



Science For A Better Life

# Role of Consultants in Preserving Insecticidal Technology

November 8, 2012 | Tunica, MS

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## Agenda/ Content

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

# BioScience – our growth strategy



Traits



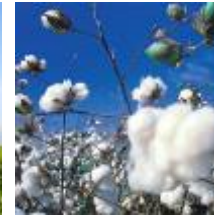
Seeds



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

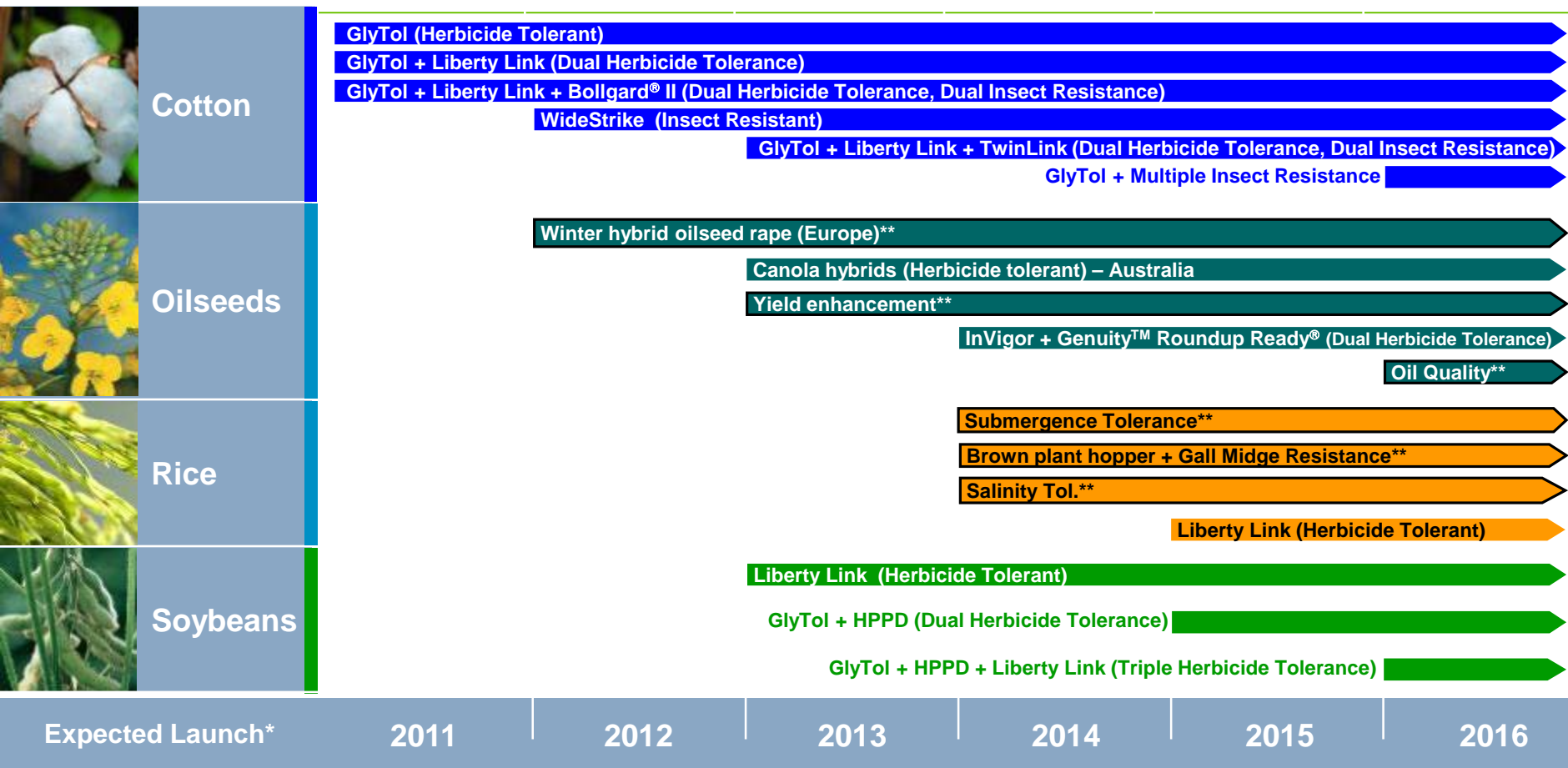
Cotton: A complete offering for customers & more value per seed bag sold



