it can be managed in each field**.
2. It wants to take this knowledge and use it to **develop and offer the best strategies and specific solutions** for resistance management, aiming to tailor them to individual fields for each farmer.
3. It wants to effectively **communicate its knowledge and solutions**.



Official Launch
November 2014



Weed Resistance Management: Weed Resistance needs a Holistic Approach



What is it ?

“Herbicide resistance is the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type.” Darwin evolution law.

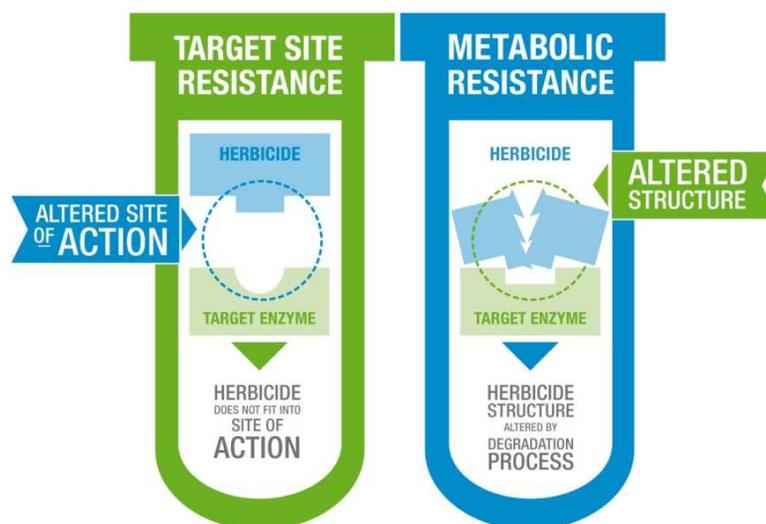
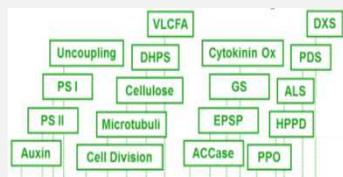
Source: Weed Technology Volume 12, Issue 4 (October-December) 1998, p. 789

TYPES OF RESISTANCE: BIOTYPE WITH

Source: Bayer

Target Site Resistance

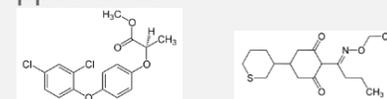
Site of action specific
=> Change MoA



Enhanced Metabolic Resistance

Site of action unspecific

=> Change to other chemical structure (can be in same MoA group) favoured by low dose applications



Others: Differential uptake, Differential redistribution, sequestration, increased gene copy number, enzyme overexpression (both also TSR), delayed germination, rapid necrosis / defoliation

Leadership in Resistance Diagnostics & Research

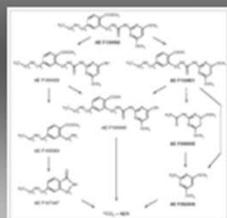
Current Diagnostics Methods

Research

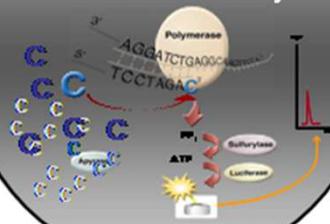
Greenhouse Bioassays



Metabolic Resistance Analysis



Target-site Resistance Analysis



- Identification of genes responsible for metabolic resistance
- Resistance evolution and driving factors
- Resistance test kit prototypes
- New herbicide discovery
- Field studies with current products (platform & resistance evolution)

Understanding resistance better helps us to make the best recommendations



Diagnostic Campaign – From the Field to the Gene



1. Dig out up to 8 black-grass plants



2. Cut off the roots



3. Place two shoots on each sheet of paper



4. Fold the paper and put it back into the bag



5. Pour in the water, remove air bubbles, and close the bag



6. and 7.

