Purdue Extension
2018 Annual Accomplishment Report to USDA NIFA
Impact Statements by Planned Program

The Purdue Extension and Research outcomes and impact statements are organized into these seven Planned Programs:

- Childhood Obesity
- Climate Change
- Food Safety
- Global Food Security and Hunger
- Human, Family, and Community, Health and Well-being
- Natural Resources and the Environment
- Sustainable Energy

Outcomes provide the metrics that our Educators and Specialists report across research and Extension program efforts. The impact statements shared highlight a program or project addressing the outcomes and provide narrative on the issue, what has been done, and the results. There are impact statements for research projects, for Extension programs, and for integrated research and Extension activities.

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Global Food Security and Hunger

Title
Calcium signaling in pig oocytes

Research
Zoltan Machaty, Animal Sciences

Outcome
120 - GF 1.3 - # of increased efficiencies (i.e. (% pregnant), or increases in yield/unit (bushels/acre; lbs. product (meat, protein, milk) per animal; lbs. feed per gain).

Issue
Foundational information is needed to improve the efficiency of swine oocyte activation methods especially in assisted reproductive technologies such as in vitro fertilization or somatic cell nuclear transfer. Despite its significance, the complete mechanism of the fertilization calcium signal has never been characterized--in particular, repetitive calcium signaling. Cloning by nuclear transfer of genetically modified cells is the only method on hand for making pigs with specific genetic modifications. However, our inability to properly activate the oocyte reconstructed during nuclear transfer is one of the reasons for the extreme inefficiency of nuclear transfer procedures. Because we don't know the underlying mechanism that mediates calcium signaling in fertilized oocytes we are not able to artificially induce the repetitive signals. Increasing our knowledge of how the sperm triggers the oscillatory calcium signals will enhance our abilities to more precisely control the process of signaling during embryo production in the laboratory.

What has been done
The project has focused on how to trigger repetitive calcium signaling in the oocyte's cytoplasm. Each elevation in the intracellular calcium concentration is followed by a calcium influx across the oocyte's plasma membrane. The team has been investigating the molecular identity of the components of the entry pathway to identify the molecules that are responsible for the generation of calcium entry across the plasma membrane. They have also been determining whether the calcium influx serves simply to replenish the calcium stores or whether it is also responsible for the activation of critical signaling pathways required for complete oocyte activation. Defining the mechanism and functions of calcium entry has deepened the knowledge about oocyte physiology and may also help improve the efficiency of a number of assisted reproductive technologies such as in vitro fertilization and somatic cell nuclear transfer.

Results
The team previously demonstrated that store-operated calcium entry across the egg plasma membrane is essential for normal fertilization. STIM1 was shown to be a protein located in the membrane of the intracellular stores known as the endoplasmic reticulum, and it is able to detect calcium levels in the stores. The calcium influx channels were shown to be made of Orai1 proteins. Using Fluorescence Resonance Energy Transfer (FRET) it was shown that changes occur in the eggs following sperm-egg fusion, indicating that fertilization is associated with repetitive interaction between STIM1 and Orai1. Appropriate inhibitors were applied to strengthen the notion that STIM1 and Orai1 proteins are essential to sustain the fertilization calcium signal in pig oocytes. In addition, the role of magnesium in the regulation of the calcium signal was demonstrated. A series of experiments showed that magnesium blocks calcium entry, probably by inhibiting the kinase domain of the TRPM channel, which in turn blocks store-operated calcium entry. This supports the major hypothesis that store-operated calcium entry mediated by STIM1 and Orai1 proteins is essential to sustain the sperm-induced calcium signal during fertilization in pig eggs.

Title
Interfacial Engineering for Enhanced Food Quality and Security

Research
Carlos Corvalan, Food Science

Outcome
303 - GF 2.1 - # New or improved innovations developed for food enterprises

Issue
Food dispersions, such as gels, foams and emulsions, are major components of the human and animal diet. Examples of common food dispersions are jam, beer, whipped cream, dressings, mayonnaise, butter, spreads, and margarine. Food dispersions constitute a multi-billion dollar part of the modern food industry that will benefit from advancing the understanding of the properties, dynamics and rheology of interfaces. New knowledge and innovative computational tools that result from this effort will help address some of the most critical issues regarding interfacial processes that are essential to control the creation and stabilization of structures in food dispersions. It can also have a direct impact in the area of nutrition and health because interfacial properties strongly influence the dynamics by which foods interact with the gastrointestinal tract. By expanding our fundamental knowledge of interfacial phenomena, and improving the realistic representation of important interfacial processes in computer models, it is expected that this research will help design formulation and processing strategies for the production of food dispersions with higher nutritive value manufactured with greater efficiency benefiting human health and enhancing food security.