Shifting the focus to integrated cotton products and solutions



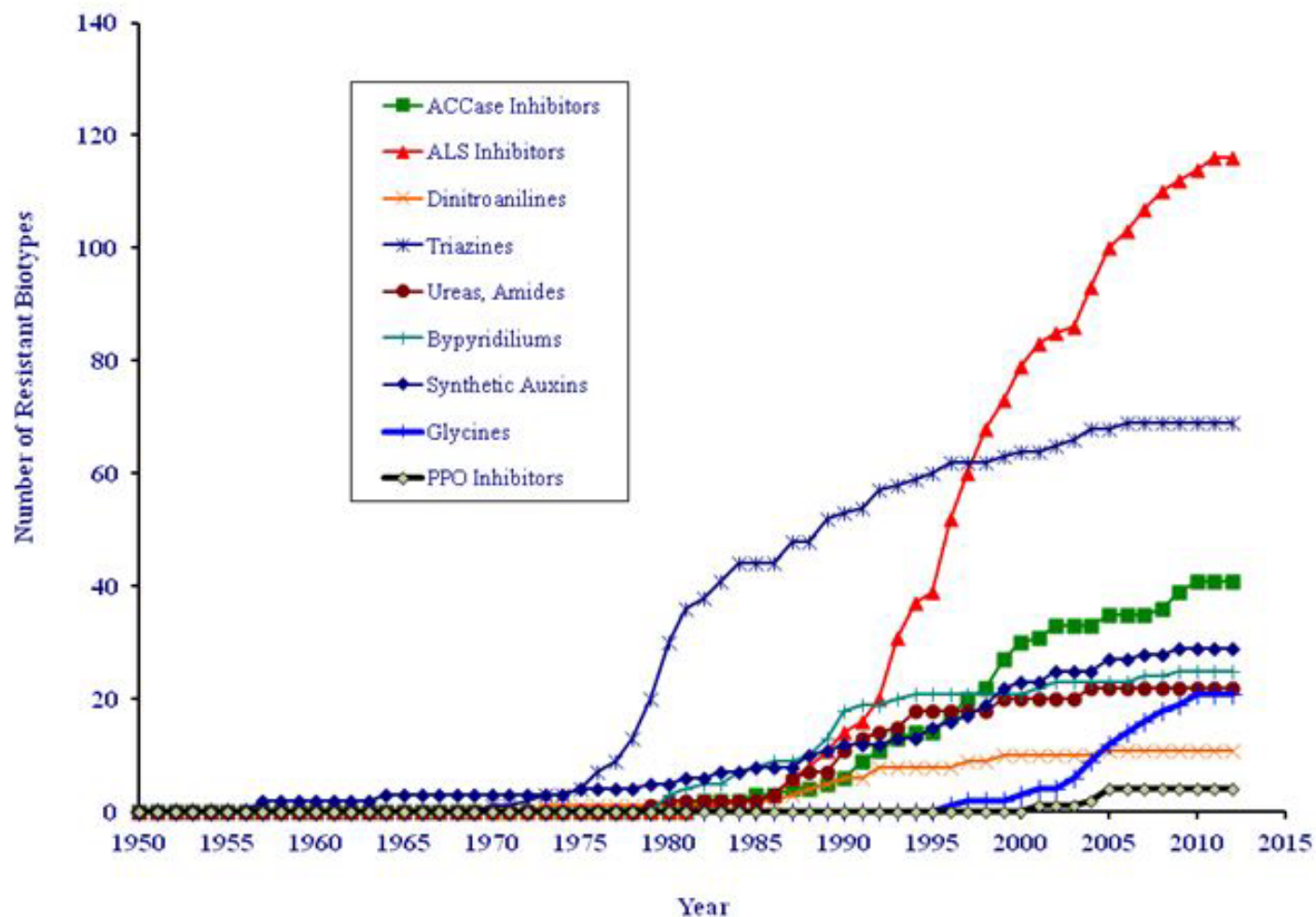
# A Strong Trait Pipeline



\* Product launches are subject to regulatory approvals  
 WideStrike™ is a trademark of Dow AgroSciences LLC,  
 Genuity™, Roundup Ready® and Bollgard®II are trademarks of Monsanto Company



