



Science For A Better Life

Role of Consultants in Preserving Insecticidal Technology

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Chris Sansone, Ph.D.
Global Regulatory Affairs Manager - IRM



Agenda/ Content

- Integrated technology pipeline
- Threats
- Successes and failures
- Consultant role

BioScience – our growth strategy



Traits



Seeds



Seed
treatment



Agrochemicals



Plant
health



Harvest
aids &
diagnos-
tics



Down-
stream

An integrated approach to crop protection



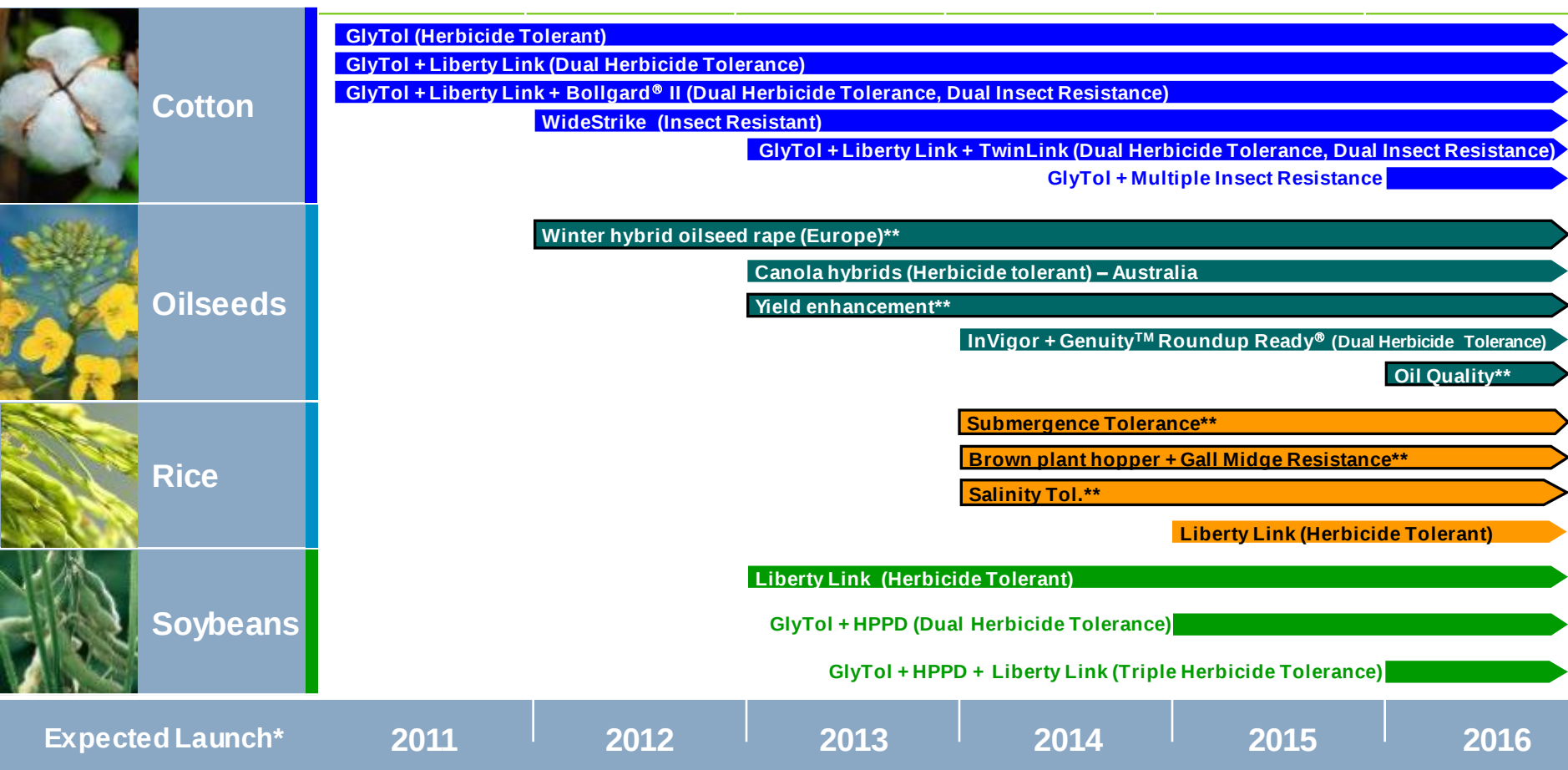
Integrated Crop Platforms – focusing on our customer's needs