What has been done
The project focused on foams (dispersion of bubbles), emulsions (dispersion of droplets), and suspensions (dispersion of solids), which are major components of the human diet.
1) Research efforts focused on assessing the influence of formulation on the interfacial dynamics of food dispersions in order to enhance their stability and process-ability. The team completed and published new findings on the effects of surface-active molecules (surfactants) adsorbed on the surface of foam bubbles and emulsion droplets. These studies were carried on using formulations representative of both commercial surfactant additives (e.g. sorbitan and sucrose esters) and surfactant naturally present in foods (e.g. lecithin, proteins and polysaccharides).
2) Investigations continue on the bulk and interfacial rheology of food dispersion in order to assess the extent to which rheology can be modulated to optimize food processing. In 2018 new findings were published on the rheological properties of starch suspensions.
3) Another study on the importance of structural changes during the formation of nanoparticles made from maize amylose/beta-lactoglobulin/alpha-linoleic acid was developed and published.

Results
1) Surfactant results: The findings show that surfactant properties can be modulated to extend the lifespan of micropores nucleated at fluid-fluid interfaces because surfactants render the interfaces more elastic in their response to

stresses (1 publication). Ultimately these results may enable food processors to design surfactant formulations to delay the coarsening of foams and emulsions improving their process-ability and increasing their shelf-life (1 publication).
2) Rheological results: The findings demonstrate that the swelling of starch granules is modulated by the degree of crosslinking in the starch network (1 publication). The gained knowledge enabled the formulation of an accurate mechanistic models to predict and control the swelling kinetics of starch suspensions (1 publication). The proposed model for starch swelling accounts for entropy of mixing, enthalpy of water-starch interaction and viscoelastic rheological forces.
3) The new insight into the structure of this amphipathic ternary nanoparticle is important to technologies for encapsulation of bioactive and aromatic compounds in food suspensions. Encapsulation cloaks the bioactive and aromatic compounds with a protective food-grade shell barrier that preserves them during processing, provides the ability to control their release for maximum effectiveness, and increases their solubility and bioavailability enhancing their health and nutritional value (1 book chapter).

Title
Purdue Wine Grape Team toasts to the 100th Indiana Winery and a $600 million Economic Impact

Research & Extension
Christian Butzke, Bruce Bordelon, Katie Barnett, Jill Blume

Outcome
1 - GF 2.3 - # Innovations adopted in food enterprises including production, allied services, processing, and distribution

Issue
Indiana has a vibrant and growing wine industry that contributes significantly to the economic wealth of our State and enhances the lives and livelihoods of its residents and visitors. Between 1991, when the program was established, and 2018, more than 100 new wineries opened statewide. As wine grape production has increased in Indiana, growers and vintners demand up-to-date information on new grape cultivars, sustainability and pest management, winemaking techniques and marketing strategies.

What has been done
The Purdue Wine Grape Team (PWGT) conducted research that led to the selection of grape cultivars that match Indiana's growing conditions while exhibiting improved fruit quality. Wine production practices have been improved through winery consultations and analytical services. Extension workshops have been designed to engage stakeholders across the state and deliver the latest scientific information in viticulture and enology. The PWGT teaches Wine Appreciation to 250+ students as well as the upper level classes Commercial Grape and Wine Production and Commercial Food and Beverage Fermentations. The integrated Extension campaign Try on Traminette created an Indiana signature wine by utilizing the team's winegrowing, winemaking and wine marketing expertise. In 2018, the PWGT organized the 14th Vintage Indiana wine festival in Indianapolis, which attracted more than 8,000 wine consumers, and the 27th Indy International Wine Competition. With almost 2,000 entries it is the largest scientifically organized event of its kind in the U.S. In 2018, the PWGT led the preparation of an independent Economic Impact Study of the Indiana wine industry that documented the significance of the team's efforts.

Results
According to the latest estimates, the Indiana wine industry now contributes more than $600 million annually to the State's economy. Grape and wine production continues to be the fastest growing segment of Indiana value-added agriculture and agri-tourism. The Purdue Wine Grape Team engages with the Midwestern wine industries through Extension, research, marketing and promotion activities. Through Purdue's leadership, Indiana's wine grape acreage has increased 50% in the past ten years. Annual wine production surpassed 1.5 million gallons (8 million bottles) in 2018, a 30-fold increase since the PWGT began its efforts. Indiana wine sales are growing by more than 18% every year. The PWGT provides transformational Extension and research leadership for viticulture and enology programs nationwide. Wineries are the number one agri-tourism destination in Indiana with 630,000 annual visitors who spend $94 million, while wine has emerged as a showcase for a valued-added agricultural product crafted in Indiana that sustains 3,900 jobs and $120 million in paid wages.