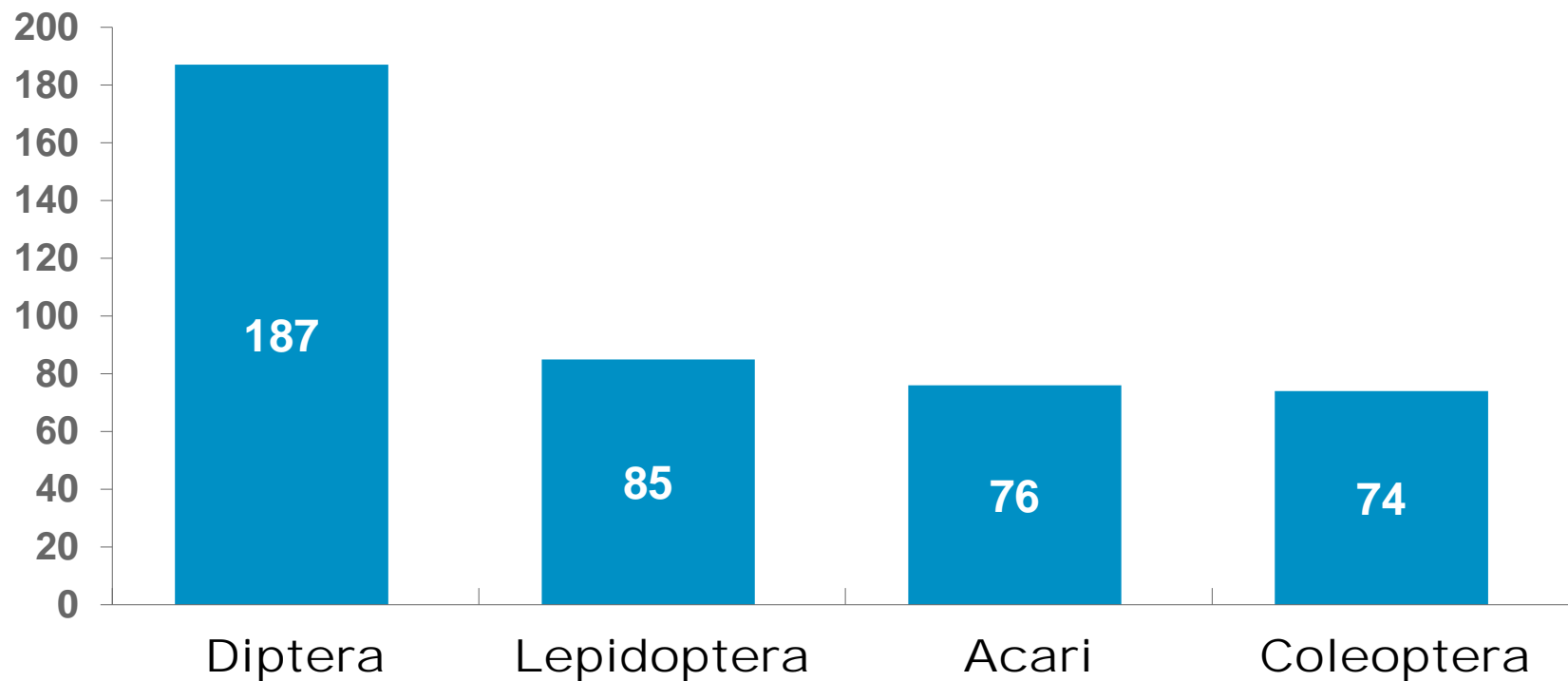
# Resistant Weed Species



Source: Ian Heap



# Resistant Arthropod