Iowa Soybean Research Center Final Report PI Name: Steven P. Bradbury Year 3 Funding period: Oct 1, 2018 - Sep 30, 2019; Project Period Oct 1, 2016 – Sep 30, 2019 Report date: October 1, 2019 Funding amount: \$75,000 over three years Project Title: IMPLEMENTATION OF THE IOWA PEST RESISTANCE MANAGEMENT PLAN

## **Progress of Work (Project Summary):**

The proposal titled, "Implementation of the Iowa Pest Resistance Management Plan" was awarded funding on May 8, 2017. This three-year project, which was back dated to October 1, 2016, supports the implementation of voluntary, community-based pest resistance management as described in the <u>Iowa Pest Resistance Management Plan</u> (IPRMP).

The overall goal of this project was to facilitate the formation of community-based pest resistance management programs and subsequent acceptance and adoption of resistance management practices, consistent with goals and objectives of the Iowa Pest Resistance Management Program (https://www.ipm.iastate.edu/protectiowacrops). Member organizations and partners of the IPRMP include the Iowa Soybean Association; Iowa Corn Growers Association; Iowa Farm Bureau Federation; Agribusiness Association of Iowa; Iowa Institute of Cooperatives; Iowa Independent Crop Consultants Association; Iowa Chapter of the American Society of Farm Managers and Rural Appraisers; Agricultural Biotechnology Stewardship Technical Committee; Insecticide Resistance Action Committee; Herbicide Resistance Action Committee; Iowa Department of Agriculture and Land Stewardship; and Iowa State University College of Agriculture and Life Sciences, Extension, and Iowa Soybean Research Center.

Insect, weed, and disease resistance to chemical, genetic, and agronomic management practices is recognized by farmers, their crop advisors, pesticide technology firms, and land grant researchers and extension specialists as a serious and increasing threat to commodity crop production in the United States, including corn and soybean production in Iowa. The IPRMP is an Iowa-specific effort to address pests--including weeds, insects and diseases--that can adapt and become resistant to chemical, genetic, and agronomic control practices. The IPRMP outlines voluntary, community-based approaches to identify and implement effective, integrated management solutions that will sustainably control pests at the local level. By fostering methods to detect resistance and implement coordinated pest management techniques, resistance can be delayed or even prevented, limiting the spread of pest resistance and reduced profitability. Because many pests are mobile and can move across farm boundaries, effective community-based management involves coordinated efforts of farmers, agribusiness representatives, local lenders, cooperative managers, and community leaders with support from ISU Extension.

In January 2015, a meeting led by the Iowa Department of Agriculture and Land Stewardship (IDALS) and the ISU College of Agriculture and Life Sciences resulted in the call for the development of a statewide, voluntary pest resistance management plan that would be coordinated by ISU and IDALS and involve participation from all sectors of Iowa agriculture. A framework for the plan was developed by a taskforce made up of representatives from the Agribusiness Association of Iowa, Agricultural Biotechnology Stewardship Technical

1

Committee, Iowa Corn Growers Association, Iowa Soybean Association, the Iowa Chapter of the American Society of Farm Managers and Rural Appraisers, Iowa Farm Bureau Federation, Iowa Independent Crop Consultants Association, Iowa Institute for Cooperatives, Pesticide Resistance Action Committees, and the Soil and Water Conservation Society. This framework, approved in December 2015, provided a structure for developing Version 1.0 of the IPRMP. The first version of the IPRMP contained chapters regarding governance, state of the science, communication and outreach, and pilot projects. The plan was approved by the partnering organizations in December 2016. A website, <u>www.ProtectIowaCrops.org</u>, was created to serve as a central hub for the IPRMP plan, project news, information, and resistance-related resources.

To advance implementation of a community-based approach to resistance management, the Iowa plan identified four pilot projects in different locations across the state. The pilot projects are envisioned to incorporate the most current pest management science and recommendations, while also acknowledging the socio-economic realities farmers face. Development of the pilot projects began in 2016-2017. Each pilot project is intended to have representation from all sectors of agriculture, including farmers, crop advisers, commodity groups, agricultural retailers, seed dealers, lenders, university research and extension, and representatives from seed and pesticide companies. A broad cross-section of stakeholders is vital as each brings unique viewpoints and valuable insights into barriers to adoption of resistance management practices as well as potential solutions. Pilot planning, facilitated by ISU, is designed from the "ground-up" by the local community teams. A brief summary of the four pilots over the three-year project period are provided below. A more detailed synopsis of project activities and outreach metrics are provided following this summary.

Pilot 1: Harrison County: Palmer amaranth and herbicide resistant weeds. This is the most advanced pilot with a motivated local farmer serving as project lead and a stable, diverse project team consisting of farmers, retail and extension agronomists, representatives from pesticide technology companies, and lenders. Since the summer of 2017, the team meets every one to three months. The group understands the seriousness of pest resistance and what must be done to make progress; namely to change the mindset regarding weed management to confront the threat of herbicide resistance. Tangible progress towards project goals include completion of a postcard survey of grower awareness and management practices, field trials in cooperator corn and soybean fields demonstrating comprehensive weed management programs, field days, videos, collection and screening of weed seeds for herbicide resistance, and numerous outreach publications. In August 2019, the team hosted a Weed Science Society of America/Entomological Society of America Policy Experience event. Over 70 invited participants from across the United States representing growers, agricultural retailers, commodity groups, pesticide and biotechnology firms, lenders, NGOs, EPA, USDA, and university research and extension scientists convened to discuss community-based pest resistance management and to learn from the success of the Harrison pilot. The goal of the meeting was to provide participants with a new perspective and tools for engaging with their organizations and reaching out to broader stakeholder groups in the development and implementation of local, voluntary, community-based resistance management.