Title
Poultry Production Systems and Well-being: Sustainability for Tomorrow

Research
Marisa Erasmus, Animal Sciences

Outcome
5 - DISEASES 1.6 - # of projects related to preventing poultry diseases and disease management

Issue
Public and consumer interest in animal well-being continues to increase along with concerns over food safety. A major welfare concern in the commercial turkey industry is that of skeletal integrity and footpad condition, specifically footpad dermatitis (lesions or inflammation of the footpad). Litter type and stocking density (the amount of space available per animal or average body weight per unit of space) are two major factors affecting footpad health and well-being of commercial turkeys. Although stocking density is recognized as an important factor influencing turkey well-being, there is little scientific evidence to support the use of a particular stocking density. Furthermore, the type of management protocol used also has a major impact on turkey well-being. In the commercial egg industry, there is movement away from conventional cage systems to alternative housing systems such as aviaries and enriched cages. However, scientific evidence regarding the impacts of these alternative systems on production, egg quality, food safety and animal well-being is lacking. Heat stress is an important poultry health and welfare issue, resulting in major economic losses. Little information is available regarding the effects of heat stress on broiler chicken behavior and core body temperature (CBT).

What has been done
The objectives of this study were to examine changes in broiler chicken behavior and CBT as a result of heat stress. Mixed-sex broiler chickens were housed in groups of 15 in 2 littered floor pens. At 34 days, data loggers (IButtons) were surgically implanted in 10 males and 10 females to continuously record CBT. Birds were maintained under thermoneutral conditions (22.5±0.1°C) until 42 days, when cyclic heat stress (HS) was imposed. The HS cycle consisted of increasing the temperature from thermoneutral conditions to a mild HS period (26.3±0.1°C), followed by a moderate (30.1±0.1°C) and hot (34.5±0.2°C) period. Each period was maintained for 1 h. Cyclic HS was repeated daily from days 42 to 45. Overhead video cameras recorded behavior on days 39 and 40 (pre-HS) and 42 and 43 (HS). Behavior (sitting, standing, drinking, eating, preening, dustbathing, walking and out of view) was analyzed using 10-min instantaneous sampling for the 17 h light period for focal birds with iButtons (n=6 males, 5 females) and birds without iButtons (n=5 males, n=4 females). The occurrence of panting was also recorded. All procedures were carried out in accordance with the guidelines of the Purdue University Institutional Animal Care and Use Committee. Data were analyzed using the GLIMMIX and MIXED procedures (SAS 9.4).

Results
The proportion of observations in which birds preened was higher pre-Heat Stress (HS) (0.07±0.009) than during HS (0.05±0.009; P=0.01) and was higher for females (0.07±0.009) than males (0.05±0.009, P=0.048). Males (0.76±0.02) sat more than females (0.70±0.02, P=0.03) and birds with iButtons sat less than birds without iButtons (0.76±0.02 vs. 0.70±0.02, P=0.02). The proportion of observations that birds were out of view differed between pre-HS and HS periods (0.017±0.008 vs. 0.05±0.008, P=0.008), males and females (0.02±0.009 vs. 0.05±0.008, P=0.01), and birds with and without iButtons (0.05±0.007 vs. 0.02±0.009, P=0.03). Core body temperature (CBT) differed among HS periods, males and females, behavioral categories and when birds were panting vs. not. CBT increased with increasing ambient temperature (thermoneutral: 41.33± 0.05 degrees C, mild: 41.92±0.08 degrees C, moderate: 42.46±0.08 degrees C, hot: 43.22±0.08 degrees C; P<0.001). Female CBT was higher than male CBT (42.53±0.06 vs. 42.17±0.06, P<0.0001). CBT was higher when birds were out of view, which typically occurred when birds were under the drinker (42.62±0.06 degrees C, P<0.001) than when birds were preening (42.35±0.06 degrees C), sitting (42.38±0.03 degrees C) and standing (42.28±0.06 degrees C). CBT was also higher when birds were panting (42.44±0.06 degrees C) than when birds were not panting (42.26±0.06 degrees C, P<0.0001). HS significantly affected broiler chicken behavior, with birds spending less

time preening during HS. CBT differed depending on the behavior birds were performing. Further research is needed to identify early changes in behavior associated with increasing ambient temperature and CBT

Title
Neonicotinoid seed treatments in Bt maize: balancing contributions to insect resistance management with impacts on soil health

Research
Christian Krupke, Entomology

Outcome
5 - Data 2.1 - # of discoveries, innovations, technologies and technology transfer related to improving data, data reconciliation, improving insights, enhancing data collaboration