Species



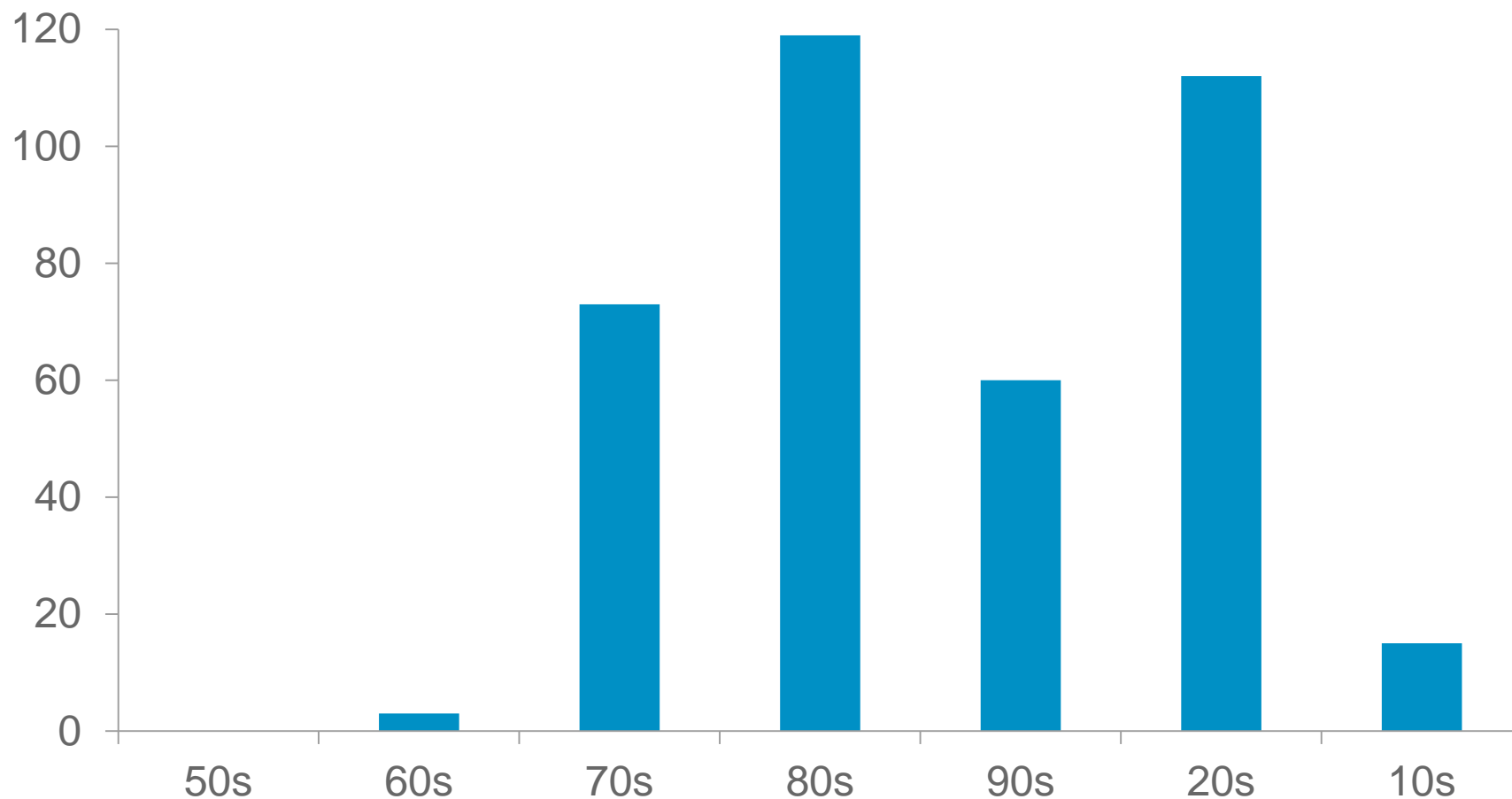
Whalon, M, et al. 2008 Analysis of Global Pesticide Resistance