*Pilot 2: Herbicide resistant waterhemp in Story County.* Sixteen meetings in 2017 – 2019 have been held with a diverse group of land managers, coop agronomists, technology providers,

and university extension staff. Land use in Story County includes seed production fields in addition to commodity production, which in turn indicates that multiple, overlapping communities of producers and support networks are in play, adding another layer of social and economic complexities to forming a community-based approach. Awareness of herbicide resistance is high and the urgency of the problem is recognized; however, a local leadership group only recently emerged in September 2019. The newly formed team consists of six local farmers and a highly respected, retired leader from a cooperative, who was instrumental in helping form this core group. The group is identifying additional producers to join the effort and will meet again following harvest. These results are encouraging and further illustrate, consistent with the Harrison County project, the importance of a local, well-respected leadership team to help initiate a community-based approach. This project combined with the Harrison County project illustrate the diversity of factors related to community team formation, including socioeconomic constraints.

*Pilot 3: Soybean aphid resistance to pyrethroids.* Soybean aphid resistance to pyrethroids is an emerging threat. This pilot serves as a test for the ability to initiate pest resistance management in the early stages of resistance development, before most producers see a significant problem. Discussions with soybean producers and ISA directors in north central and northeast Iowa have provided valuable information and insights. The extent to which growers or their advisors are scouting fields every seven to ten days from the end of June through R5.5, as recommended by extension entomologists, is uncertain. Despite a well-documented and supported economic threshold for aphid management, some discussions indicate a belief that the economic threshold should be much lower due to the economics of application, commodity prices, and misinformation; e.g., a concern there is an additive interaction between soybean cyst nematode and soybean aphid. In addition, in some instances pyrethroid insecticides are applied in a tank mix with scheduled fungicide treatments, regardless of aphid pressure. Previous research indicates decisions to use fungicides in corn production are likely influenced by perceived economic gains, beliefs, and attitude towards risk. After the 2019 harvest, the IPRMP team will resume discussions to better understand the combined use of fungicides and insecticides with leading soybean producers and ISA directors.

*Pilot 4: Western corn rootworm resistance to Bt traits.* Team leaders from the IPRMP have held seven meetings with stakeholders in three northeast Iowa counties to understand awareness and attitudes concerning Bt-resistance, identify barriers to adoption of resistance management practices, and identify potential project participants and leaders. A statewide grower survey conducted in the summer of 2018 is being used to better assess grower perspectives. Thus far, discussions and the survey results indicate challenges to greater adoption of best management practices, including grower disinterest in crop rotation due to field topography, proximity to ethanol plants, co-management of livestock operations, and lack of confidence in the feasibility of profitable soybean production. Other challenges include inadequate knowledge of Bt traits and the current resistance profile, combined with a belief that commercialization of new technologies to solve the problem are imminent. The results of the survey will help guide future discussions with local leaders and representatives of member companies in the Agriculture Biotechnology Stewardship Technical Committee.

The efforts of the IPRMP were recently recognized by the Weed Science Society of America (WSSA), Entomological Society of America (ESA), Corteva, and the United States Department of Agriculture Animal and Plant Health Inspection Service. These organizations collaborated to hold a national Science Policy Experience event on August 6 and 7, 2019 concerning community-based approaches to address weed and insect resistance. This event was held in Iowa, which is the only state actively pursuing community-based approaches. Over 70 invited participants from across the United States representing growers, ag retail, commodity groups, pesticide and biotechnology firms, lenders, NGOs, EPA, USDA, and university research and extension scientists convened to discuss pest resistance management and to learn from the success of the Harrison pilot. The goal of the meeting was to provide participants with a new perspective along with strategies to engage broader stakeholder groups in the development and implementation of local, voluntary, community-based resistance management. The participants spent August 6<sup>th</sup> in Harrison County meeting with the local team. During the day the deputy secretary of Iowa Department of Agriculture and Land Stewardship also spoke and stressed the importance of the IPRMP for Iowa and producers across the nation. On August 7<sup>th</sup>, the participants convened in Ankeny, Iowa to discuss and explore how experiences such as those gained in Iowa could be adapted to other parts of the country. Dr. Paul Lasley from ISU provided a presentation, titled: A Model for Community Change.

Over the course of the three-year project, numerous outreach products were released and activities undertaken, which are summarized below.

Presentations at professional, commodity meetings: 23 Webinar: 1 Extension Publication: 1 News Media/ISU Articles: 39 Handouts: 10 Videos: 5 Radio interviews: 3 Field Days: 5 Website: 1

**Next Steps:** A major finding of this project is that socio-economic factors are fundamental to understanding how and why some community-based approaches readily form (e.g., Harrison County), while others are more difficult to form and gain momentum. Moving forward, and in consultation with ISA, ICGA, IFBF, and other IPRMP partners, over the next three years the IPRMP will assess socio-economic factors that influence the formation of community-based pest resistance management, through a recently awarded USDA grant, titled *Assessment of the Socio-Economic Factors Impacting Adoption of Voluntary Pest Resistance Management by Rural Communities*. Letters of support in the grant proposal included those from the Dean of the College of Agriculture and Life Sciences, the Vice President for Extension and Outreach and numerous ISU faculty. In addition, IDALS and the ISA, ICGA, IFBF, Iowa Institute of Cooperatives, Agribusiness Association of Iowa, Insecticide Resistance Action Committee, Herbicide Resistance Action Committee, and Agricultural Biotechnology Stewardship Technical Committee. The award is for \$299,000 over three years (July 2019 – June 2021). The project team includes economists and sociologists from Iowa State University and the University of

Northern Iowa. The grant, which is an integrated research/extension project, will assess socioeconomic factors that influence the formation of community-based pest resistance management with a continued focus on advancing the four pilot projects in the IPRMP.

**Leveraging:** With the support of the ISA, this project helped highlight the IPRMP nationally. With the contributions from ISA, the ICGA and the IFBF, the IPRMP project was able to leverage additional funds to support the effort during the three-year project period. These investments will help sustain the IPRMP into the future. Over the course of the three-year project the ICGA and IFBF also provided \$75,000 (\$150,000 combined). In addition a grant of \$50,000 was received from the North Central IPM Center (March 2017 – February 2019), which helped support efforts to establish local community-based teams. As summarized above, the IPRMP also was awarded a \$299,000 grant (July 2019 – June 2022) from USDA to address socio-economic factors that impact the formation and progress of the four pilot projects. During the three-year project period, the pest management technology providers through the Insecticide Resistance Action Committee, Herbicide Resistance Action Committee, Crop Life America, and the Agriculture Biotechnology Stewardship Technical Committee contributed \$77,500 of their \$225,000 cost-share. These partners are in discussion to complete their pledge for the IPRMP and to that end as ABSTC and CLA interim contributions of \$30,000 and \$10,000, respectively, are confirmed for October, 2019.