Issue
The European corn borer (ECB) (Ostrinia nubilalis) and western corn rootworm (WCR) (Diabrotica virgifera virgifera) account for over $1 billion each in control costs and grain losses annually. Research conducted by this multi-state committee was used to develop models predicting the rates of resistance evolution and efficacy of refuge in preventing resistance. This led to the Integrated Pest Management (IPM) approach that used a 20% independent refuge planting; however, as genetically modified (GM) technology has evolved, so has IPM. Recently deployed GM corn hybrids use multiple genes that target ECB and WCR. The IPM plan for these hybrids requires a smaller refuge, and seed mixtures (Bt and non-BT) are now being deployed. The models supporting these IRM modifications were constructed using the best information available, but a number of assumptions had to be made. These assumptions must be tested and research conducted to move them from assumptions to quantified variables. Furthermore, information is needed on the economics of this evolving technology at the field, farm, and regional levels. Addressing these knowledge gaps forms the basis for several objectives of the project. The long-term goal of our research is to develop sustainable ways to manage the corn insect pest complex.

What has been done
The relationship between pest management technologies and the agricultural environment was investigated. The committee worked on 3 objectives. First, they assessed the need, efficacy and pest management window of seed treatment insecticides, primarily neonicotinoids, to control secondary below-ground insect pests. They evaluated the possible effects of insecticidal seed coatings on non-target beneficial insects.
Second, they investigated the ecology, biology, evolution, genetics, and behavior of corn arthropods. In 2018, they characterized the dispersal of adult WCR and lepidopteran pests, and assessed its implications for integrated pest management (IPM) and for resistance development, spread, and mitigation.
Third, they employed diverse delivery methods to disseminate information related to sustainable management of corn arthropod pests. 1) Establish an NC-205 video library website with permanent high quality versions of IPM videos for open online access and download to computer and portable electronic devices. 2) Produce and deploy a comprehensive IPM system for cost-effective prevention, early detection, rapid diagnosis, and mitigation of new and emerging corn pests that links all stakeholders who have common interests in pest detection and management. 3) Develop an array of IPM and IRM distance education workshops.

Results
First, they found that neonicotinoids that were applied to corn are consistently found in nearby waterways and this has implications for the aquatic organisms that live there, including unintended mortality. A publication in the Journal of Applied Ecology, demonstrated that dusts originating from seed treatments applied to corn seeds move over a wide proportion of the environment, covering most of the state of Indiana. This means that non-target exposure of honey bees and other pollinators is likely and in some cases lethal. Second, another publication demonstrated that WCR in refuge/Bt environments tend to mate close to where they feed and that the current levels of refuge beetles produced in fields are likely insufficient to contribute towards delaying resistance significantly. Third, a video was developed as a unique method to disseminate information. The video is meant to provide a jumping-off point for future work that

reaches out to corn producers and pest managers in educating them about how and when to prevent resistance development.

Title
Utilizing reflectance spectroscopy to assess plant responses to biotic and abiotic stress

Research
John Couture, Entomology

Outcome
11 - GF 2.5 - # New diagnostic systems

Issue
Reflectance spectroscopy is emerging as a promising tool with potential applications in agricultural management because it is a non-destructive, rapid, and a relatively low-cost approach to monitoring vegetation status. In vegetation, reflectance spectroscopy relies on the interaction of light with plant chemical and structural composition and water content. Reflection of light in the visible (400-700 nm), near-infrared (NIR, 700-1100), and short-wave infrared (SWIR, 1100-2400 nm) can provide a comprehensive assessment of both shifts in visual symptoms (e.g., pigments, leaf color) and the underlying biochemical (e.g., nutrient composition, secondary metabolism) and physiological (e.g., photosynthetic activity, water relations) responses to disease or stress. Spectroscopy can also aid in the retrieval of plant traits, and has been utilized to predict a wide range of plant biochemical constituents and physiological processes based on the optical properties of foliage, including concentrations of nutrients and secondary metabolites and leaf structural and morphological composition and plant physiological status or specific physiological processes. To date, the applications of spectroscopy in agriculture have largely focused on disease detection through classification strategies, development of narrow- or broad-band disease indices, or relating vegetation indices sensitive to plant stress with plant disease status. Hyperspectral data is also utilized for classification of plant varieties and genotypes. Less is known about the ability of hyperspectral data to classify differences in plant stress responses between stressors that produces similar physiological effects, an emergent outcome of the proposed research. The use of hyperspectral data to detect specific biochemical and physiological responses to disease in crop systems is less explored and represents a promising and novel approach for not only the classification of disease status via spectral profiles, but also non-destructively quantifying responses of plants to stress.

What has been done
The goal of this research is to evaluate the ability of hyperspectral data as a potential tool for plant management of agricultural and natural areas. Specifically, determine the ability of spectroscopy to: 1) Detect asymptomatic responses by plants to biotic and abiotic stress, i.e., before the occurrence of visual symptoms. 2) Identify specific biochemical and physiological responses by plants to biotic and abiotic stress that allow spectral information to detect stress. 3) Determine the ability of hyperspectral data to accurately classify multiple different stressors, alone and in combination. 4) Determine that ability of hyperspectral data to achieve points 1, 2, and 3 accurately across multiple plant developmental stages. 4) Evaluate the ability of field-based approaches for points 1, 2, 3, and 4 across multiple measurement scales.

