Trait and Pesticide Conservation Through Integrated Pest Management

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Outline

• Integrated Pest Management (IPM) & Resistance Management
  – Tactics

• The Problem
  – Product durability timelines
  – Adoption of IPM & Resistance Management

• Adapting IPM to improve implementation
  – Recognize a “New IPM Paradigm” for the modern age
  – Manage for “appreciation” instead of “annual return”
  – Community-based area-wide Best Management Practices (BMP) discussions
  – Change the conversation!
Integrated Pest Management (IPM)

- Integration (strategy, tactics, tools), Economics (EIL, ET), Monitoring
- IPM, if used as a combination of BMPs and Resistance Management, can lead to sustainable and profitable farming
Definition of Resistance Management

• Resistance Management is the combination of proactive and complementary practices to slow, detect, and mitigate the development of resistance (across pests – insects, weeds, diseases)

• Resistance defined as:
  • IRAC: a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species (https://www.irac-online.org/)
  • HRAC: is the ability of a weed biotype to survive a herbicide application, where under normal circumstances that herbicide applied at the recommended rate would kill the weed. (https://www.hracglobal.com/)
As scientists, we use this roadmap to develop “Best Practices” for Bt Crops……pretty simple….right??

- IPM-compatible Insecticides
- Monitor Pests to Reduce Unnecessary Sprays
- Biological Controls
- Cultural Pest Control Practices
- Host Plant Resistance
- Refuge
- Native Traits
- Transgenic Traits
- Best Agronomic Practices (BMPs)
- Build Consensus of Companies, Regulators and Academic Stakeholders re IRM Strategy
- Delaying Resistance Development
- Train Growers, Consultants and Company Personnel
  - Refuge Requirements
  - Pest Sampling and Thresholds
  - Pesticide Compatibility with Biological Controls
- Make information readily available: grower guides, label instructions, license agreements, etc.
- Define metrics of IPM and IRM Implementation
- Conserving susceptible pests

(Adapted from: Hoy 1998: Myths, models and resistance mitigation)
Key Resistance Management Tactics

Crop Protection Chemistry
• Use multiple pest management tactics
• Scout and apply at economic thresholds
• Rotate among, or apply mixtures of, chemistries with different modes of action
• Follow label rates
• Monitor effectiveness of treatment

Insect Protection Traits
• Use multiple pest management tactics
• Use cultural controls to limit pest populations
• Choose pyramided trait products with multiple proteins effective against target pests
• Manage refuge areas
• Monitor effectiveness of trait(s)
Best Management Practices for Corn Rootworm (CRW)
Pre-Plant Decisions in Continuous Corn

Can corn field be rotated?

- **NO**

Do you know the size of last summer’s rootworm population?

- **NO**

Was last summer’s corn rootworm population high? (see chart below)

- **YES**

Was last summer’s corn rootworm population low? (see chart below)

- **NO**

Was field planted 2 or more continuous years with the same Bt-CRW trait?

- **YES**

Estimating Corn Rootworm Population Size

<table>
<thead>
<tr>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>&gt;1</td>
</tr>
<tr>
<td>&lt;21</td>
<td>&gt;50</td>
</tr>
<tr>
<td>&lt;0.5</td>
<td>&gt;1.0</td>
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</table>

- **NO**

Soil-applied insecticides + Bt-CRW traits?? Consult with an extension agent, crop consultant or your Pioneer technical seed rep to determine need

- **YES**

BMP Example
Replacement Options for Current Coleopteran-Active Biotech Products are Difficult to Predict

Mid- and Early-development release options

<table>
<thead>
<tr>
<th>Year</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
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</thead>
</table>

Worst Case (2-4 yrs) Standard Case (5-8 yrs) Best Case (> 8 yrs)

- Future replacement products are dependent upon maintaining the value of current products…
- Current product value is dependent upon adoption of BMPs

<table>
<thead>
<tr>
<th>Variable</th>
<th>Worst Case</th>
<th>Standard Case</th>
<th>Best case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adoption of BMPs</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
</tr>
</tbody>
</table>

Time for Action is NOW

Produced by Agricultural Biotechnology & Stewardship Technical Committee (ABSTC)
Analyses of Bt Field Failures


• Low pest sensitivity to Bt proteins
• Challenging pest biology (environmental influence)
• *Lack of compliance with planting of refuges*
• *Limited adoption of recommended BMPs*

Why?

*Little understanding of the human element*
“Complexity in Agriculture: The Rise and Fall of Monsanto”

3 Elements Increase Complexity
- Resistance (weeds & insects)
- Consumer Preferences
- Precision Agriculture

Budzynski 2017

HI = human intelligence
AI = artificial intelligence

Figure 1. Monsanto’s Role in Declining Complexity in US Row Crop Agriculture.
Utilizing a New “IPM Paradigm” for the Modern Age

S. K. Dara (2019)

Last 50 years
- Ecological and economic focus

New Age
- Management
  - Tools (tactics, digital etc) & knowledge/resources to develop strategies
  - Decision-making (Predictive Ag)/implementation & sharing information
- Business
  - Producer, consumer, and seller
- Sustainability
  - Economic viability, environmental safety, social acceptability
Socially Responsible Land Investment

81 years positive
13 years negative
Average = 11.5%
> S&P 500
57 of past 64 yrs
 Appreciation = 7%
Annual return = 4.5%

“Socially responsible farmland investment is a means by which farmland investors can consider the full consequences of their actions. It lets the investor think beyond simply the immediate dollar returns from the land.”

Can we apply similar concepts and implement “socially responsible pest management”?

- Weeds, insects, diseases
  - “Common pool resources”
  - “Tragedy of Commons”

- Is there a way to estimate the externality costs/benefits?

- What positive impact could farmers that focus on “appreciation” decisions have on their neighbors/community?
Community-based Approaches Toward Implementation

Desired Outcome: Participants (key partners) will leave empowered with a clear identification of their roles in leading immediate and sustained actions at the national, state, and local levels to enable the local formation and implementation of community-based pest resistance management efforts.

Iowa Pest Resistance Management Plan
https://www.ipm.iastate.edu/about-the-iprmp
Changing the Conversation from “Managing Resistance” to “Sustaining Value”

Understanding risk

Intentionally crafted integrated solutions

Creating appreciable long-term profitability

Social accountability

Human & environmental safety

Farm & community sustainability

Intentionally crafted integrated solutions
Moving Toward “Modern Age IPM”

• Annual return → Appreciable return
• Producer focus → Producer, consumer, seller
• Product programs → Intentionally crafted recommendations
• Resistance focus → Value creation or sustaining value
• “Monsanto valley” → Managed complexity
• Technical BMP focused → Implementation focused
• Single farmer approaches → Community-based approaches

Changing conversations so all key stakeholders understand the long-term impact of decisions made today
Thank you