## Synopsis of Project Activities and Outreach Products

As reported throughout the three-year project period, efforts progressed in a manner consistent with the initial proposal, which was based on leveraging resources and participation of numerous partners. Below is a summary of activities and milestones met throughout the project.

From October 2016 through December 2016, the IPRMP plan was finalized and approved by AgState (https://www.ipm.iastate.edu/protectiowacrops). The IPRMP plan includes four pilot projects: Palmer amaranth and herbicide resistant weeds in Harrison County; herbicide resistant weeds in Story County; soybean aphid resistance to pyrethroids; and western corn rootworm resistance to Bt traits. The IPRMP was announced publically in January 2017 by Secretary Northey, Iowa Department of Agriculture and Land Stewardship; John Lawrence, Associate Dean, College of Agriculture and Life Sciences, and Larry Buss, farmer, Harrison County. During the first half of 2017 the scope and nature of the four pilot projects were refined with commodity group representatives. Consistent with the AgState approved plan, an IPRMP program manager position at ISU was advertised and Dr. Evan Sivesind joined the team in June 2017. In April 2019, the ISU IPRMP staff held a teleconference with Ian Burke and Katherin Dentzman from Washington State University, who are working to begin a similar collaborative effort in the northwest United States to combat weed resistance issues. IPRMP details were shared, including how it began, how the program is structured and what progress has been made. Challenges were also discussed.

Progress for the four pilot projects through September 2019 are summarized below. Outreach materials referenced in the summary that are not available online can be found in File 1. In addition, representative presentations are provided in File 2. Palmer amaranth and herbicide resistant weeds in Harrison County. The Harrison County Pest Resistance Management Project pilot project was the most mature and robust of the pilot projects over the last three years. This was due to the presence of a motivated, dedicated local champion who had formed a comprehensive team by spring 2017. From October 2017 through March 2018, five meetings were held with project participants from ICGA, IFBF, Midstates Bank, Farm Credit Services of America (FCSA), Heartland Coop, ISU Extension and Outreach, Agriland FS, Bayer, USDA FSA, BASF, and local farmers. Farmer cooperators were recruited for future field demonstration trials, which involved three soybean sites (two tilled, one no-till) and one corn site. Replicated trials were designed to demonstrate effect of row width and comprehensive herbicide programs on weed management in tilled soybeans and corn and no-tillage soybeans.

From March 1 to September 30, 2018, six meetings were held with project team participants. Replicated trials were implemented with cooperators at four sites: three soybean sites (two no-till and one tilled) and one corn site. Ten comprehensive herbicide programs were applied by a custom applicator (DM Crop Research). Two field days were planned and held: one at the corn site on June 18<sup>th</sup>, the other at one of the no-till soybean sites on July 13<sup>th</sup>. Attendance at the first, corn field day was modest. Thirty-five people attended the second, soybean-focused field day. The increase in attendance was attributed to increased promotion of the event, weed pressure in beans and engaging the Iowa Cattlemen's Association, which catered lunch with support from Midstates Bank and FCSA. In addition to the field demonstrations, attendees received tutorials on Palmer amaranth identification and results of weed screenings for herbicide resistance. A video was produced to document the soybean field day and support project promotion see: https://www.youtube.com/watch?v=ydTzOFrZREY&t=7s. On August 2<sup>nd</sup>, the team had the opportunity to brief US Environmental Protection Agency (EPA) and USDA representatives about the IPRMP and the Harrison County pilot. The Harrison County pilot team also presented results of the field trials and promoted the project at a Pre-Harvest Crop Fair in Dunlap, Iowa on September 18<sup>th</sup>.

From October 1, 2018, to April 1, 2019, three team meetings were held. Strip trials for 2019 were planned for tilled and no-tilled soybean fields operated by cooperating farmers. Trials were designed to demonstrate different herbicide programs. In 2019, fungicide resistance management was incorporated into the Harrison County project, and samples were collected from fungicide field trials (disease and resistance results pending). A 2018 herbicide handout showing the resistance screening results from seeds collected in 2017 was distributed at local field days. All waterhemp populations sampled exhibited some degree of resistance to Roundup (HG 9), with survival between 36% and 75% 21 days after treatment. Waterhemp response to Cobra (HG 14) was variable, with plant survival between 10% and 100%. Palmer amaranth showed moderate to high

level of resistance to Roundup and Callisto (HG 27), but was completely controlled by Cobra. Survival of giant ragweed to Roundup was between 21% and 78%, while one giant ragweed sample was highly resistant to Callisto. All giant ragweed samples in this study were susceptible to Cobra. In 2018, samples were once again collected from locations across Harrison County. Four waterhemp samples were submitted for molecular analysis to the University of Illinois Plant Clinic. All four samples tested positive for resistance to glyphosate, while two of four samples tested positive for resistance to PPO-inhibitors. These results confirm the presence of resistance to many of the most commonly used herbicides in corn and soybean production in weed populations in Harrison County. A 2018 Harrison County brochure summarizing the activities of the project was also created and distributed at events and through local businesses. The Harrison County project team agreed to host the WSSA/ESA/Corteva/USDA APHIS Science Policy Experience event, which addressed the nature and role of voluntary, community-based pest resistance management programs. The WSSA/ESA organizers selected the IPRMP and the Harrison County pilot as the focus for the event since it is the only community-based pest resistance management effort in the nation.