Cotton: A complete offering for customers & more value per seed bag sold



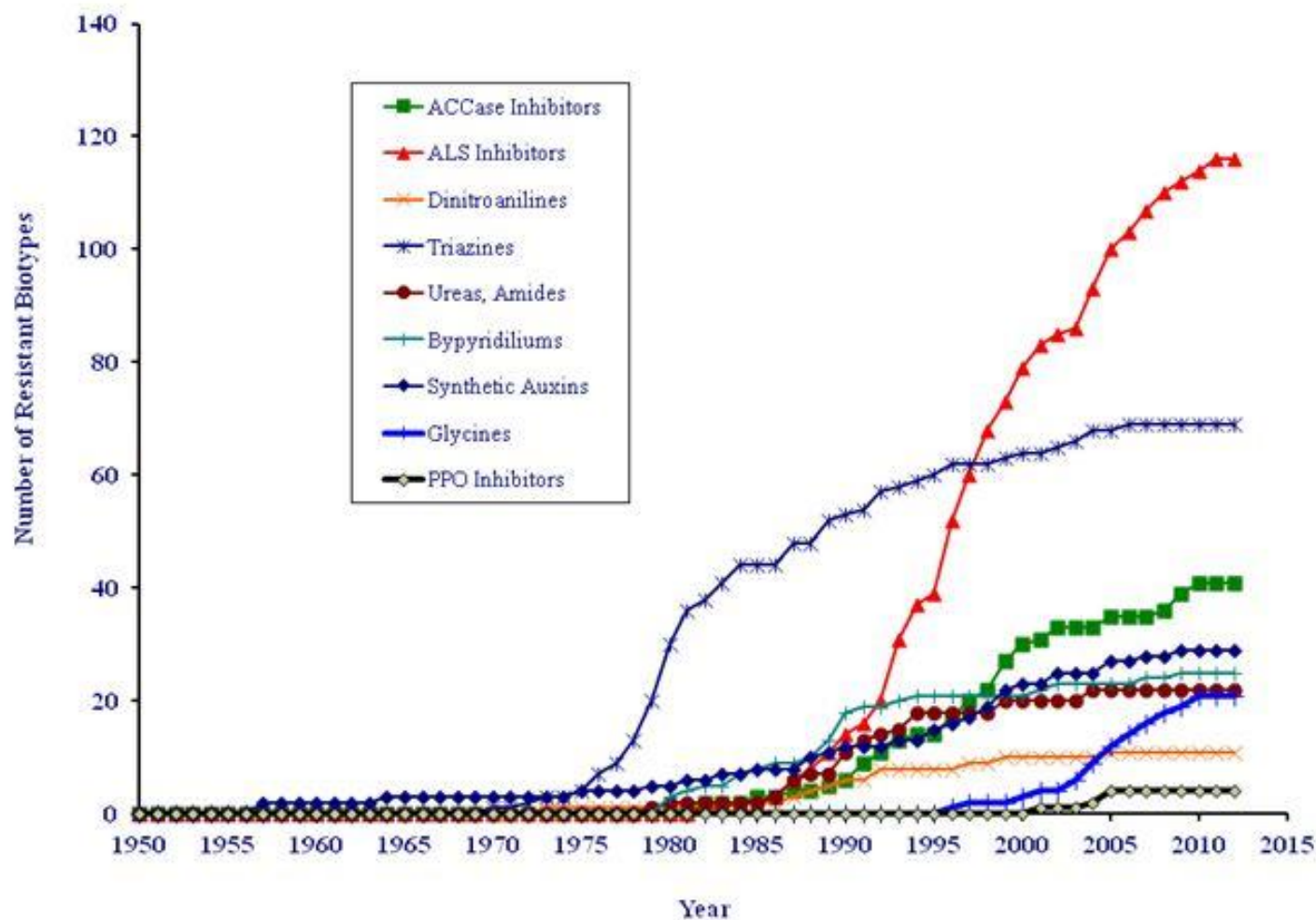
Shifting the focus to integrated cotton products and solutions