Results
The following has been accomplished through the use of hyperspectral data: 1) Monitored seasonal variation in wheat nitrogen under different fertilization application rates; 2) Monitored nitrogen in wheat as a breeding tool to assess nitrogen use efficiency; 3) Tracked wheat defense responses to Hessian fly infestation; 4) Quantified specific physiological responses of maize to water stress and are working to use these data in a high-throughput, trait-based breeding approach for yield-stability under water stress; 5) Detected western corn root worm infestation in maize, with implications for the monitoring development of Bt-resistance; 6) Quantified specific physiological responses of high-value hardwood species in response to biotic and abiotic stress;
7) Quantified physiological responses of lettuce to common stressors in a protected agrosystem; and 8) Quantified the impact of different agronomic management practices on the chemical profiles of industrial hemp (THC, CBD, etc.).

Title
Elucidating the microbial mechanisms mediating plant productivity in specialty crop systems

Research
Lori Hoagland, Horticulture

Outcome
120 - GF 1.3a - # of increased efficiencies (i.e. (% pregnant), or increases in yield/unit (bushels/acre; lbs. product (meat, protein, milk) per animal; lbs. feed per gain).

Issue
Nitrogen (N) is generally the most limiting nutrient in specialty crop systems and growers apply substantial amounts of fertilizer to meet plant needs. Only 50 percent of N is utilized by most crops. The unused N leaches to the environment causing serious environmental problems. This leaching is a major contributor to the growing hypoxic zone in the Gulf of Mexico. Organic fertility amendments (i.e. compost and cover crops) have potential to help reduce N loss, though meeting crop N needs with these amendments is more challenging. The soil N cycle is largely mediated by microorganisms, and learning more about the ecology of this system and how it is impacted by alternative fertility amendments has potential to increase crop N uptake and reduce N loss.

What has been done
Soil quality (or health) is now widely regarded as essential for maintaining plant and environmental health, but the direct mechanisms mediating these beneficial relationships are less clear. Research conducted as a part of this project supports the results of previous studies demonstrating that soil quality can be improved by amending soil with organic substrates. Moreover, results demonstrate that the composition and amount of these substrates can alter the structure of soil microbial communities that interact with plants to help them withstand biotic and abiotic stress.

Results
Over the course of this project, several experiments were conducted at Purdue research stations and on-farm trials throughout the Midwest to quantify the effects of various types of fertility amendments on N cycling and crop productivity in vegetable cropping systems. Results of these studies confirm that both amendment composition and site-specific soil and environmental factors are key factors affecting the soil N cycle. In particular, amendments derived from organic sources increased microbial activity and the activity of key microbial genes steering the N cycle relative to amendments derived from inorganic sources. This indicates that application of organic amendments could reduce nutrient loss if incorporation of the amendments are timed appropriately. Microbes with genes controlling the N cycle were also more abundant in the plant rhizosphere than bulk soil, indicating that plants can play a significant role in steering the soil N cycle. Finally, in addition to affecting plant growth, nutrient availability also affected the susceptibility of plants to pathogens and insect pests, indicating that pest dynamics are intimately related to nutrient management strategies.

Title
Pesticide Applicators in Indiana Gain Knowledge and Intend to Adopt Recommended Practices of Dicamba

Extension
William Johnson, Cheri Janssen, Fred Whitford, Greg Bossaer, Joseph Ikley, John Obermeyer, David Scott, Walter Sell, Amanda Mosiman, Amy Alka, Amy Thompson, Andrew Martin, Andrew Westfall, Ashley Adair, Austin Pearson, William Horan, Bob Bruner, Brad Kohlhagen, Bryan Overstreet, Corey Roser, Courtney Schmidt, Courtney Stierwalt, Crystal Van Pelt, Curtis Campbell, Curt Emanuel, Dana Gadeken, Danielle Walker, David Osborne, Edward Farris, Elysia Rodgers, Eugene Matzat, Hans Schmitz, Jorge Benitez, James Wolff, Jeffrey Burbrink, Jeffery Hermesch, Jenna Nees, James Luzar, Jodie Thomas, John Woodmansee, Jon Charlesworth, Kamile Brawner, Karen Mitchell, Kelly Heckaman, Kenneth Eck, Kristine Medic, Krista Pullen, Kyle Weaver, Larry Temple, Lonnie Mason, Luis Santiago, Lyndsay Ploehn, Mark Carter, Mary Rodenhius, Megan Voyles, Nicholas Held, Nicole Witkowski, Ophelia Davis, Paul Marcellino, Phillip Cox, Phil Woolery, Richard Beckort, Robert Yoder, Roy Ballard, Sadie Davis, Sara Dzimianski, Sarah Hanson, Daniel Gabbard, Simon Kafari, Steven Engleking, Valerie Clingerman, Will Schakel, Julie Huetteman