From April 1 to September 30, 2019, five meetings were held in Harrison County to plan a 2019 Field Day and to prepare for the WSSA/ESA Science Policy Experience. The team also began planning for 2020 activities and edited text to add to the protectiowarcrops.org website. The field day was promoted online and with news articles and handouts. The Harrison team hosted the field day on July 9 with a focus on weed management trials and the Harrison County project; about 30 people attended. On August 6 and 7, the Harrison County team hosted the WSSA/ESA Science Policy Experience event. Over 70 invited participants from across the United States representing growers, ag retail, commodity groups, pesticide and biotech firms, lenders, NGOs, EPA, USDA, and university research and extension scientists convened to discuss pest resistance management and to learn from the success of the Harrison pilot (see 2019 Science Policy Experience Welcome and Science Policy Experience agenda, meeting summary link https://www.ipm.iastate.edu/science-policy-experience). The goal of the meeting was to provide participants with a new perspective, along with strategies, to engage broader stakeholder groups in the development and implementation of local, voluntary, community-based resistance management. The meeting included a presentation by Dr. Paul Lasley from ISU, titled: A Model for Community Change. The deputy secretary of Iowa Department of Agriculture and Land Stewardship also spoke at the event and stressed the importance of the effort for Iowa and producers across the nation.

Herbicide resistant waterhemp in Story County- From October 2017 through February 2018, seven meetings were held with participants from DuPont Pioneer (now Corteva), Dow Agrosciences (now Corteva), Syngenta, Monsanto, Key Coop, Heartland Coop, and Hertz Farm Management. Farmer cooperators were recruited for field trials to demonstrate effectiveness of herbicide resistant management strategies. A 2018 IFBF young farmer handout was created and provided to IFBF for use at their Young Farmer Conference to increase visibility and gain participation with this key farmer demographic.

From March 1 to September 30, 2018, six meetings were held with team members and local stakeholders. The project was promoted at an ISU Extension herbicide resistance field day in June. Numerous discussions were carried out with local cooperators concerning on-farm field trials, but due to a late spring and other concerns, all pesticide company cooperators declined involvement. At the time, additional progress for this project was hampered by retirements of key community leaders, lack of commitment by technology providers, and unsuccessful attempts to identify local leaders.

Success of this pilot depends upon securing adequate local leadership, hence identification of dedicated individual(s) was determined paramount. From October 1, 2018, to April 1, 2019, several meetings were held with Story County individuals with extensive knowledge and experience with producer families to help identify key influential producers to be involved with this project.

From April 2 to September 30, 2019, one meeting was held in Story County, featuring six local farmers, a cooperative advisor, and a highly respected, retired leader from a cooperative who was instrumental in helping form this core group. The group agreed that Story County action was needed. The group discussed creating a video to use through social media to help raise awareness. The group also agreed to identify additional producers in the area to join the effort. The group agreed to meet again following harvest. The results of the meeting were encouraging and further illustrated, consistent with the Harrison County project, the importance of a local, well respected leadership team to help initiate a community-based approach.

Soybean aphid resistance to pyrethroids- From October 2017 through February 2018, discussions were held with ISA directors April Hemmes, Suzanne Shirbroun, and Brent Renner and former ISA President Wayne Fredericks. Among the topics of discussion were the interaction between fungicide applications and the prophylactic application of insecticides, as well as a perception held by some farmers of an interaction between the stresses induced by soybean cyst nematode and soybean aphid that require insecticide applications for aphid populations that are well below the North Central Land Grant University recommended threshold. Discussions were also held with University of Minnesota Extension and research personnel concerning their resistance management efforts. They shared similar challenges in advancing resistance management programs, despite more examples of resistance populations in their state.

From March 1 to September 30, 2018, discussion and contact with ISA directors continued. Discussions with growers and agronomists indicated that

soybean aphid resistance is fairly low on the hierarchy of concerns for growers and well below such issues as weed management and trade issues. Increasing grower awareness and recognition of the risk to production posed by soybean aphid resistance to pyrethroid insecticides remains a challenge. After the 2019 harvest, the IPRMP team will resume discussions with leading soybean producers and ISA directors.

Western corn rootworm resistance to Bt traits- Five meetings were held from late summer 2017 through April 2018 involving representatives from DuPont Pioneer, ICGA, ISU Extension, Schneider's Milling, SilverEdge Coop, Innovative Ag Services, independent crop consultants, and local farmers. A survey of current management practices and awareness of Bt resistance was finalized for distribution. Educational materials were disseminated at the Hawkeye Farm Show and the NE Iowa Research Farm annual meeting. Educational materials were also developed and provided to Terry Basol, ISU Extension agronomist for Region 4, and Kristine Schaefer, ISU for inclusion in Pesticide Applicator Training sessions. Approval was sought and received from the ABSTC, and the specific companies that are members of ABSTC, to share information with farmers, crop advisors and other partners that the value of future RNAi technology is dependent upon the stewardship of current Bt traits. This outreach topic was initiated based on discussions with farmers and crop advisors who indicated this issue was not widely known and that it raises the stakes for implementing effective corn rootworm resistance management with existing Bt traits.

From March 1 to September 30, 2018, efforts to identify the best location and team for this project continued. A meeting was held in Fayette County to discuss Bt resistance and the potential of a project in Delaware or surrounding counties. Delaware was identified due to its high frequency of continuous corn, history of Bt resistance, and reported unexpected damage cases concerning Cry 34/35. A statewide grower survey of management practices and awareness of Bt resistance was conducted to inform future project directions.

From October 2018 to April 2019, the IPRMP program manager and Iowa State faculty met with ICGA directors to discuss how to speed progress of a Bt resistance project in Delaware County and the surrounding region. This area remains especially important due to the announcement of documented unexpected damage in fields planted to hybrids containing Cry 34/35Ab1 in Delaware County.