**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](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

*Busseola fusca*

Cry1F maize in Puerto Rico

*Spodoptera frugiperda*

Cry1Ac cotton in Gujarat India

*Pectinophora gossypiella*

Cry3Bb1 corn in Iowa

*Diabrotica virgifera virgifera*

No evidence of field  
relevance

Cry1Ab maize in USA

*Ostrinia nubilalis*

*Diatraea grandiosella*

Cry1Ac cotton in USA

*Heliothis virescens*

*Helicoverpa zea*

*Pectinophora gossypiella*

Cry1Ac cotton in China

*Helicoverpa armigera*

*Pectinophora gossypiella*

Cry1Ac cotton in Australia

*Helicoverpa armigera*

*Helicoverpa punctigera*

Cry2Ab cotton in Australia

*Helicoverpa armigera*

*Helicoverpa punctigera*



## 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 agro-ecosystem 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

*Busseola fusca*

Cry1F maize in Puerto Rico

*Spodoptera frugiperda*

Cry1Ac cotton in Gujarat India

*Pectinophora gossypiella*

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



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



# EPA Requirements for TwinLink

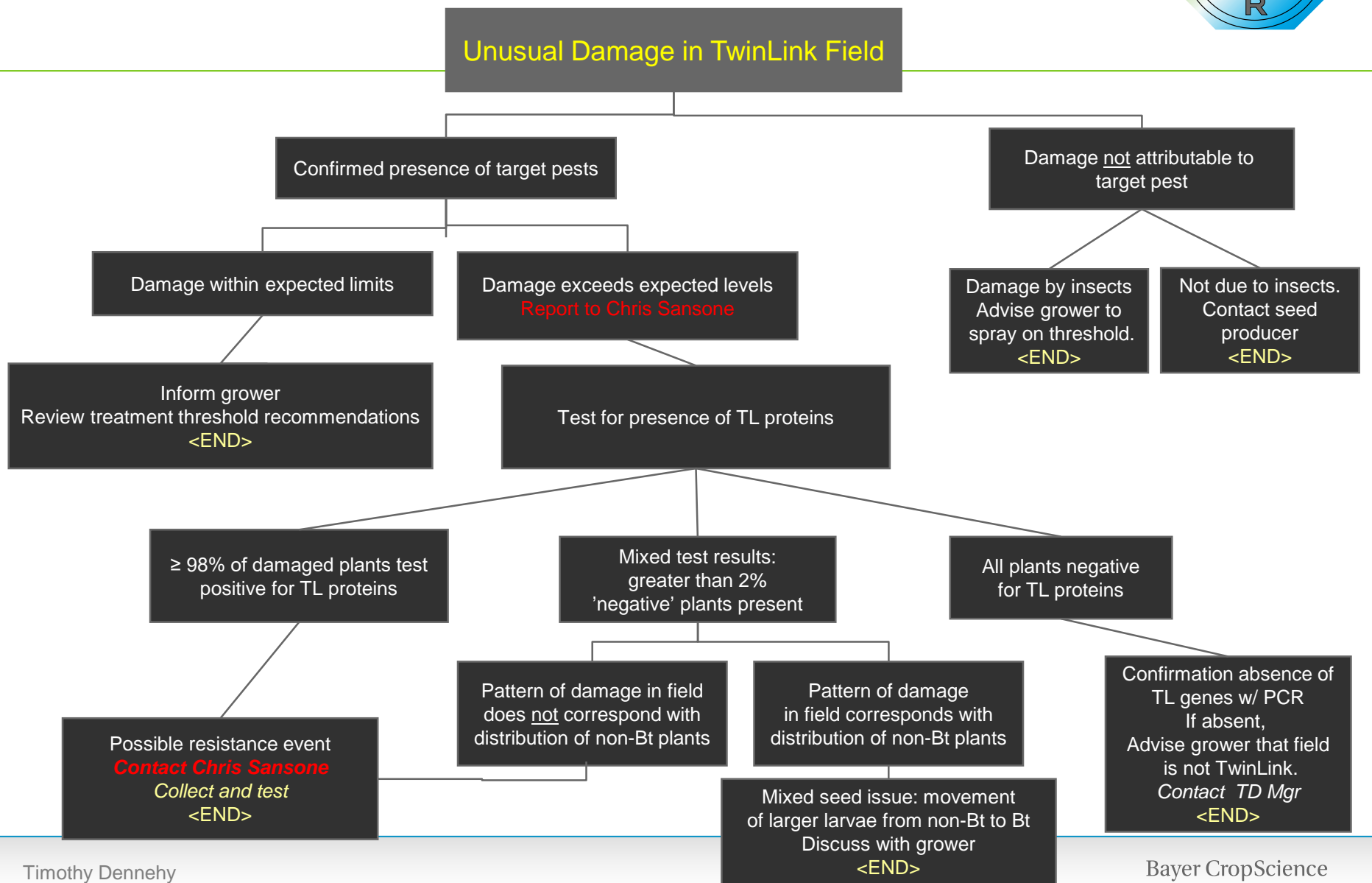
**BCS must ....**

*Monitor resistance, including:*

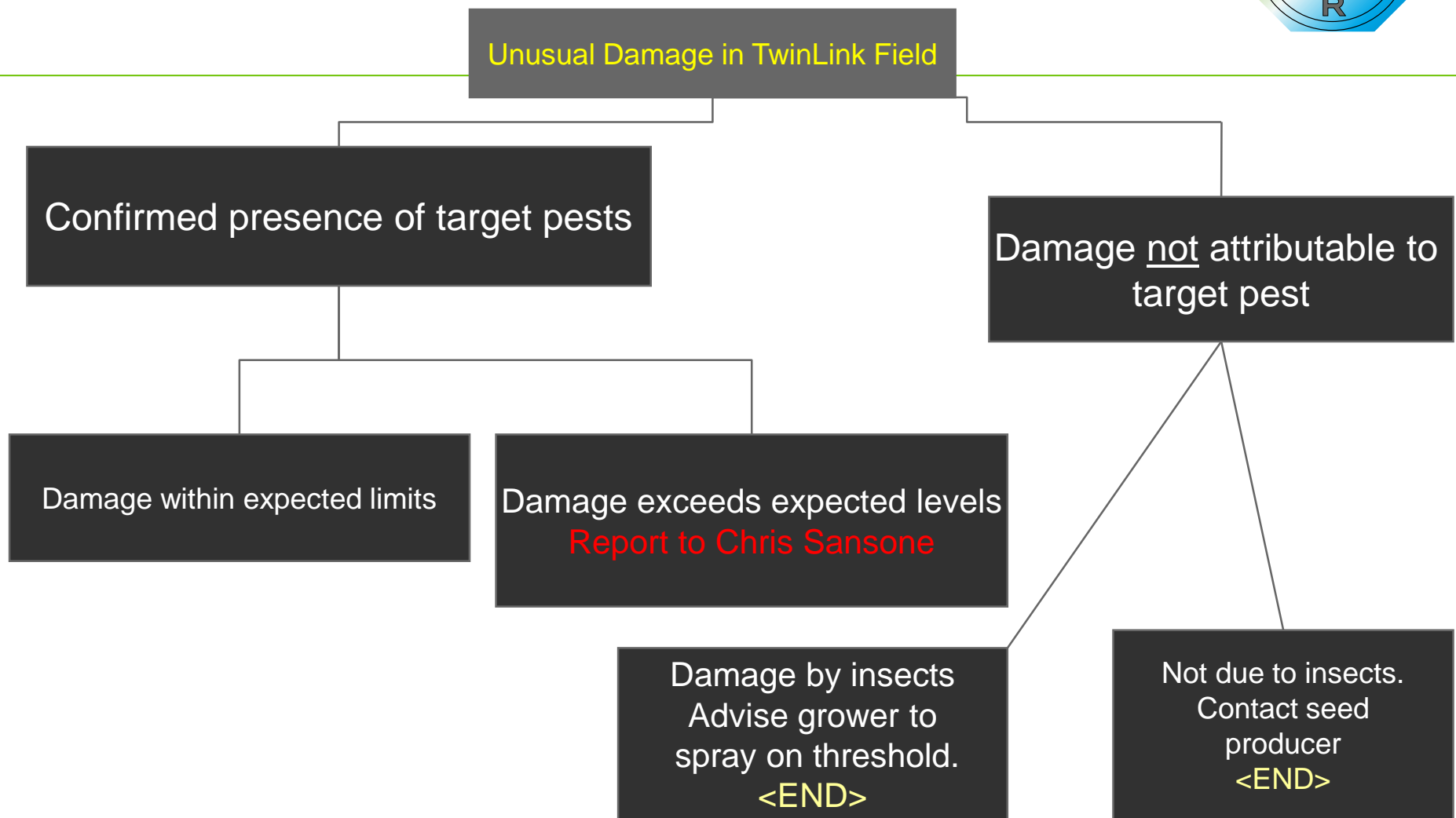
- *Surveying and testing insects for potential resistance*
- *collection of information from growers about events that may indicate resistance.*