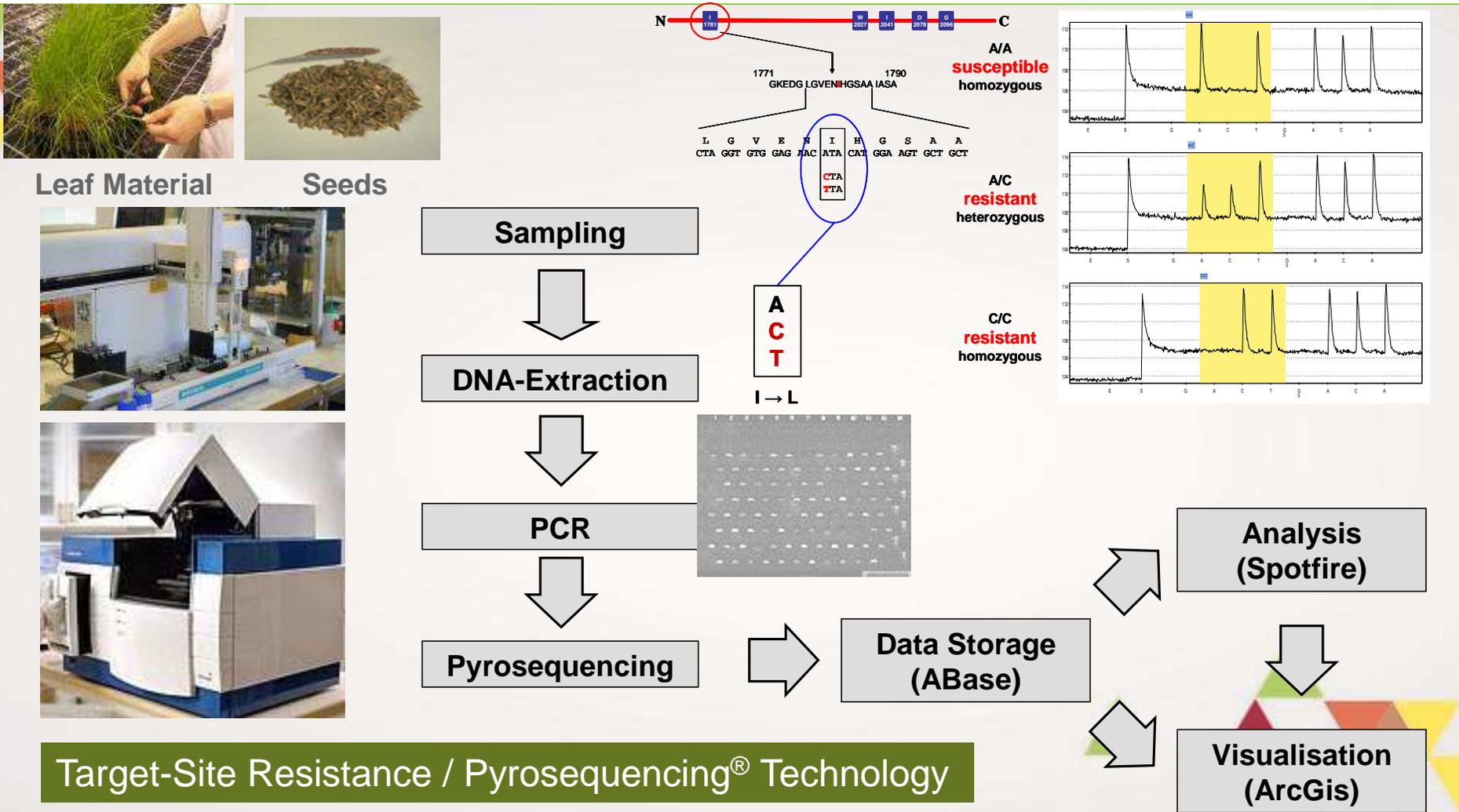
Fill in the form! Put all bags into the envelope provided and send it!