Outcome
19,381 - ANR Horticulture - NIFA GF 1.4 - # of participants adopting best practices and technologies resulting in increased yield, reduced inputs, increased efficiency, increased economic return, and/or conservation of resources

Issue
Many herbicide-resistant weeds affect soybean production. Johnson (2018) estimates costs to control marestail is $20/acre, giant ragweed $30/acre, and waterhemp and Palmer Amaranth $50/acre. Many growers are reluctant to return to more intensive, tillage practices. In some situations, cover crops can help reduce over wintering weed populations, but results can be erratic. Some growers are migrating to short-term solutions strictly through utilizing new GMO seed technologies, versus adopting longer-term best management practices, which might include cover crops, pre-emergent residual herbicide applications, and utilizing a variety of herbicide mode of actions along with post emergent herbicide applications. Dicamba containing herbicides are good for managing these weeds but these herbicides have been under review by pesticide regulatory officials in Indiana and other states for damage related to chemical drift. In 2017, 2,708 dicamba drift issues had been reported to State Departments of Agriculture or Chemists Office across 25 soybean-growing states (Bradley, 2017). In Indiana the State Chemist Office conducted 257 drift investigations, compared to between 74 and 92 in the previous four years. Of the investigations, 129 (50%) were related to dicamba, as compared to just 3 to 8 dicamba investigations in the previous four years. In the fall of 2017, the Indiana Pesticide Review Board classified all pesticide products containing at least 6.5% dicamba, as Restricted Use Pesticides (RUPs) in Indiana and can only be sold to certified applicators. At the same time, the Environment Protection Agency (EPA) reached an agreement with Monsanto, BASF and DuPont on measures to further minimize the potential for drift to damage neighboring crops from the use of dicamba formulations used to control weeds in genetically modified cotton and soybeans. New requirements for the use of dicamba over the top (application to growing plants) will allow farmers to make informed choices for seed purchases for the 2018 growing season. As a result of steep increases in drift complaints across the country, the EPA and the manufacturers of dicamba products created federal label-mandated training requirements for 2018 for users of Engenia, FeXapan, or Xtendimax in 2018.

What has been done
The Office of the Indiana State Chemist and Purdue Extension delivered 193 one-hour training sessions in person and via webinar from January 1 to April 30, 2018 to users of dicamba products and other interested in the dicamba regulations. Instruction focused on practices to reduce drift and volatilization, including buffers, wind direction and speed, application timing, temperature, rain, recordkeeping, nozzles, boom height, ground speed, sprayer cleaning and spray volumes for application of dicamba products. There were 5,669 private pesticide applicators, currently certified in Indiana, who attended the training.

Results
In many of the training sessions, program evaluations were conducted. A survey was distributed at the end of the training for attendees to complete. A total of 3,898 evaluations were collected for statewide compilation. Evaluations were from 78 counties, across the 10 geographic areas and 5 districts of Indiana. Responses (n=3722) on acreage showed that half of the attendees (50%) reported having over 1,000 acres which they farm or advise.
Based on paired t-test analysis of the retrospective pretest evaluation data, gains in knowledge of the dicamba issues and practices among the attendees were statistically significant regarding dicamba application: 1) decreasing drift, 2) decreasing volatilization, 3) buffers of at least 110 feet, 4) wind direction toward sensitive crops, 5) wind speed between 3 and 10 mph, 6) rainfall forecast within 24 hours, and 7) regulatory authority of drift complaints. Responses about knowledge for all topics showed a shift from before to after. The knowledge levels of none and some decreased, and the knowledge levels of much to expert increased. At the conclusion of the training, attendees (n=3,579) showed accurate knowledge of: 1) proper boom height (98.8%), 2) causes and effects of dicamba volatilization (85.7%), and 3) locating dicamba sensitive crops (82%). Attendees indicated actions they are planning to take in 2018. The largest number of attendees indicated that they would: 1) Maintain required records (75.6%), 2) Review updated dicamba regulations (75.4%), 3) Prepare a checklist for spray day (72.4%), 4) Inventory sprayer nozzles (63.4%), and 5) Survey nearby dicamba sensitive crops (62.2%). On each of these items there were 10%-18% of responses from attendees who indicated these actions did not apply to them. Training attendees were asked about the importance of dicamba. From 3,662 attendees, 69.8% indicated that having dicamba technology available is very to extremely important. Attendees indicated how what

they learned in the training would benefit them and their operation. They found the training helpful to them. Many expressed desire to do it right, be more aware, be careful, follow the label and regulations, communicate with neighbors, and apply what they learned in their operation this year or in the future. Others expressed that it confirmed their feelings or convinced them to avoid applying dicamba. These increases in knowledge and intentions to adopt recommended practices related to dicamba among Indiana's private pesticide applicators and others in agriculture may contribute to improved safety and compliance with regulations and containing drift complaints and other issues related to dicamba use in current and future growing seasons.