*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



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# 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

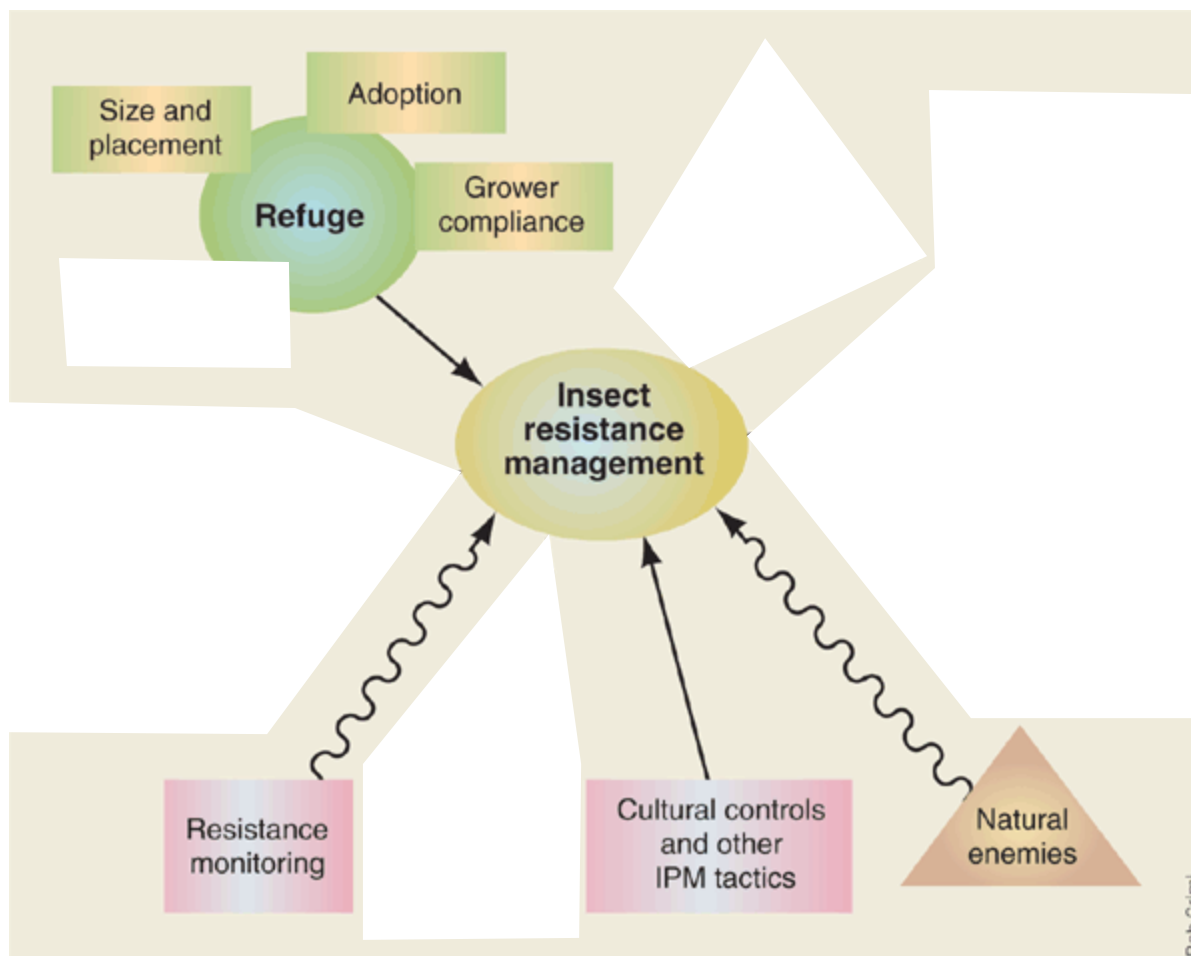