A Strong Trait Pipeline



* Product launches are subject to regulatory approvals
 WideStrike™ is a trademark of Dow AgroSciences LLC,
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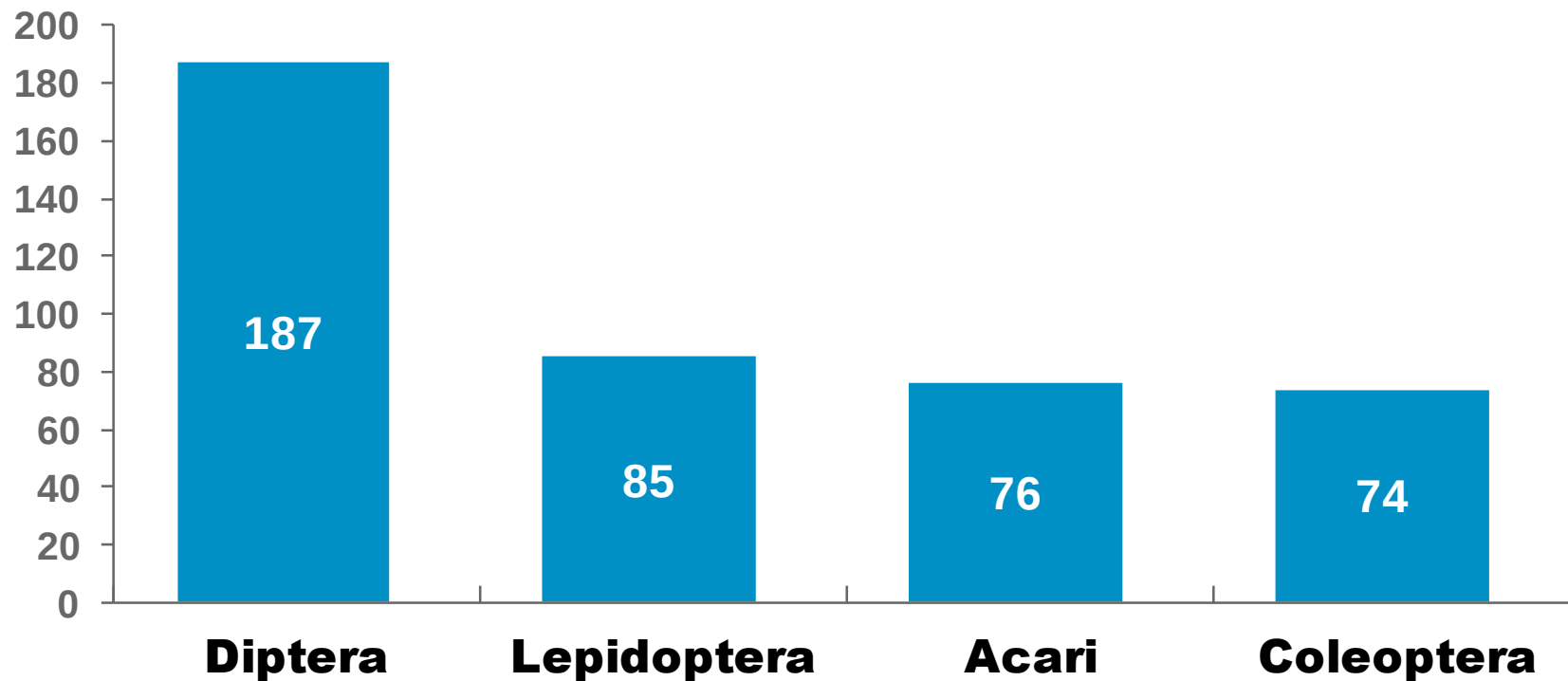
Resistant Weed Species