- Live plant material (for metabolic resistance)
- Also done for seeds e.g. complaint handling
- In close coordination with Bayer teams in countries
- Need to share resources between countries

Rapid logistics and processing can lead to in-season recommendations

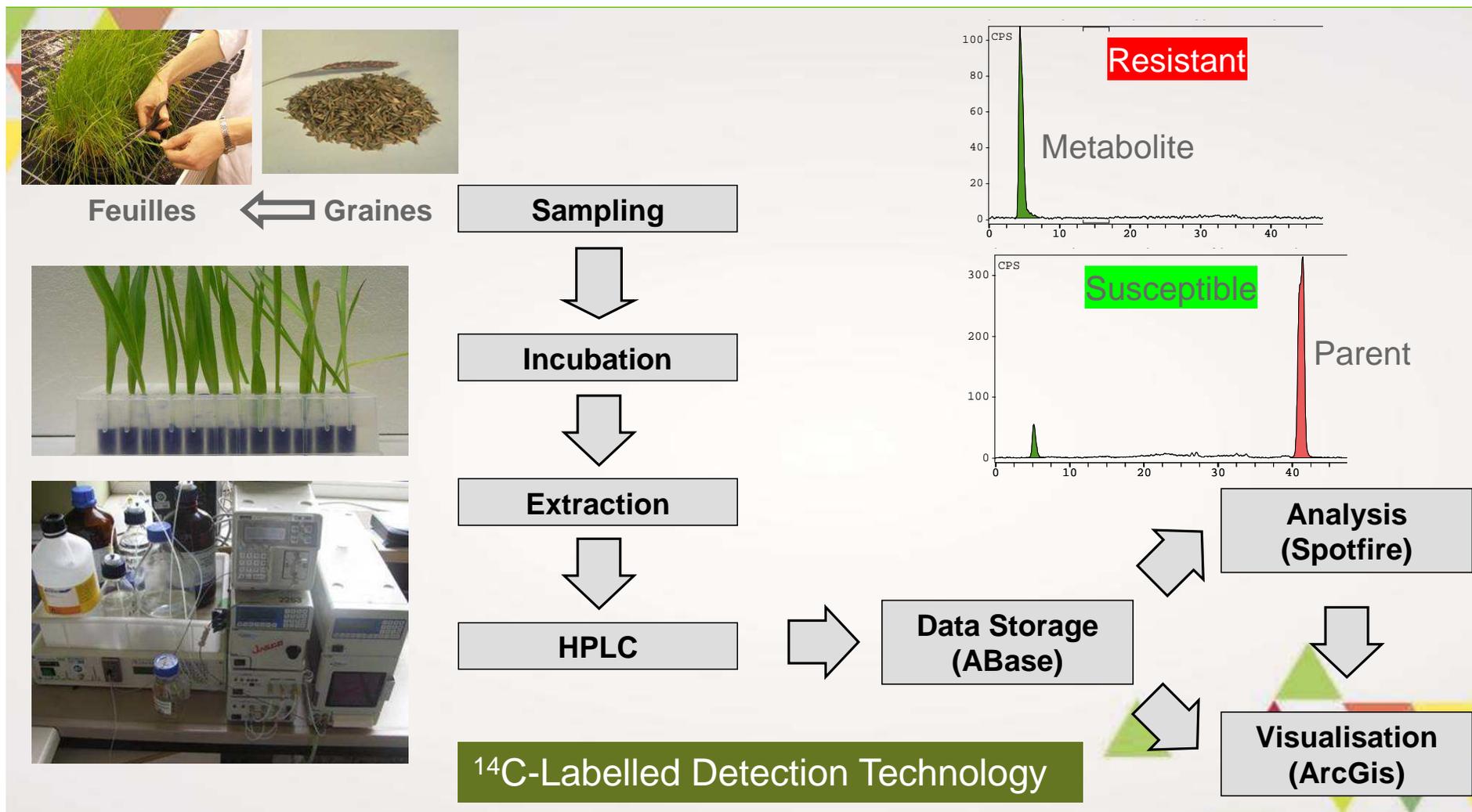


Mutation Diagnostics- Target-Site Resistance



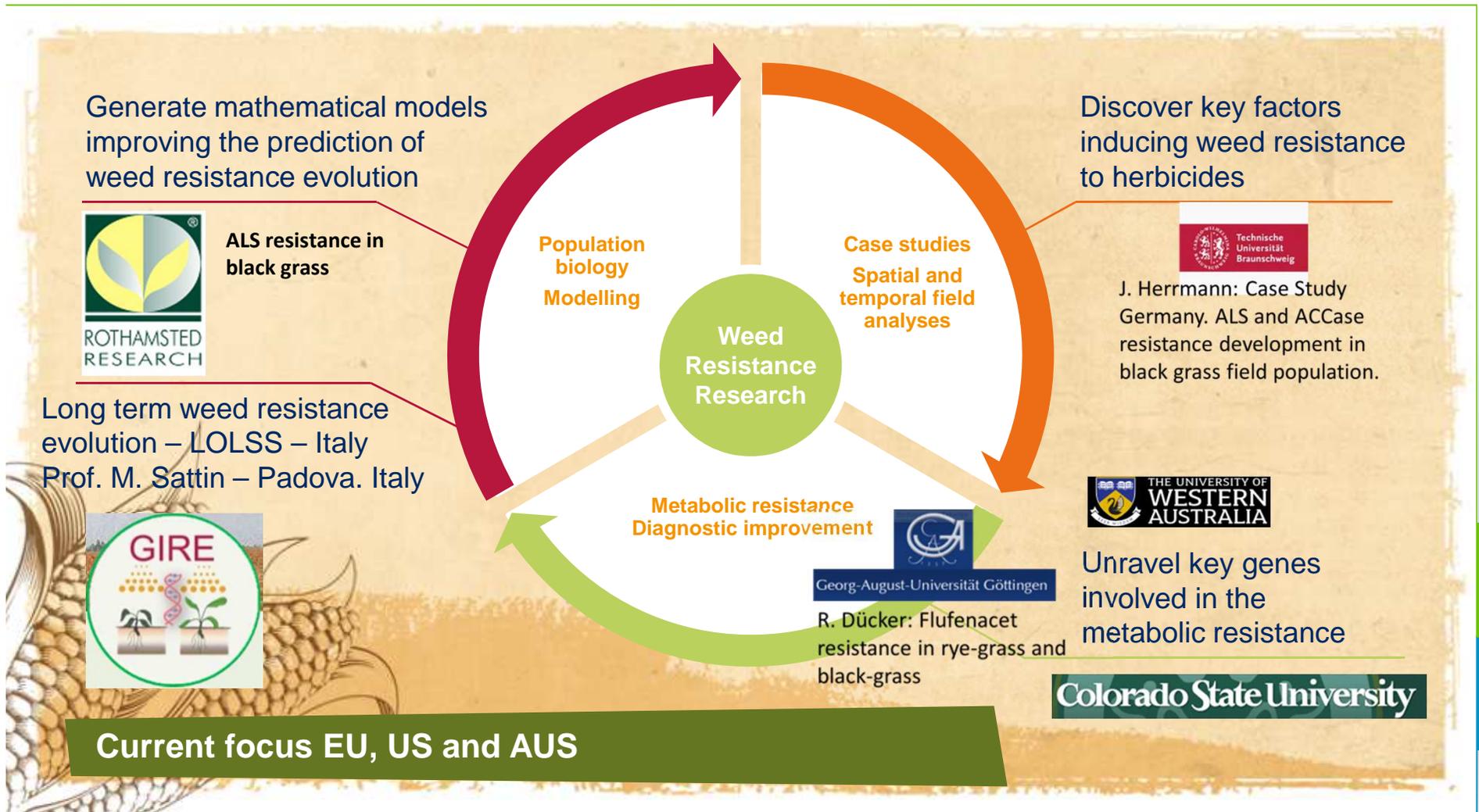


Herbicide Metabolism Diagnostic



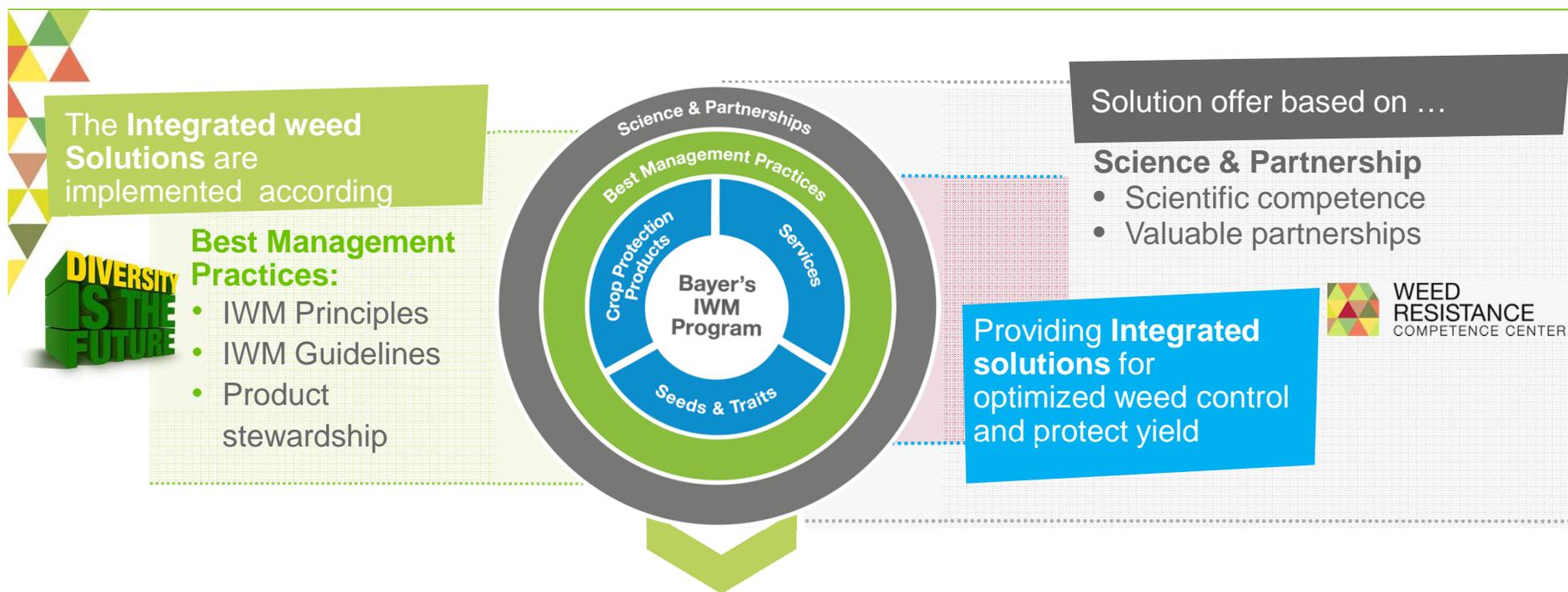


External collaborations: examples





Bayer's Integrated Weed Management (IWM) program offers farmer customized solutions



Two main approaches to enhance farmers' productivity and secure food supplies in the long term:

- ✓ Offering new solutions to increase productivity
- ✓ Offering solutions solving an issue (e.g. weed resistance management) by proposing the appropriate solution case by case



Spread of ALS-resistant *Apera spica-venti* in Germany



Weed control is field-by-field and can be achieved with the existing solutions, and the application of good practices and recommendations. Keep the soil seedbank as low as possible.



Summary

- Sustainability of **modern herbicides** is at a crossroads because of **resistance**
- Lack of new **resistance-breaking herbicides** is a serious liability
- We need to **sustain the effectiveness of our current products** by getting farmers to use the products as recommended, and combinations including more non-chemical weed control measures to **increase diversity** ...and
- We need to find **new, effective herbicides**

Bayer CropScience is investing heavily in the future of weed control





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Thank you for your attention