From April 2019 – September 2019, a preliminary analyses of the online survey conducted in 2018 was prepared. During the summer of 2018, 89 farmers responded to an online Qualtrics survey that was distributed to producers by Corteva and the ICGA. The respondents were from 63 Iowa counties. Approximately 20% of the respondents indicated they had difficulty managing western corn rootworm over the last five to ten years, and 64% indicated they

were very strongly or strongly concerned about corn rootworm resistance to Bt traits. In response to a statement that reports of resistance do not affect individual farmer decisions, 61% strongly disagreed or disagreed. In response to a statement that farmers should improve trait management to maintain current Bt technologies, 81% of the respondents somewhat or strongly agreed; however, 80% also somewhat agreed or strongly agreed that they were already doing all the resistance management practices they can or are willing to do. Crop rotation every five years (70% of the respondents), use of hybrids with two Bt traits (59%) and soil-applied insecticide with non-Bt corn (29%) were the most commonly used rootworm management techniques reported that are components of a sound resistance management program. Use of hybrids with one Bt trait (34% of respondents), soil-applied insecticide with Bt-corn (33%), and foliar applied insecticide to manage adult beetles (29%) were reported management techniques that are not generally considered effective in slowing the development of resistance. The most prevalent constraints in implementing resistant management practices included a need to maintain acres in corn (23% of respondents; 44% of the respondents indicated they have grown corn for three or more years in some fields) and lack of equipment to use soil applied insecticides (27%). In response to a question concerning the reliability of four commercially available Bt traits, between 33% to 50% of the respondents declined to answer, suggesting many of the farmers completing the survey were unsure if current traits still provide reliable control. Contrary to industry projections, 46% of the respondents strongly or very strongly believed industry will release new technologies before current Bt traits become ineffective; however, 32% were uncertain about the statement and the remainder strongly disagreed or disagreed. When asked how would they manage western corn rootworm if Bt traits were no longer effective, crop rotation, use of soil applied insecticides, and use of foliar insecticides to manage adult beetles were the most commonly identified practices. The responses of the survey; e.g., belief 'a silver bullet' will resolve the resistance issue, uncertainty as to which Bt traits are most vulnerable, management decisions influenced by neighbors practices, and agronomic/economic constraints to implementing resistance management practices, will help guide future discussions with local leaders.

## **Outreach Products (also see File 1 and File 2)**

Outreach and communication are an essential part of the IPRMP. Listed below is a summary of outreach activities and materials over the course of the three-year project.

- Outreach and communication efforts from October 2016 through March 2018 included:
  - 16 presentations
    - Communication about the IPRMP launched in January, 2017 during a press conference (Secretary Bill Northey, Associate CALS Dean John Lawrence, and farmer Larry Buss)

- Iowa Power Farming Show: Introducing Iowa's Pest Resistance Management Plan (Deputy Secretary of Agriculture Mike Naig and Steven Bradbury). February 2, 2017.
- ISA Research Conference: Weed Resistance, We are all in this Together (Steven Bradbury). February 7, 2017.
- Pest Resistance. AAI Showcase: Introductory session. (Steve Bradbury). February 14, 2017.
- Iowa Resistance Plan: 2016 Update. AAI Showcase: Afternoon session. (Steve Bradbury). February 14, 2017.
- Iowa Pest Resistance Management Plan. Iowa Independent Crop Consultants Association. (Steve Bradbury). Meeting. February 15, 2017.
- Minnesota Valley Testing Lab training Pesticide Resistance Management. (Steve Bradbury). February 23, 2017.
- Iowa pest resistance management plan: implementing a community-based approach. Crops Team Spring In-Service. (Steve Bradbury). April 3, 2017.
- North Central IPM Center Stakeholder Panel Meeting. Grand Rapids, MI. Update: A Community-Based Approach to Integrated Pest-Resistance Management Affecting Corn and Soybean: Case Studies for the North Central Region. (Evan Sivesind). August 15, 2017.
- Iowa World Soybean Research Conference. Ames, IA. Iowa Pest Resistance Management Plan: Implementing a Community-Based Approach. (Evan Sivesind). September 13, 2017.
- The Iowa Pest Resistance Management Plan: A community-based approach to address pest resistance in Iowa (Evan Sivesind).
   Proceedings of the 29<sup>th</sup> Annual Integrated Crop Management Conference, Iowa State University. Ames, IA. November 29-30, 2017. pp. 57-61.
- Iowa Pest Resistance Management Program. Iowa Soybean Association Board Member Event. (Steve Bradbury). Ames, IA. January 31, 2017.
- Iowa Pest Resistance Management Program. American Society of Farm Managers and Rural Appraisers- Iowa Chapter 2018 Annual Meeting. Ames, IA. (Evan Sivesind). February 1, 2018.
- Iowa Pest Resistance Management Program and the Resistance Management Specialty (RMS): Opportunities for CCAs. Agribusiness Association of Iowa Annual Showcase. (Evan Sivesind). February 13-14, 2018.
- Iowa Pest Resistance Management Program. Iowa State Sustainable Agriculture Colloquium. (Evan Sivesind). March 28, 2018.
- Roundtable Discussion: Managing Pesticide Resistance in Iowa. Iowa Institute for Cooperatives Office, Ames, IA. January 26, 2018.

- 1 webinar
  - Iowa Pest Resistance Management Plan. Recorded December 20, 2017. (Evan Sivesind). <u>https://www.iowafarmbureau.com/Article/Webinar-Iowa-Pest-Resistance-Management-Plan</u>
- 1 extension publication
  - The Iowa Pest Resistance Management Plan: A community-based approach to address pest resistance in Iowa. Proceedings of the 29<sup>th</sup> Annual Integrated Crop Management Conference. Iowa State University, Ames, IA. November 29-30, 2017. https://pdfs.semanticscholar.org/ba7a/5ccdf2c6888d2240dc9711e8 13832f55a682.pdf
- 17 articles
  - Iowa Pest Resistance Management Plan Unveiled. ISU IPM website. January 30, 2017. <u>https://www.ipm.iastate.edu/iowa-pest-resistance-management-plan-unveiled</u>
  - Iowa Pest Resistance Management Plan Unveiled. ISU CALS. January 30, 2017. http://www.cals.iastate.edu/news/releases/iowa-pest-resistance-

management-plan-unveiled

 Iowa Pest Resistance Management Plan Unveiled. Iowa Department of Agriculture and Land Stewardship. January 30, 2017.