Source: Ian Heap



Resistant Arthropod Species



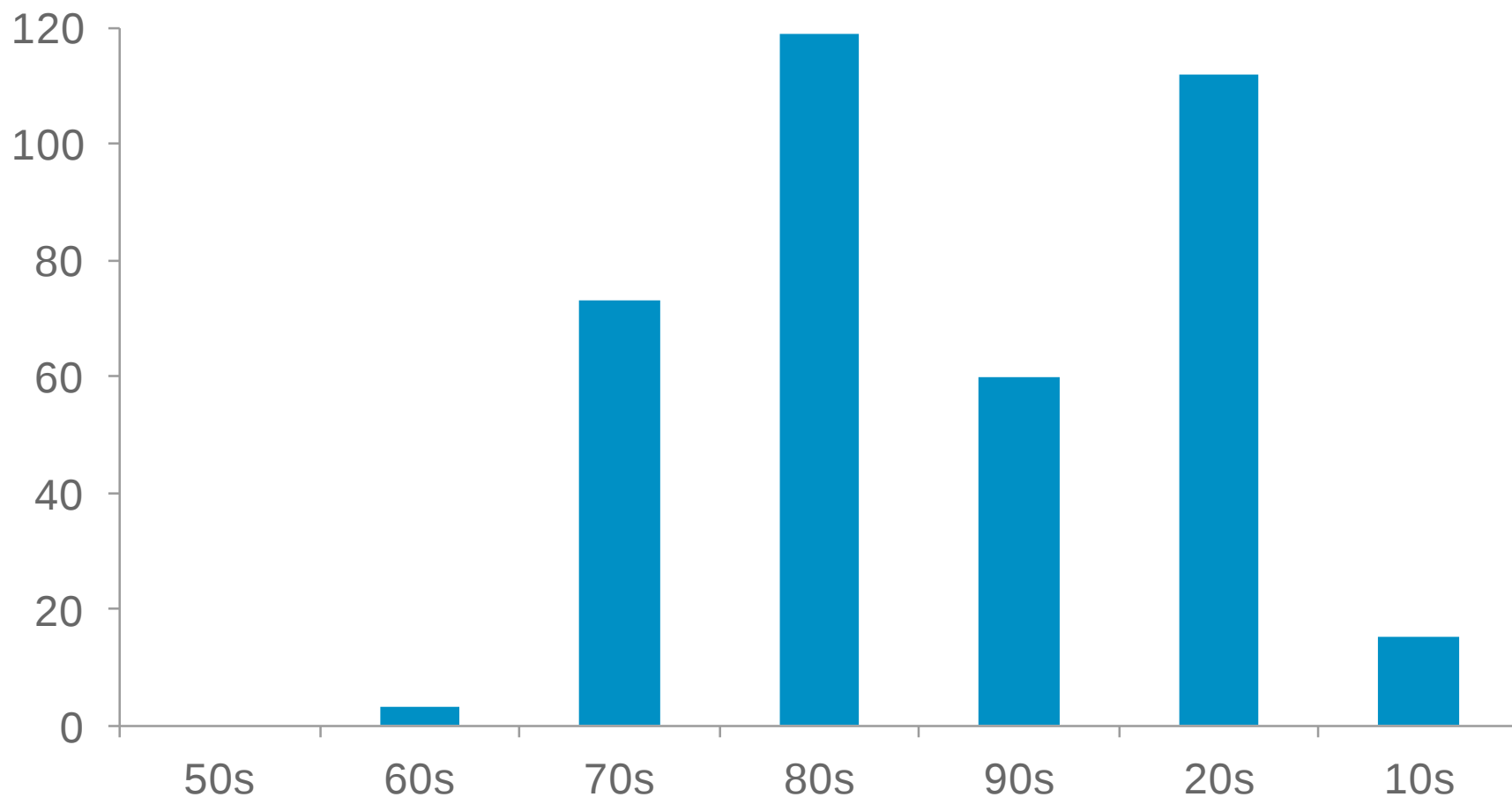
Whalon, M, et al. 2008 Analysis of Global Pesticide Resistance

553 Arthropod Species are resistant, 306 agriculturally important



Resistant Plant Disease Species

FRAC. http://www.frac.info/frac/publication/anhang/List-of-resistant-plant-pathogens_2012.pdf



Tarnished plant bug

Constant battle

- Multiple MOA resistance
 - OP's
 - Pyrethroids
 - Cyclodienes
 - Carbamates



Global Bt Crops Resistance Picture



Field-Relevant	Cry1Ab maize in South Africa	<i>Busseola fusca</i>
	Cry1F maize in Puerto Rico	<i>Spodoptera frugiperda</i>
	Cry1Ac cotton in Gujarat India	<i>Pectinophora gossypiella</i>
	Cry3Bb1 corn in Iowa	<i>Diabrotica virgifera virgifera</i>
No evidence of field relevance	Cry1Ab maize in USA	<i>Ostrinia nubilalis</i> <i>Diatraea grandiosella</i>
	Cry1Ac cotton in USA	<i>Heliothis virescens</i> <i>Helicoverpa zea</i> <i>Pectinophora gossypiella</i>
	Cry1Ac cotton in China	<i>Helicoverpa armigera</i> <i>Pectinophora gossypiella</i>
	Cry1Ac cotton in Australia	<i>Helicoverpa armigera</i> <i>Helicoverpa punctigera</i>
	Cry2Ab cotton in Australia	<i>Helicoverpa armigera</i> <i>Helicoverpa punctigera</i>



Lessons from 17 Years of Bt Crop Use....