Title

Indiana agricultural producers adopt practices resulting in increased return and decreased costs per acre

Extension

Alyssa Besser, Amy Alka, Andrew Martin, Andrew Westfall, Ann Kline, Ashley Adair, Austin Pearson, Beth Vansickle, William Johnson, Brad Kohlhagen, Brad Shelton, Bryan Overstreet, Bryan Young, Christopher Hurt, Corey Gerber, Courtney Stierwalt, Crystal Van Pelt, Curt Emanuel, David Osborne, Don Carlson, Edward Farris, Elysia Rodgers, Eugene Matzat, Fred Whitford, Gary Tragesser, James Camberato, James Wolff, Jason Tower, Jeff Boyer, Jeffrey Burbrink, Jeffery Hermesch, Jill Andrew-Richards, Jim Beaty, Joel Wahlman, John Hawley, John Obermeyer, John Woodmansee, Jon Charlesworth, Jonathan Ferris, Justin Curley, Kamile Brawner, Karen Mitchell, Katherine Rainey, Keith Johnson, Kelly Heckaman, Kelly Pearson, Kenneth Eck, Kristine Medic, Kyle Weaver, Larry Temple, Lenny Farlee, Lonnie Mason, Mark Carter, Mary Rodenhius, Mitchell Tuinstra, Nicholas Minton, Nicole Witkowski, Phil Woolery, Richard Beckort, Robert Nielsen, Robert Yoder, Ron Rathfon, Ronald Lemenager, Shaun Casteel, Stephen Boyer, Steven Engleking, Will Schakel, William Horan, Julie Huetteman

Outcome

17,466 - GF 1.4.a - # Of producers indicating adoption of recommended practices

Issue

There are 56,800 farming operations in Indiana. 97% of Indiana farms are family-owned. Of Indiana's roughly 23.3 million acres of land, 84% of it is farms, forests and woodland. Corn ($3.16 billion) and soybeans ($2.84 billion) account for the largest value of sales for Indiana's commodities. Successful and sustainable production requires attention to a vast array of variables, including, but not limited to, soil health, water availability and access, prevalence of weeds, insects, invasive species, and diseases, and seasonal and weather variability. The need for access to and understanding of new technologies and management is great for Indiana's producers and the future of crop production. It is prudent for Indiana to protect its resources and support productivity of the land, farms, and operations.

What has been done

Seven Purdue Agricultural Centers (PACs) Field Day events provided 35 hours of educational activities on many topics, including wildlife and woodlot management, forage and beef cow management, corn and soybeans, herbicide and weed management, putting a sprayer on the road, UAVs/drones, soil fertility economic outlook, cash rent options, integrated pest management, pollinator protection, and crops pathology. Continuing Education Units (CEUs) for Certified Crop Advisors, Continuing Certification Hours (CCHs) for Indiana Commercial Pesticide Applicators, and Private Applicator Recertification Program (PARP) credits were available. 12 external partners and 44 funders provided a total of $15,525 in support of the events. A total of 1,032 adults participated in the seven events. 437 (42% response rate) participants completed the post-survey. 34% indicated they currently farm/advise over 1,000 acres, 24% farm 101 to 500 acres, 17% don't farm, 13% farm 501 to 1,000 acres, and 10% farm 100 acres or less. Respondents live in 63 of Indiana's counties, and 9 from out of state. Largest numbers were from these counties with 10 or more each: Randolph, LaPorte, Tippecanoe, Porter, St. Joseph, Ripley, Whitley, Wayne, Huntington, Jay, Jasper, Jennings, Kosciusko, Jefferson, Pulaski, and White.

Results

Participants found Field Day useful, with 75% indicating it was extremely or very useful. Participants indicated they would apply information to their farm/operation. Most common included: 1) drones/UAVs, 2) equipment, 3) weed management, 4) diseases, 5) pesticides, and 6) insects. A few comments of information participants planned to apply to

their operation included: the different uses of UAVs and the possible future use of them, doing a better job of taking care of equipment, water hemp control options, difference between sudden death syndrome and brown stem rot, and being more careful of over spray to protect bee population.
There were 35% (n=73) of returning respondents who indicated they had adopted a new, recommended practice for their farm/operation since last year's event. Most frequently reported practices that were adopted included: 1) using sulfur on beans, 2) pesticide application, 3) no till / cover crops, 4) scouting, and 5) seeds. Some 19% (n=39) indicated their operation's financial position since last year's event had improved. Improvements were: 1) 46% (n=21) had increased dollar return per acre due to adopted recommended practices, and 2) 50% (n=24) had reduced costs per acre due to adopted recommended practices. Field Days, as reported by participants are useful and applicable, and by returning participants reporting adoption of new, recommended practices, can help contribute to improved productivity, yield, environmental stewardship, and financial management for farms and operations across Indiana.