http://www.iowaagriculture.gov/press/2017press/press01302017b. asp

- Iowa Pest Resistance Management Plan Unveiled. Brownfield Ag News for America. January 30, 2017.
- Iowa Pest Resistance Management Plan Unveiled. The Land. January 30, 2017.
   <u>http://www.thelandonline.com/news/nuts\_bolts/iowa-pest-resistance-management-plan-unveiled/article\_ab0b8002-e724-11e6-ac9a-5baee073c8cd.html</u>
- Iowa Pest Resistance Management Plan Unveiled. PrecisionAgWired.com January 31, 2017. <u>http://precision.agwired.com/2017/01/31/iowa-pest-resistance-management-plan-unveiled/</u>
- Iowa Pest Resistance Management Plan Unveiled. February 1, 2017. Spencer Daily Reporter. http://www.spencerdailyreporter.com/story/2382446.html

- Iowa Pest Resistance Management Plan Unveiled. February 2, 2017. Iowa Soybean Weekly. http://www.iasoybeans.com/egldstnd/article.php?newsletter\_id=42
   7&article\_id=3833&\_cldee=Ym1leWVyQGlhc3RhdGUuZWR1&recipientid=contact-b8b071f63c5de3118f666c3be5a8ea94-2df7de8d6c1942058b9d625b4f436032&esid=25ff21d2-86e9-e611-80fc-5065f38be0c1&urlid=9
- Iowa unveils wide-ranging effort to slow pest resistance. February 6, 2017. Iowa Farm Bureau Federation. <u>https://www.iowafarmbureau.com/Article/Iowa-unveils-</u> <u>wideranging-effort-to-slow-pest-resistance</u>
- Iowa Pest Resistance Management Plan Unveiled. Tama News Herald The Toledo Chronicle. February 7, 2017. <u>http://www.tamatoledonews.com/page/content.detail/id/603550/Io</u> <u>wa-pest-resistance-management-plan-unveiled.html?nav=5006</u>
- Iowa Pest Resistance Management Plan Unveiled. February 8, 2017. Wallaces Farmer.
   <u>http://www.wallacesfarmer.com/weeds/iowa-pest-resistance-management-plan-unveiled</u>
- Iowa State University Hires Program Manager to Strengthen Statewide Pest Resistance Management Efforts. ISU IPM. August 1, 2017.

https://www.ipm.iastate.edu/iowa-state-university-hires-programmanager-strengthen-statewide-pest-resistance-management-efforts

- Iowa Pest Resistance Management Plan includes a pilot project in Harrison County. Missouri Valley Times. July 26, 2017.
- EPA Releases Guidance on Slowing Pest Resistance. November 14, 2017.

https://www.ipm.iastate.edu/epa-releases-guidance-slowing-pestresistance

- January 5, 2018. Farm News. Iowa Pest Resistance Management Plan
- Harrison County Project to Combat Weeds Resistant to Herbicides. February 13, 2018. https://www.cals.iastate.edu/news/releases/harrison-county-

project-combat-weeds-resistant-herbicides

- Iowa State University leads Harrison County Project to Combat Weeds Resistant to Herbicides. Missouri Valley Times. March 13, 2018.
- 3 videos
  - IPRMP Launch. IDALS Facebook page. January 30, 2017. <u>https://www.facebook.com/Iowadeptofag/videos/14527367180929</u> <u>14/</u>

Iowa-Specific Pest Resistant Plan Unveiled. KCRG. February 1, 2017.

http://www.kcrg.com/content/news/Iowa-Specific-Pest-Resistant-Plan-Unveiled-412400883.html

- Commercial Pesticide Applicator Training Continuing Instruction Course. 2017. <u>https://vimeo.com/240061440/e0e5e501a9</u>
- 2 radio interviews
  - Iowa Pest Resistance Management Plan Unveiled. January 31, 2017. WHO Radio. <u>http://whoradio.iheart.com/onair/the-big-show-4636/iowa-pest-resistance-management-plan-unveiled-15518188/</u>
  - KICD FM 107.7 Spencer, IA. February 14, 2017. <u>http://cd1077fm.com/.</u>
- 2 handouts
  - 2017 IPRMP summary handout
  - 2018 IFBF young farmer handout
- 1 website
  - Protectiowacrops.org
- Outreach and communication efforts from March 2018 through September 2018 included:
  - 4 presentations
    - Iowa Pest Resistance Management Program Update for Iowa Farm Bureau Federation. (Recorded). (Evan Sivesind). Ames, IA. July 30, 2018.
    - EPA Tour. Logan, IA. (Larry Buss). August 2, 2018
    - Iowa Farm Bureau Federation Field Crops Advisory Committee. Ames, IA. (Steve Bradbury). August 7, 2018.
    - Pre-Harvest Crop Fair. Dunlap, IA. (Larry Buss). September 18, 2018
  - 7 articles
    - Iowa State University leads Harrison County project to combat weeds resistant to herbicides. Missouri Valley Times News. April 29, 2018. <u>http://www.enterprisepub.com/movalley/news/iowastate-university-leads-harrison-county-project-to-combatweeds/article\_e3ce0aec-4969-11e8-8e1d-e7afcc51a6ce.html
      </u>
    - Weed Management Field Day to be Held in Harrison County June 18. Iowa State University Integrated Pest Management. June 7, 2018. <u>https://www.ipm.iastate.edu/weed-management-field-daybe-held-harrison-county-june-18</u>