- High dose/refuge strategy can effectively delay resistance
- Pyramids of toxins reduce resistance risk/refuge size
- Functionally monophagous pests present the greatest challenges



Lessons learned (cont.)

- Polyphagous pests must be managed at the agroecosystem level in intensive agricultural systems
- Small and very large farms pose the greatest challenges with compliance with IRM and refuge requirements
- Resistance must be defined in the both the laboratory and the field



Lessons learned (cont.)

- Objective of IRM is to delay resistance, not prevent it
- Sustainable Bt crops = IPM + IRM + research pipeline



The high dose/refuge strategy can effectively delay resistance

Example: Pink bollworm in Southwestern USA

- Monophagous pest
- High resistance risk
- Very high Bt cotton deployment rates
- Major gene/intensive resistance isolated in 1997
- 70-80% compliance with planting of 5%/20% refuges
- Intensive monitoring: bioassays and molecular



The high dose/refuge strategy can effectively delay resistance

.....if refuges are adequate.

Cases of field-relevant resistance

Cry1Ab maize in South Africa	<i>Busseola fusca</i>
Cry1F maize in Puerto Rico	<i>Spodoptera frugiperda</i>
Cry1Ac cotton in Gujarat India	<i>Pectinophora gossypiella</i>

- ✓ All cases with low/no compliance with refuge requirements



Gujarat, India. Pink bollworm emergency hole on single-gene (Cry1Ac) cotton



EPA Requirements for TwinLink

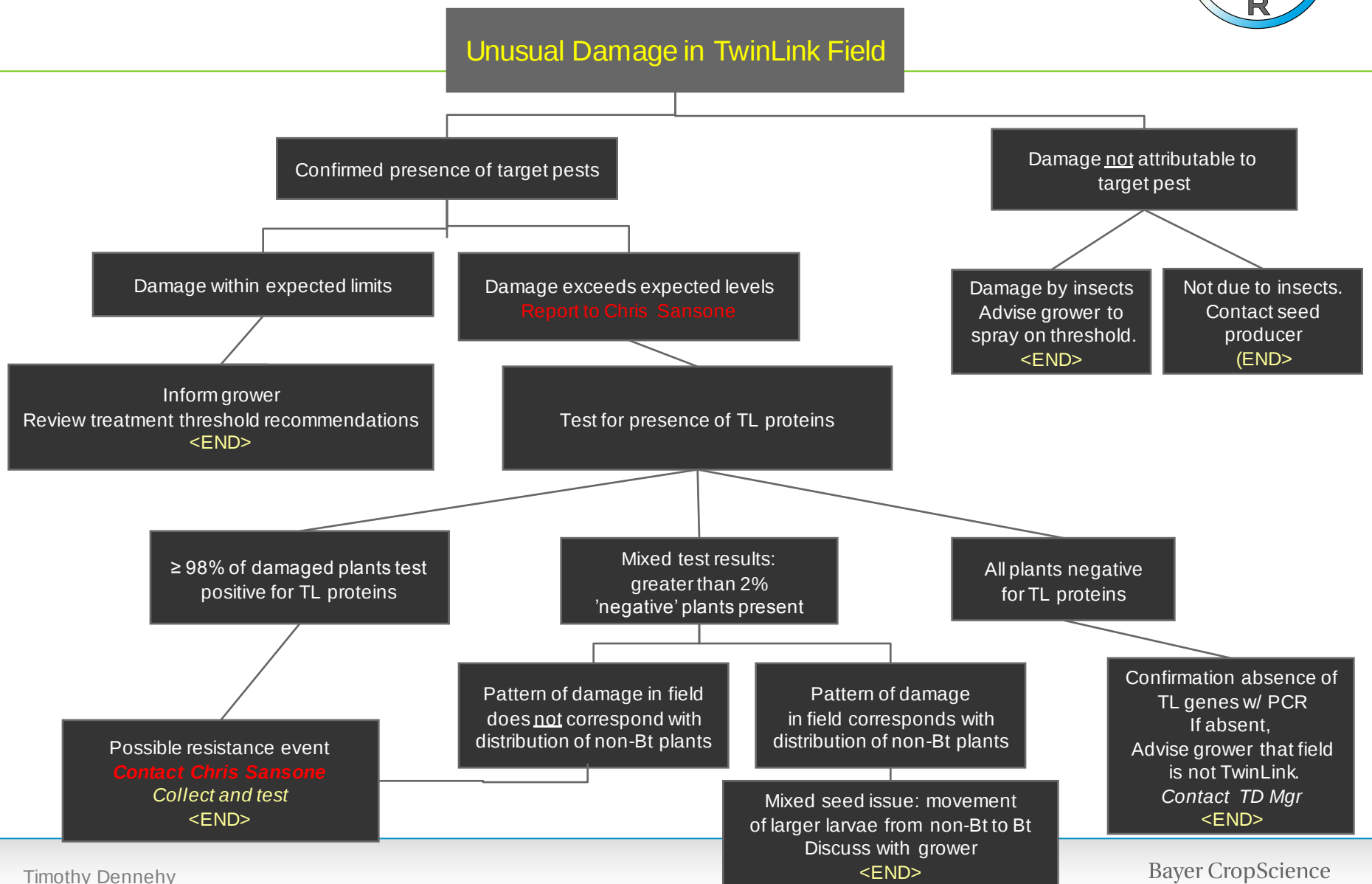
BCS must

Monitor resistance, including:

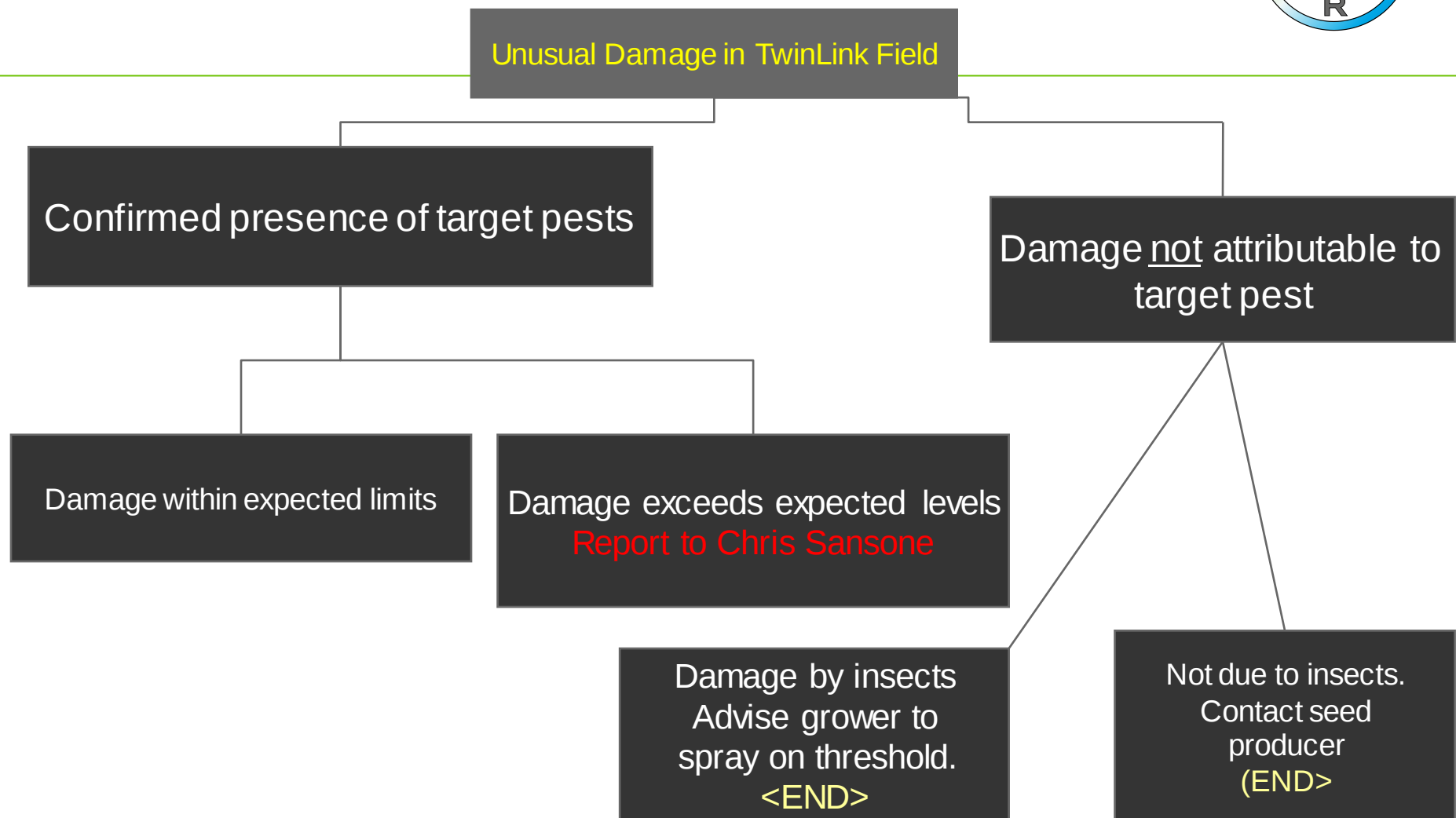
- *Surveying and testing insects for potential resistance*
- *collection of information from growers about events that may indicate resistance.*