Title
Purdue Extension trains applicators for safe and effective pesticide use

Extension
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Outcome
3,483 - GF 2.7 - # People trained in early detection and rapid response of plant pest, animal pests and diseases

Issue
In 2016, Indiana had 57,500 farms with 14,700,000 acres of land. (Indiana Agricultural Statistics 2016-2017, USDA, NASS). Corn was the leading source of income for Indiana farmers and amounted to $3.16 billion. Soybeans were second at $2.84 billion. Farmers and agribusiness personnel including fertilizer and chemical dealers, seed and company agronomists and crop consultants, need up-to-date information on pest populations, outbreaks, and management strategies, pesticide label changes, safety and environmental issues related to pest control, and the use and application of pesticides, for safe use of pesticides and herbicides. Appropriate application of pesticides is extremely important for our food systems, environment, health, wildlife, and water supply.

What has been done
PARP (Private Applicator Recertification Program) is a training program for private pesticide applicators who need to keep their certification current. Private applicator permits last five years. In that five years, private applicators are required to attend three recertification programs or take the pesticide or fertilizer certification exam. A private applicator may attend recertification programs hosted by Purdue Extension based in the counties across Indiana. Recertification programs are at least two hours in length and include presentations on fertilizer and/or pesticide-related topics. Each program includes an approved regulatory topic. A private applicator can attend and receive credit for a recertification program in any county, not just their home county. There are 11,784 PARP certificates managed per year in Indiana by the Purdue Pesticide Program. Purdue Extension provided 208 PARP trainings in the past year. To keep PARP certification current, 6,390 farmers attended these trainings. Regulatory and elective training topics were selected and presented to match local needs at the county. Topics included dicamba, pollinator protection, herbicides, weeds, drift watch, recordkeeping, cover crops, soil health, pests, nitrogen, plus many others. The Office of the Indiana State Chemist, charged with administering several agricultural laws involving animal feeds, fertilizers, pesticides and seeds to ensure truth-in-labeling, food safety, user safety and the protection of our environment, manages the 14,930 commercial applicator certificates in all categories. In the past year, for the agricultural pest management category there were 2,702 certified commercial applicators, and 2,158 for agricultural fertilizer application. A total of 700 training programs were approved last year for commercial applicator continuing certification hours (CCHs).Purdue Extension provided many of these trainings. While agriculture is a large part of those programs, it is not nearly the whole. Turf management, ornamental pest management, right of way, forest pest management and professional pest control all benefit from Purdue Extension (and Extension programs all over the country). Extension is not only a part of the initial training programs but plays a huge part in recertification programs. Extension Specialists in weed science, entomology, turfgrass and many others are critical to the recertification programs for commercial applicators.

Results

Application of pesticides is regulated to ensure safe and appropriate use. Those who administer pesticides, herbicides, and fertilizers, must complete training and pass tests to be certified. They obtain certification initially and then participate in ongoing training to keep current. Purdue Extension provides training opportunities throughout the year at locations across the state. Depending on the training program, participants may receive credit toward their recertification for private applicator (PARP), or commercial applicator continuing credit hours (CCHs).

Responses of the training participants reflect the variety of topics provided across Indiana. Here is a sampling of actions they plan to take as a result of the training: 1) they will be making changes to their farm practices, 2) they will adopt agronomic practices to assist in reducing cost and increasing dollar return per acre, 3) they will take precautions and safety measures recommended in the program, 4) they will likely have more group discussions with farm co-owners, and with people who rent the farm, 5) they intend to utilize herbicide mode-of-action charts to make herbicide decisions, and 6) they will monitor weed height more closely to ensure effectiveness of herbicide applications.

Participants stated the benefits they received: 1) the training helped their understanding of safety practices, 2) the program helped them understand the importance of recordkeeping, 3) they learned something new about temperature inversions, droplet size and drift, rust, grain storage insects, keeping records, and soybean cyst nematode races, 4) they increased their knowledge of management strategies for weed control, disease control, insect control, and pesticide control related to pollinators, and 5) they feel comfortable knowing how and when to plant cover crops correctly.

The availability and delivery of ongoing training provided by Purdue Extension makes it possible for individuals to keep their certification and helps Indiana to have better informed farmers and agribusiness personnel more likely to make economically and environmentally sound decisions for safe and appropriate application of pesticides.