# Consultant Role with Insecticides



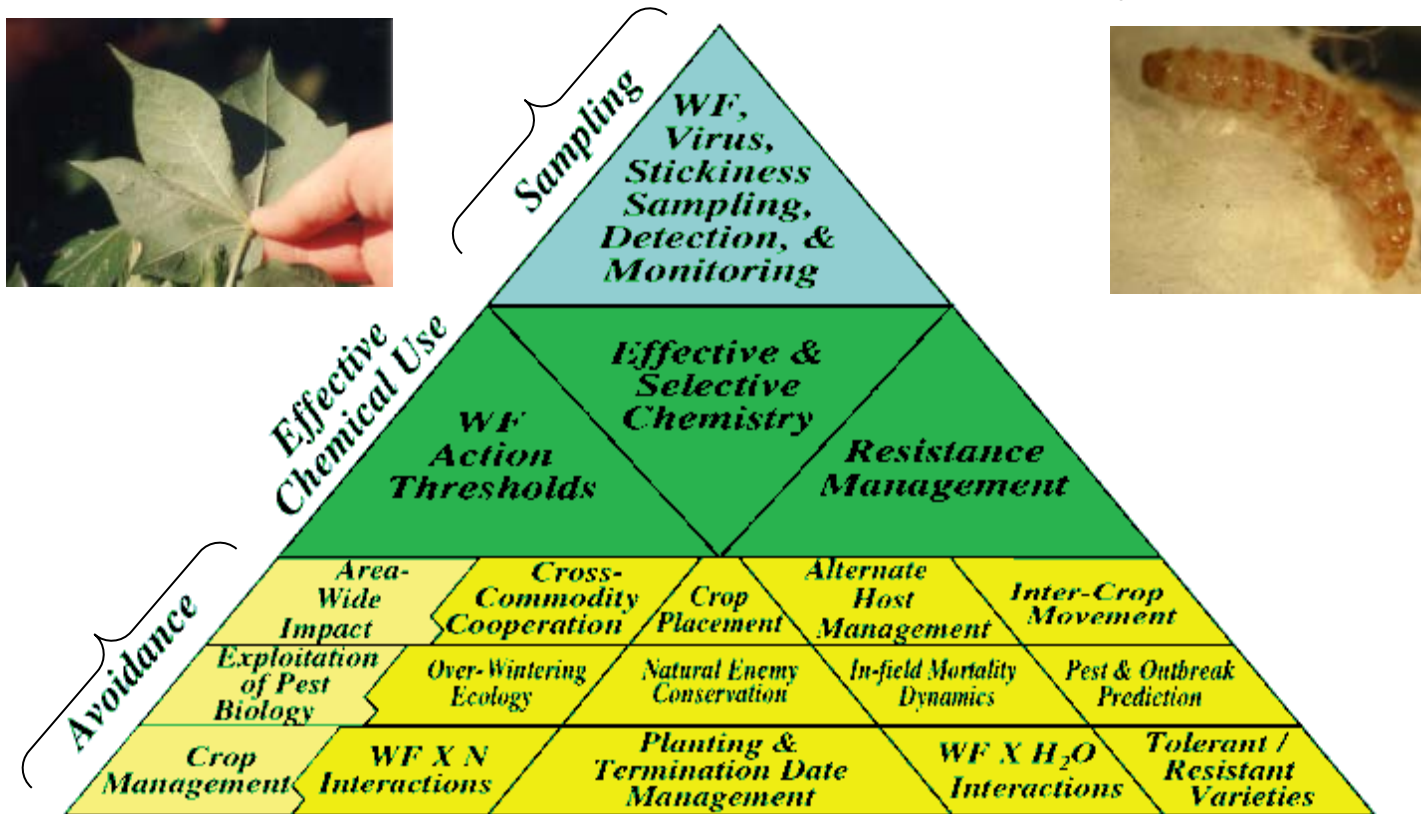
# Consultant Role with Insecticidal Proteins





# 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



# Forward-Looking Statements

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