If a substantiated resistance incident occurs, Bayer CropScience must report this to EPA, do follow-up investigations and submit and execute a plan to remediate the problem.

Responsibilities and Reporting Expectations



Responsibilities and Reporting Expectations





Integrated Pest Management

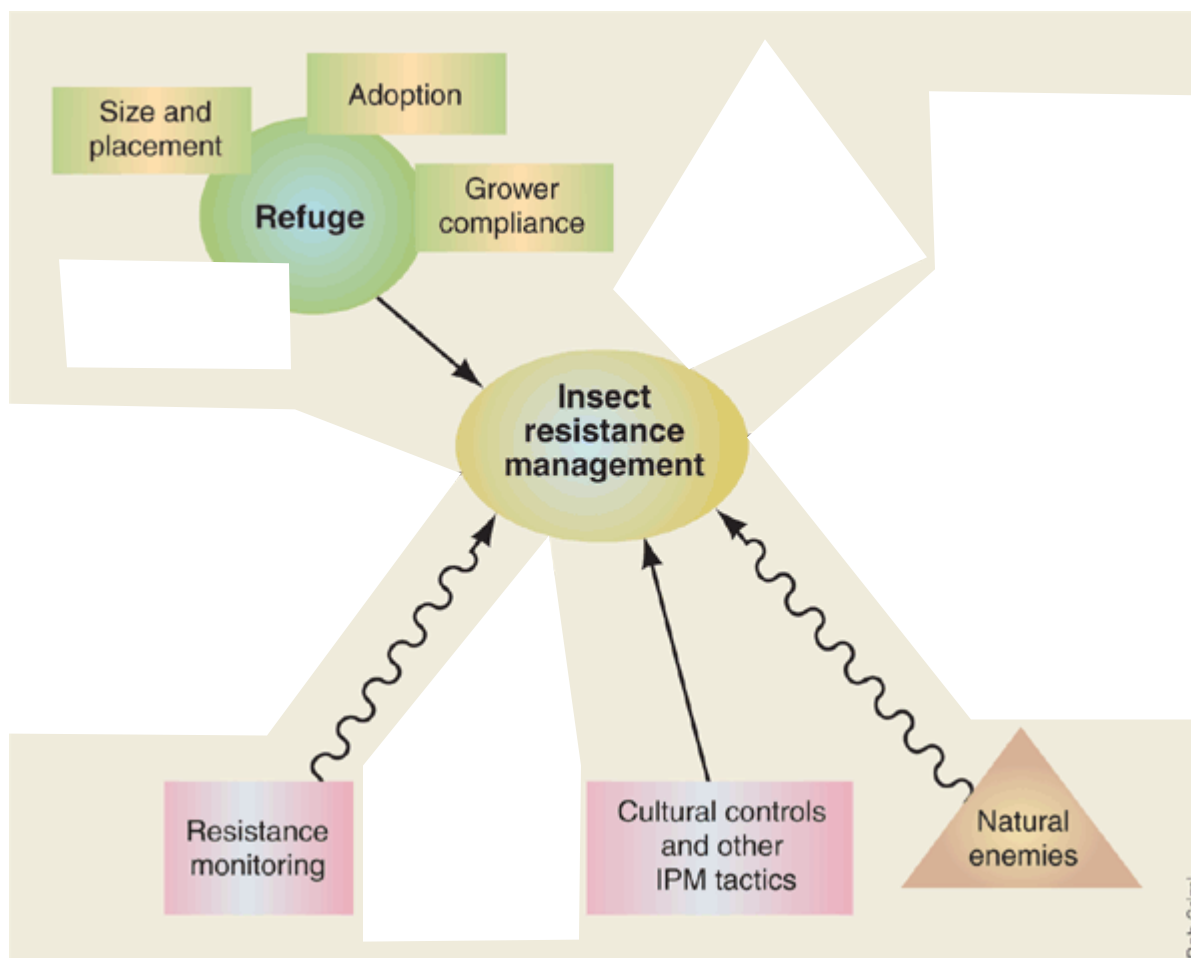
- System or strategy
- Utilizes all methods of pest suppression
- Tactics used are compatible
- Maintain pests below economically damaging level
 - Should be environmentally sound