- Weeds Are Winning the War against Herbicide Resistance. (IPRMP mention). Scientific American. June 18, 2018. <u>https://www.scientificamerican.com/article/weeds-are-winning-the-war-against-herbicide-resistance1/</u>
- Weed Management Field Day to be Held in Harrison County July 13. Iowa State University Integrated Pest Management. June 20, 2018. <u>https://www.ipm.iastate.edu/weed-management-field-daybe-held-harrison-county-july-13</u>
- ISU offers July crop clinics, field days. Wallaces Farmer. July 11, 2018. <u>https://www.wallacesfarmer.com/crops/isu-offers-july-cropclinics-field-days</u>
- Events in Harrison County Highlight Pest Resistance Management Efforts. Iowa State University Integrated Pest Management. August 30, 2018. <u>https://www.ipm.iastate.edu/events-harrisoncounty-highlight-pest-resistance-management-efforts</u>
- Iowa Corn Roots. Tackling Pest Resistance in Iowa. pg 12-14. September, 2018. <u>https://issuu.com/iowacorn10/docs/final\_roots\_magazine\_b7637fe\_1904dc3/12</u>
- 1 video
  - Harrison County Herbicide Resistance Project 2018 Field Day. Published September 11, 2018. <u>https://www.youtube.com/watch?v=ydTzOFrZREY&t=7s</u>
- 3 field days
  - Harrison County Corn field day June 18, 2018
  - Harrison County Soybean field day July 9, 2018
  - Harrison County Project presentation to EPA/USDA Herbicide Crop Tour
- 3 handouts
  - 2018 Harrison Field Day ad
  - 2018 Herbicide Results Handout
  - 2018 IPRMP Harrison flyer
- Outreach and communication efforts from October 2018 through March 2019 include:
  - 8 articles
    - Western corn rootworm Resistance to Final Bt trait confirmed. Iowa State University Integrated Pest Management. November 7, 2018. <u>https://www.ipm.iastate.edu/western-corn-rootworm-resistance-final-bt-trait-confirmed</u>

- Expect Resistance Ahead: Rootworm Resistance to Bt Pyramids is on the Rise -- With No Relief in Sight. Progressive Farmer. November 14, 2018.
   <u>https://www.dtnpf.com/agriculture/web/ag/news/article/2018/11/15</u> /rootworm-resistance-bt-pyramids-rise
- Managing pests takes team approach. Wallaces Farmer. February 20, 2019. <u>https://www.farmprogress.com/crop-protection/managing-pests-takes-</u> team-approach
- Managing pest resistance in Iowa. KMA Ag Mag. Pg 34-36. March 2019. http://online.flipbuilder.com/jrfj/mnxw/mobile/index.html
- Battling resistance takes a community effort. KMA Ag Mag. Pg 44-45. March 2019.
  - http://online.flipbuilder.com/jrfj/mnxw/mobile/index.html
- A Perspective on Weed Management: Can we Win the Battle? KMA Ag Mag. Pg 10-11. March 2019. http://online.flipbuilder.com/jrfj/mnxw/mobile/index.html
- Pests: Weeds, Insects, Fungi and Bacterial or Viral Diseases. KMA Ag Mag. Pg 41-43. March 2019. http://online.flipbuilder.com/jrfj/mnxw/mobile/index.html#p=41
- Set goals, work to achieve them. Wallaces Farmer. March 25, 2019.
   <u>https://www.farmprogress.com/master-farmers/set-goals-work-achieve-them</u>
- 5 web pages
  - Harrison County added five pages featuring the Harrison County Project to the protectiowacrops.org website. <u>https://www.ipm.iastate.edu/harrison-county-pest-resistance-management-project-overview</u>
- 1 presentation
  - Porpiglia, P, EC Sivesind, and SP Bradbury. Update on Iowa's Novel Pest Resistance Management Program. Annual Meeting of the Entomological Society of America, Vancouver, BC, November 11-14, 2018
- 1 handout (see uploaded files)
  - 2018 Harrison County Brochure-summary of activities

- Outreach and communication efforts from April 2019 through September 2019 include:
  - 2 presentations
    - Community based approach to pest resistance management: Overview of pest management strategy. ISU Extension ANR Spring Training. Mike Witt, Carter Oliver, Steve Bradbury, Paul Lasley. April 5, 2019.
    - Exploring a Voluntary Community Response to Pest Resistance Management. Paul Lasley. WSSA/ESA 2019 Science Policy Experience. August 7, 2019.
  - 2 Field days
    - Harrison County Field Day, July 9, 2019
    - WSSA/ESA Science Policy Experience hosted in Harrison County and Ankeny, IA, August 6 – 7, 2019
  - 4 handouts
    - 2019 Harrison Field Day ad flyer
    - 2019 Harrison County Brochure
    - 2019 IPRMP ad
    - 2019 Field Day Plot Summary Sheet
  - 1 radio interview
    - KTIC out of Nebraska, July 9, 2019.
  - 7 articles
    - Harrison County Project Finds Local Weeds Resist Common Herbicides. CALS website. June 17, 2019. <u>https://www.cals.iastate.edu/news/releases/harrison-county-project-finds-local-weeds-resist-common-herbicides</u>
    - Harrison County Pest Resistance Management Field Day Scheduled July 9. CALS website. June 20, 2019. <u>https://www.cals.iastate.edu/news/releases/harrison-county-pest-resistance-management-field-day-scheduled-july-9</u>
    - It takes a community to manage pest resistance. Wallaces Farmer. June 26, 2019
       <u>https://www.farmprogress.com/weeds/it-takes-community-manage-pest-resistance</u>
    - 2019 Science Policy Experience brings National Spotlight to Successful Harrison County Pest Resistance Management Project. ISU IPM website. September 5, 2019. https://www.ipm.iastate.edu/2019-science-policy-experience-

brings-national-spotlight-successful-harrison-county-pestresistance

- Science Policy Experience: Changing Our Dialogue on Resistance Management. Entomological Society of America newsletter, September 2019 issue.
   <u>https://www.magnetmail.net/actions/email\_web\_version.cfm?ep=s</u> <u>AmMIygfd6U2DTzmuegnmTHa92YwwQDyt5qjPk99fyyFun\_Hl2</u> <u>HWUVirXXZj\_kh56TQ-</u> <u>SdrpoIwD5NW40Mp8TX0ua3N9zKSo3Ltx-</u> MstUs4Nhyd1uDCEcL3umZxBT\_vW
- What a Community in the Heartland Can Teach Us About Resistance Management. Entomology Today. September 18, 2019. <u>https://entomologytoday.org/2019/09/18/what-a-community-in-the-heartland-can-teach-us-about-resistance-management/</u>
- Upcoming: Wallaces Farmer article from Paul Lasley and Rod Swoboda. TBD.
- Video footage
  - Captured footage, presentations, interviews during Harrison Field Day and Science Policy Experience events; video compilation in progress