Consultant Role with Insecticides

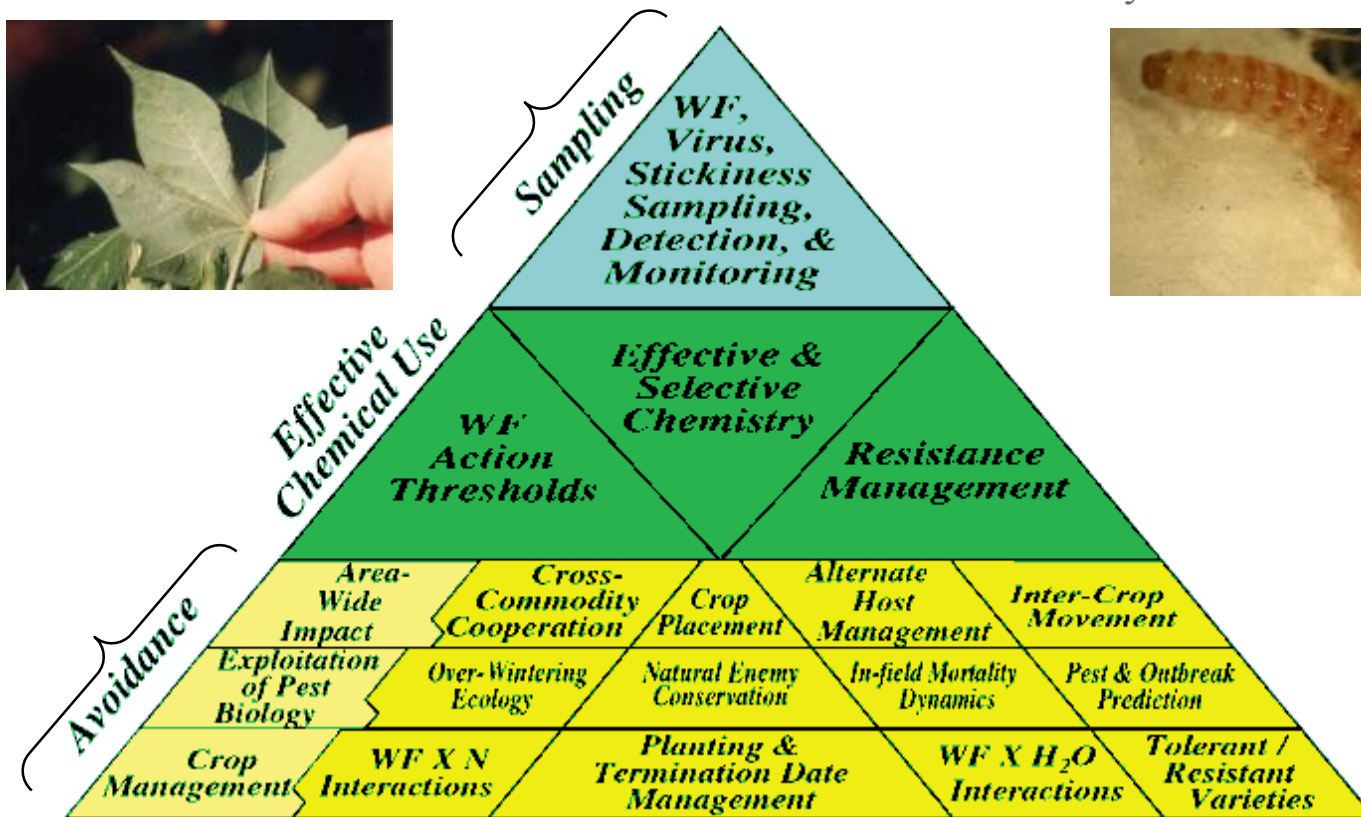


Consultant Role with Insecticidal Proteins



Consultant Role with IPM

From: P. Ellsworth,
University of Arizona





LET'S GET THINGS DONE AND ... PROPEL FARMING'S FUTURE

- Stay up to date
- Understand the broader issues
- Educate your 'clients'
 - ✓ Producers, universities, industry



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