## **IPRMP:** Next Steps

While the three-year funding from ISA is now complete, the IPRMP staff and community leaders will continue to meet with stakeholders to help build and implement project teams around the four pilot projects in the IPRMP. Outreach efforts will continue to expand visibility of the IPRMP and pilot efforts. The program will continue to seek external funding for program and pilot projects. Communication efforts will be distributed locally and statewide, and will publicize progress made by pilot projects. The IPRMP website, www.ProtectIowaCrop.org, will continue to be updated and expanded with informational resources, updates, and communication pieces regarding program progress. Annual meetings of the IPRMP partners will continue to foster communication of issues, update progress and identify areas for collaboration.

A major finding of this project indicates socio-economic factors are fundamental to understanding how and why some community-based groups readily form (e.g., Harrison County), while others are more difficult. Moving forward, and in consultation with ISA, ICGA, IFBF, and other IPRMP partners, over the next three years the IPRMP will assess socioeconomic factors that influence the formation of community-based pest resistance management, through a recently awarded USDA grant, titled *Assessment of the Socio-Economic Factors Impacting Adoption of Voluntary Pest Resistance Management by Rural Communities.* The grant, which is an integrated research/extension project, will continue to focus on the four pilot projects in the IPRMP. The grant co-principal investigators include Dr. Paul Lasley, Sociology and Extension, ISU; Dr. Alejandro Plastina, Economics and Extension, ISU; Dr. John Miranowski, Economics, ISU; Dr. Alicia Rosburg, Economics, UNI, and Dr. Steven Bradbury, Entomology and Extension, ISU.

A synopsis of the projected milestones for July 2019 – June 2022 in the grant are summarized below. Meetings and dialogue with IPRMP partners organizations will be integrated within the grant's activities. As interim findings are gained through the grant's efforts they will be shared with IPRMP partners, including updates at the annual IPRMP meeting.

Year	Milestones for Objective 1 (Research) and Objective 2 (Extension)
2019	Assess existing levels of social capital (both bonding and bridging capital) within each county (Obi 1a)
	Conduct focus groups and workshops to identify leaders, establish networks, and begin
	formulation of project plans (Obi 1a)
	Develop enterprise budgets and identify scenarios for Harrison County (Obi 1b. 1c)
	• Since there is an existing working group of stakeholders in Harrison County, it is a logical choice for our "first run" at gathering the necessary information from stakeholders to develop enterprise budgets and identify scenarios. Our experiences from Harrison County can be used to adjust our information-gathering process (e.g., questions asked, stakeholders to include, etc.) in the other three pilot locations; we expect this process to be more efficient than
	trying to tackle all four locations at once.
	Establish focus groups for the other three locations and begin gathering data to develop enterprise budgets (Obj 1b)
2020	Formalize goals and objectives for increasing adoption of resistance management
	practices suitable for the region (Obj 1a)
	Expand from planning committee project to countywide initiative and extend
	stakeholder participation (Obj 1a)
	Identify plausible scenarios for pest resistance paths under status quo and alternative PRM strategies, and develop enterprise budgets in four locations. Evaluate
	economic implications of the identified scenarios for all locations using net present
	value analysis (Obj 1b, 1c)
2021	Assess progress in forming communities; evaluate acceptance and effectiveness of community response (Obj 1a).
	Use the developed budgets and net present value results to evaluate the economic
	incentives faced by farmers to maintain status quo (Obj 1e).
	Connect information gathered from the budget analysis, focus groups, and Model for
	Community Change to evaluate cost-effectiveness of alternative interventions (Obj 1f).
	Publish four extension articles in the Ag Decision Maker website
	(https://www.extension.iastate.edu/agdm/) summarizing the findings of the case
	studies in each pilot location. The articles will include a link to our prototype
	budgets (Obj 2).
	Publish prototype budgets (spreadsheets) with an expanded section on pest resistance
	management focused on aphids, corn rootworm, and weeds (Obj 2).

	Formulate draft extension/outreach recommendations for replication of project in other
	communities; obtain feedback from Advisory Council (Obj 2).
	Disseminate draft recommendations at ISU Extension Meetings (Obj 2).
	Organize capstone training and evaluation workshop for stakeholders to share
	information, recount successes and failures, and plan for next steps to capitalize on
	momentum (Obj 2).
	A revision of The Model for Community Change extension bulletin that incorporates
	measures of community capital necessary to initiate community action to address
	pest resistance management (Obj 2).
2022	Submit articles to peer-reviewed academic journals (Obj 1 outputs). Examples:
	- Pest resistance management strategies in Midwest agriculture: an economic
	analysis. Journal of Applied Farm Economics. This article will describe the
	prototype budgets, discuss the short- vs. long-term economic incentives to
	adopt alternative pest management practices, and suggest how to adjust the
	prototype budgets to local conditions based on feedback from focus group
	participants.
	- Farmers' and agribusinesses' perspectives on pest resistance management
	strategies in U.S. Midwest agriculture. <i>Renewable Agriculture and Food</i>
	<i>Systems</i> . This article will compare perspectives about pest resistance
	management across stakeholders at different points in time, with a particular
	focus on how they converged or diverged in parallel to the progression of our
	project and their interaction through focus and working groups.
	- Limiting socio-economic factors to voluntary pest resistance management
	adoption: a community-based approach. <i>Pest Management Science</i> . This article
	will integrate the lessons from the sociological and economic components in
	our project and propose a way forward to foster a community-based approach
	to voluntary pest resistance management.
	- One academic journal article exploring the community, demographic, and
	cultural factors that account for varying levels of social capital that are viewed
	prerequisite to developing a sustainable community response.
	- One journal article will focus on measurement of social capital appropriate for
	farm dependent communities in the Corn Belt.
	- One journal article will examine levels of social capital and its relationship to
	community organizing.